A survey of PM$_{2.5}$ preventive behavioral intention and related factors among community elderly in Northern Taiwan

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**Abstract**

Population aging and air pollution are global concerns. The purpose of this study is to explore the relationship among particulate matter with a diameter of 2.5 μm or less (PM$_{2.5}$) knowledge, PM$_{2.5}$ preventive attitude, and PM$_{2.5}$ preventive behavioral intention in the elderly.

A cross-sectional survey design was applied in this study, including usage intention and snowball sampling. A total of 617 elderly people aged over 65 participated, and the collected data were quantitatively analyzed.

The results showed that the mean score of PM$_{2.5}$ knowledge of the elderly was 10.34 (79.53%) with the standard deviation (SD) of 3.42, the mean score of PM$_{2.5}$ preventive attitude was 4.58 (91.60%) with SD of 0.49, and the mean score of PM$_{2.5}$ preventive behavioral intention was 4.72 (94.40%) with SD of 0.40. Elderly people’s characteristics regarding PM$_{2.5}$ knowledge and PM$_{2.5}$ preventive attitude explained 22% (adjusted $R^2 = 0.22$, $F = 30.44$, $P < .001$) of the variance in PM$_{2.5}$ preventive behavioral intention.

It is concluded that we found no difference in PM$_{2.5}$ knowledge, PM$_{2.5}$ preventive attitude, or PM$_{2.5}$ preventive behavioral intention among the elderly with or without chronic diseases. In our opinion, health education regarding the threat of PM$_{2.5}$ to the health of the elderly should be strengthened, to enhance their knowledge, preventive attitude, and preventive behavioral intention of PM$_{2.5}$.

**Abbreviations:** ANOVA = analysis of variance, H1N1 = Influenza A virus subtype, PM$_{2.5}$ = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation.

**Keywords:** knowledge, particulate matter, preventive attitude, preventive behavioral intention

1. **Introduction**

Particulate matter with a diameter of 2.5 μm or less (PM$_{2.5}$) is an important compound substance causing air pollution. PM$_{2.5}$ is mainly derived from nature and human behavior, and exposure of individuals to PM$_{2.5}$ environments will cause health damage.[1] The World Population Prospects (2019) points out that the world is an aged society, and the health protection of the elderly is an important issue for countries all over the world.[2] PM$_{2.5}$ can easily cause cardiovascular diseases, lung diseases, anxiety, and other diseases in the elderly.[3–6] Exposure of patients with cardiovascular diseases to PM$_{2.5}$ environments may increase the risk of readmission to hospital and death.[7] The mortality from heart and lung diseases is higher in the elderly than in younger people.[8,9] The exposure of the elderly to the environment of PM$_{2.5}$ will reduce the telomere-mitochondrial axis length and mitochondrial deoxyribonucleic acid content and affect the health of the elderly.[10] Recent research in Taiwan found that there is a significant correlation between elderly exposure to PM$_{2.5}$ environment and frailty.[11] Therefore, the elderly are vulnerable to PM$_{2.5}$.[12] Taiwan is now an aged society, and the elderly population is mainly concentrated in the northern region.[13] The average annual concentration of PM$_{2.5}$ in northern Taiwan in 2019 was 13.8 μg/m$^3$,[14] which is higher than the World Health Organization standard of 10 μg/m$^3$.[15] Thus, it is evident that elderly living in a higher PM$_{2.5}$ concentration region for a long time are more likely to have health damage than general adults. Therefore, investigating the prevention and control factors related to PM$_{2.5}$ for elderly people in northern Taiwan is a primary task for health administration in Taiwan to maintain the health of elderly people.

Knowledge, attitude, and behavioral intention are important variables in psychological research on human health-related behaviors. Studies of the elderly have found that improving the knowledge of healthy diet and food safety in the elderly helps promote the behavior of healthy diet.[16] The higher the...
knowledge and attitude of the elderly regarding tetanus, pneumococcal, and influenza vaccination, the higher the behavior of vaccination against tetanus, pneumococcal, and influenza vaccine.[17] However, when predicting whether some health-related behaviors will be performed by human beings in the future, behavioral intention is a factor that directly predicts behavior.[18,19] Most studies took behavioral intention as a dependent variable; for example, in a study in Taiwan, elderly people were found to have a higher intention to get an influenza vaccine when their attitude toward influenza (H1N1) pandemic was of concern to them.[20] In Australia, the elderly with higher knowledge and attitude to use electronic health insoles have a stronger intention to use them.[21] It can be seen that the knowledge and attitude of the elderly affect their behavioral intention.

In a study of air pollution prevention and control, it was found that the knowledge and attitude of residents regarding air pollution prevention and control would affect their behavioral intention of air pollution prevention and control.[22] When people have more knowledge of air pollution, their attitudes and intentions to reduce car use are higher.[23] In addition, the higher the attitude of students to use masks in an air polluted environment, the higher their behavioral intention to use masks.[24] When a residential environment suffers from air pollution, residents’ attitude is to stay away from the polluted environment, meaning they intend to move away from the polluted environment, to avoid harm to their health, as caused by air pollution.[25] However, such studies found that the elderly population lacked knowledge of air pollution, as compared with other age groups,[26,27] thus, some elderly people still choose to live where the air is polluted.[28] It can be seen that different age groups have different knowledge, attitudes, and behavioral intentions toward air pollution.

To sum up, the increasing number of elderly people worldwide and the problem of air pollution are important public health issues at present. While the current research objects of air pollution are mainly young residents of the community,[29] teenagers,[30] students,[31] children,[32] and pregnant women,[33] there are few studies on the factors related to air pollution prevention and control by the elderly. Therefore, this study intends to investigate PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention in the elderly, to serve as a reference for future health maintenance policies and measures for the elderly.

1.1. Purpose

The purposes of this study are to explore (1) the relationship among PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention in the elderly and (2) the relevance of the demographic characteristics regarding PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention.

2. Methods

2.1. Design

This study applied the cross-sectional quantitative research method.

2.2. Research conceptual model

Figure 1 shows the conceptual model of this study. The relationship between elderly people’s PM2.5 knowledge, PM2.5 preventive attitudes, and their PM2.5 preventive behavioral intention will be investigated. The relevance of demographic characteristics of the elderly (ie, gender, age, education level, and chronic disease) to PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention will also be investigated.

2.3. Participants

Intention and snowball sampling were applied in this study. The samples for intention sampling were from 2 elderly learning centers in Taipei City and 2 community elderly activity centers in New Taipei City. The elderly who participated in the courses, as organized by the learning centers and the community elderly activity centers, were restricted by the organizers to those without

![Figure 1. Conceptual model of this study.](image-url)
2.6. Data collection

The researchers explained to the participants that the main purpose of this study was to investigate the relationship among PM_{2.5} knowledge, preventive attitude, and preventive behavioral intention in the elderly. Voluntary participants were required to complete the self-administered questionnaire for this study on their own and could not discuss the contents with each other. If there was any illiterate participant, the researchers would read out questions verbatim, and ask the participants to answer, but could not explain the original meanings of the questions. Upon completing the questionnaire, the participants were asked to check whether they have completed all the questions. When they hand it back to the researchers, the researchers would check the completion again; if incomplete, the participants were asked to answer the missed items. It took about 15 to 20 minutes to complete the questionnaire. This study collected 638 questionnaires from June 2019 to January 2020, of which 21 were incomplete and 617 (96.71%) were complete (204 from Taipei City and 413 from New Taipei City).

2.7. Data analysis

The IBM SPSS 22.0 statistical package was utilized to analyze all the data for this study, including frequencies, percentages, means, standard deviation (SD), Pearson correlation, regression, and one-way ANOVA.

3. Results

A total of 617 elderly people over 65 years old were enrolled in this study. The demographic background distribution results are, as follows: 421 females (68.23%) and 196 males (31.77%). The age group gap was 5 years: 305 people 65 to 69 years old (49.43%), 172 people 70 to 74 years old (27.88%), 81 people 75 to 79 years old (13.14%), 39 people 80 to 84 years old (6.32%), and 20 people ≥85 years old (3.24%). Education level is as follows: 3 people are illiterate (0.49%), 6 people are uneducated, but literate (0.97%), 88 people with elementary school education (14.26%), 114 with junior high school (18.48%), 170 with high school (vocational school) education (27.55%), and 236 with college, undergraduate, and higher education (38.25%). Chronic disease: Yes: 352 (57.05%) and No: 265 (42.95%).

3.1. Pearson correlation analysis on PM_{2.5} knowledge, PM_{2.5} preventive attitude, and PM_{2.5} preventive behavioral intention

The results of Pearson correlation analysis indicate that PM_{2.5} knowledge is positively correlated to PM_{2.5} preventive attitude, r = .404 (P < .01) and PM_{2.5} preventive behavioral intention r = .284 (P < .01). Furthermore, PM_{2.5} preventive attitude is positively correlated to PM_{2.5} preventive attitude, r = .459 (P < .01) (Table 1).

3.2. Elderly people’s mean scores for PM_{2.5} knowledge, PM_{2.5} preventive attitude, and PM_{2.5} preventive behavioral intention

The participants had an adequate sense of PM_{2.5} knowledge, with a mean score of 10.34/13 items (79.54%), SD 3.42; PM_{2.5} preventive attitude, with a mean score of 4.58/5-point scale (91.60%),...
ventive attitude, and PM2.5 preventive behavioral intention. PM2.5 knowledge 1 .404
[29x636]difference in education level (76 to 93. The ratio of
3.3. Elderly people’s characteristics and PM2.5 knowledge
Elderly people (n = 617) Mean SD
PM2.5 knowledge 10.34 (79.54%) .40
PM2.5 preventive attitude 4.58 (91.60%) .49
PM2.5 preventive behavioral intention 4.72 (94.40%) .40
PM2.5 = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation.
SD.49; and PM2.5 preventive behavioral intention, with a mean score of 4.72/(5-point scale) (94.40%), SD.40 (Table 2).
3.3. Elderly people’s characteristics and PM2.5 knowledge
The results of participants’ answers on each PM2.5 knowledge item are listed in Table 3. The mean value of each question in PM2.5 knowledge ranges from .76 to .93. The ratio of participants that gave the correct answer, incorrect answer, and “not sure” of each question are also presented in a separate columns. One-way ANOVA testing shows that participants’ PM2.5 knowledge has a significant difference in age (P < .05). Similarly, participants’ PM2.5 knowledge has a significant difference in education level (P < .001) but participants’ PM2.5 knowledge has no significant difference in gender (P > .05) or chronic diseases (P > .05) (Table 4).

Table 1
Pearson correlation analysis on PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention.

| PM2.5 knowledge | PM2.5 preventive attitude | PM2.5 preventive behavioral intention |
|-----------------|---------------------------|---------------------------------------|
| PM2.5 knowledge | 1                         | .404**                                |
| PM2.5 preventive attitude | 1                    | .284**                                |
| PM2.5 preventive behavioral intention | 1            | .459**                                |

PM2.5 = particulate matter with a diameter of 2.5 μm or less.

Table 2
Elderly people’s mean scores on PM2.5 knowledge, PM2.5 preventive attitude, and PM2.5 preventive behavioral intention.

| PM2.5 knowledge | Mean (SD) |
|-----------------|-----------|
| Elderly people  |
| PM2.5 knowledge | 10.34 (79.54%) |
| PM2.5 preventive attitude | 4.58 (91.60%) |
| PM2.5 preventive behavioral intention | 4.72 (94.40%) |

PM2.5 = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation.

Table 3
PM2.5 knowledge items distribution.

| Item | Mean | SD  | Yes | No | Not sure |
|------|------|-----|-----|----|----------|
| 1    | .76  | .43 | 69.7| 1.5| 28.8     |
| 2    | .86  | .35 | 81.0| 2.6| 16.4     |
| 3    | .93  | .25 | 88.7| 3.4| 17.2     |
| 4    | .83  | .36 | 75.5| 4.4| 20.1     |
| 5    | .84  | .37 | 78.4| .8 | 20.7     |
| 6    | .91  | .28 | 88.6| 1.6| 9.6      |
| 7    | .79  | .41 | 74.6| 4.9| 20.6     |
| 8    | .90  | .30 | 86.1| 1.1| 12.8     |
| 9    | .84  | .36 | 80.2| 3.1| 16.7     |
| 10   | .87  | .34 | 82.2| 3.2| 14.6     |
| 11   | .76  | .43 | 67.6| 1.1| 31.3     |
| 12   | .93  | .26 | 90.1| 2.1| 7.8      |
| 13   | .81  | .40 | 71.3| 2.6| 26.1     |

PM2.5 = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation.

Table 4
One-way ANOVA of elderly people’s characteristics and PM2.5 knowledge.

| PM2.5 knowledge | n | Mean | SD  | F value |
|-----------------|---|------|-----|---------|
| Elderly people  |
| Gender          | 617 |      |      |         |
| Male            | 196 | 10.32| 3.39| .13     |
| Female          | 421 | 10.40| 3.48|         |
| Age             | 617 |      |      |         |
| 65–69 yrs old   | 305 | 10.87| 2.80| .01     |
| 70–74 yrs old   | 172 | 10.18| 3.58|         |
| 75–79 yrs old   | 81  | 9.63 | 3.81|         |
| 80–84 yrs old   | 39  | 9.38 | 3.57|         |
| 85 yrs old and above | 20 | 8.45 | 4.52|         |
| Education level | 617 |      |      |         |
| Illiterate      | 3   | 4    | 2   | .01     |
| Literate        | 6   | 9.17 | 3.54|         |
| Elementary school | 88  | 9.14 | 3.86|         |
| Junior high school | 114 | 9.37 | 3.99|         |
| High school and vocational school | 170 | 10.75| 3.05|         |
| College and undergraduate and higher | 236 | 11.08| 2.87|         |
| Chronic disease | 265 | 10.57| 3.26|         |
| Yes             | 352 | 10.17| 3.53|         |
| Not sure        | 352 | 10.17| 3.53|         |

ANOVA = analysis of variance, PM2.5 = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation
* P < .05.
** P < .001.

3.4. Elderly people’s characteristics and PM2.5 preventive attitude
The results of one-way ANOVA testing show that participants’ PM2.5 preventive attitude has a significant difference in age (P < .05). On the other hand, participants’ PM2.5 preventive attitude has no significant difference in gender, education level, or chronic diseases (Table 5).

Table 5
One-way ANOVA of elderly people’s characteristics and PM2.5 preventive attitude.

| PM2.5 preventive attitude | n | Mean | SD  | F value |
|----------------------------|---|------|-----|---------|
| Elderly people  |
| Gender          | 617 |      |      |         |
| Male            | 196 | 4.54 | .49 | .00     |
| Female          | 421 | 4.59 | .49 |         |
| Age             | 617 |      |      |         |
| 65–69 yrs old   | 305 | 4.58 | .49 |         |
| 70–74 yrs old   | 172 | 4.62 | .45 |         |
| 75–79 yrs old   | 81  | 4.53 | .52 |         |
| 80–84 yrs old   | 39  | 4.45 | .48 |         |
| 85 yrs old and above | 20 | 4.54 | .62 |         |
| Education level | 617 |      |      |         |
| Illiterate      | 3   | 4.39 | 1.06|         |
| Literate        | 6   | 4.19 | .73 |         |
| Elementary school | 88  | 4.44 | .56 |         |
| Junior high school | 114 | 4.49 | .48 |         |
| High school and vocational school | 170 | 4.58 | .50 |         |
| College and undergraduate and higher | 236 | 4.68 | .41 |         |
| Chronic disease | 265 | 4.58 | .49 |         |
| Yes             | 352 | 4.57 | .48 |         |
| Not sure        | 352 | 4.57 | .48 |         |

ANOVA = analysis of variance, PM2.5 = particulate matter with a diameter of 2.5 μm or less, SD = standard deviation
* P < .05.
3.5. Elderly people’s characteristics and PM$_{2.5}$ preventive behavioral intention

The results of one-way ANOVA testing show that participants’ PM$_{2.5}$ preventive behavioral intention has a significant difference in gender ($P < .05$), in age ($P < .05$), and an education level ($P < .001$). On the contrary, participants’ PM$_{2.5}$ preventive behavioral intention has no significant difference in chronic disease (Table 6).

3.6. Elderly people’s characteristics, PM$_{2.5}$ knowledge, and PM$_{2.5}$ preventive attitude to predict PM$_{2.5}$ preventive behavioral intention

Participants’ characteristics, PM$_{2.5}$ knowledge, and PM$_{2.5}$ preventive attitude can explain 22% of the variances of our model (adjusted $R^2 = .22$, $F = 30.44$, $P < .001$) (Table 6). Table 6 shows the results of regression analysis with the variables of participants’ characteristics and education level ($B = .03$, $t = 2.31$, $P < .05$), PM$_{2.5}$ knowledge ($B = .01$, $t = 2.74$, $P < .01$), and PM$_{2.5}$ preventive attitude ($B = .32$, $t = 10.14$, $P < .001$). The results reveal that PM$_{2.5}$ knowledge and PM$_{2.5}$ preventive attitude combined have the strongest impact on participants’ PM$_{2.5}$ preventive behavioral intention (Table 7). Moreover, the education level of participants has the second-highest impact on PM$_{2.5}$ preventive behavioral intention (Table 7). Although gender and age showed confounding effects on PM$_{2.5}$ knowledge (Table 4), PM$_{2.5}$ prevention attitude (Table 5), and PM$_{2.5}$ prevention intention (Table 6). These 2 variables did not show significance on PM$_{2.5}$ prevention intention in Table 7 but were kept in the model as control variables and list them in Table 7.

4. Discussion

Recent studies on air pollution have found that PM$_{2.5}$ is an important substance causing air pollution, which may affect

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Table 6
One-way ANOVA of elderly people’s characteristics and PM$_{2.5}$ preventive behavioral intention.

| Elderly people’s characteristics (n=617) | PM$_{2.5}$ preventive behavioral intention | F value |
|----------------------------------------|------------------------------------------|---------|
| Gender                                 | n Mean SD                                |         |
| Male                                   | 196 4.69 .43                             |         |
| Female                                 | 421 4.73 .38                             |         |
| Age                                    | 6.03*                                    |         |
| 65–69 yrs old                         | 305 4.72 .38                             |         |
| 70–74 yrs old                         | 172 4.72 .35                             |         |
| 75–79 yrs old                         | 81 4.71 .46                              |         |
| 80–84 yrs old                         | 39 4.64 .55                              |         |
| 85 yrs old and above                  | 20 4.76 .42                              |         |
| Education level                       | 5.23***                                  |         |
| Illiterate                             | 3 4.20 .72                               |         |
| Illiteracy Uneducated                  | 6 4.10 .92                               |         |
| Elementary school                     | 88 4.68 .50                              |         |
| Junior high school                    | 114 4.62 .51                             |         |
| High school and vocational school     | 170 4.74 .31                             |         |
| College and undergraduate and higher  | 236 4.78 .28                             |         |
| Chronic disease                       | 3.56                                     |         |
| No                                     | 265 4.71 .36                             |         |
| Yes                                    | 352 4.72 .42                             |         |

ANOVA = analysis of variance, PM$_{2.5}$ = particulate matter with a diameter of 2.5µm or less, SD = standard deviation.

* $P < .05$

** $P < .01$

*** $P < .001$

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Table 7
Regression analysis on elderly people’s characteristics, PM$_{2.5}$ knowledge, and PM$_{2.5}$ prevention attitude to predict PM$_{2.5}$ prevention intention.

| Variables                      | Unstandardized coefficients | Standardized coefficients |
|--------------------------------|-----------------------------|---------------------------|
|                                | $B$ estimates | SE | Beta distribution | T values | Adjusted $R^2$ | F values |
| Constant                      | 2.93          | .14 | .32             | 20.33    | .22          | 30.44*** |
| Gender                        | -.03          | .03 | -.03            | -.96     |             |          |
| Age                           | .01           | .01 | .04             | .94      |             |          |
| Education level               | .03           | .01 | .09             | 2.31*    |             |          |
| Chronic disease               | .02           | .03 | .02             | .63      |             |          |
| PM$_{2.5}$ knowledge          | .01           | .01 | .11             | 2.74**   |             |          |
| PM$_{2.5}$ prevention attitude| .32           | .03 | .40             | 10.14*** |             |          |

PM$_{2.5}$ = particulate matter with a diameter of 2.5µm or less.

* $P < .05$

** $P < .01$

*** $P < .001$. 

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people’s health and even cause diseases; therefore, relevant research began to explore the relevant factors of PM$_{2.5}$ prevention and control to maintain health. Our study results show that regarding the demographic characteristics of the elderly, PM$_{2.5}$ knowledge and PM$_{2.5}$ preventive attitude explained 22% of the variances of PM$_{2.5}$ preventive behavioral intention. Elderly people’s PM$_{2.5}$ knowledge has a significant positive impact on their PM$_{2.5}$ preventive behavioral intention, and elderly people’s PM$_{2.5}$ preventive attitude has a significant positive impact on their PM$_{2.5}$ preventive behavioral intention (Table 7). Literature has pointed out that people’s knowledge of air pollution and air pollution preventive attitude would affect their behavioral intention to prevent and control air pollution.\textsuperscript{[28]} Our results are consistent with previous studies. In addition, we found that the elderly’s education level has a significant positive impact on their PM$_{2.5}$ preventive behavioral intention (Table 7). Those with higher education level are more willing to reduce the generation of PM$_{2.5}$ (intention question 1: I will take public transportation to reduce exhaust emissions and energy consumption). Literature has pointed out that people with higher education level are more willing to buy electric vehicles to reduce air pollution.\textsuperscript{[35]} While our results are in line with those found in the literature. Our study found that those with higher education level are more likely to reduce the harm of PM$_{2.5}$ to health (intention question 3: When the air quality is poor, I will wear a mask to prevent inhaling dirty air). Although there is literature regarding the motivation of young people to use masks in air pollution,\textsuperscript{[22]} education level has not been mentioned.

In this study, the mean score of the PM$_{2.5}$ knowledge of the elderly is 10.34/13 items, the mean score of the PM$_{2.5}$ preventive attitude of the elderly is 4.58/6 items, and the mean score of the PM$_{2.5}$ preventive behavioral intention of the elderly is 4.72/5 items (Table 2). It can be seen that the elderly have high PM$_{2.5}$ knowledge, PM$_{2.5}$ preventive attitude, and PM$_{2.5}$ preventive behavioral intention, which may be because the elderly will increase their understanding of PM$_{2.5}$ through the relevant knowledge broadcasts of TV news media, and government organizations have provided publicity manuals regarding PM$_{2.5}$ prevention and control, to increase the public methods of PM$_{2.5}$ prevention and control. Moreover, the Taipei-Keelung metropolitan area is the major economic and industrial area in Taiwan. Despite subway and bus systems already exist, the major transportation tools are automobiles and other locomotives. Over 3 million locomotives were used as daily transportation which accounts for over one-third of the total locomotives in this country.\textsuperscript{[16]} The emission of PM$_{2.5}$ from locomotives in the northern region is 32.1 $\mu g/m^3$, which is the highest in national PM$_{2.5}$ emission among public transportation.\textsuperscript{[17]} Therefore, the elderly living in northern Taiwan can feel the emissions of automobile and locomotive exhaust and the potential impact on their physical health. In consequence, they have the behavioral intention to prevent and control PM$_{2.5}$ to avoid harm to their health.

The PM$_{2.5}$ knowledge of the elderly will be affected by age and education. We found that PM$_{2.5}$ knowledge has a significant difference in age ($P<.05$). The older the elderly, the lower their PM$_{2.5}$ knowledge (Table 4). Our results are similar to other studies.\textsuperscript{[26]} The elderly receive new information by watching TV, reading newspapers, and listening to the radio.\textsuperscript{[22]} However, with their increasing age, their sensory systems gradually degenerate,\textsuperscript{[38]} and they become unable to accept a large amount of new information, resulting in the loss of knowledge. PM$_{2.5}$ knowledge has a significant difference in education level ($P<.001$). The elderly with lower education level has lower PM$_{2.5}$ knowledge (Table 4). Our results are similar to those found in the literature.\textsuperscript{[27]} In other words, the elderly with higher education level would worry about the impact of PM$_{2.5}$ on their health and actively collect online information or use multimedia to acquire more PM$_{2.5}$ knowledge.\textsuperscript{[39,40]} Therefore, we believe that digital advocate methods should be used to improve the knowledge of PM$_{2.5}$ among the elderly.

Elderly people’s PM$_{2.5}$ preventive attitude will be affected by age and lifestyle. PM$_{2.5}$ preventive attitude has a significant difference in age ($P<.05$); the older the elderly, the more they comply with the PM$_{2.5}$ environment (Table 5). Our results are similar to those found in Kenyan literature, which showed that young people in Kenya would move away from the places where air pollution was harmful to their health, while the elderly would be forced to stay in the places where air pollution was harmful due to their poor living conditions, even though they knew that air pollution caused harm to their health.\textsuperscript{[41,42]} So, the older the elderly, the less they are able to do preventions, although they care about the damage of PM$_{2.5}$ to their health. Regarding convenience in life (attitude 2: Increasing product manufacturing and transportation to make life items easy to buy) and their original lifestyle (attitude 5: Burning joss paper for ancestor worship), the elderly living in this area would still choose to face the air pollution with a negative attitude, even if they know about it. Therefore, the attitudes of the elderly in different economic and cultural areas regarding air pollution are different.

Elderly people’s gender has a different effect on PM$_{2.5}$ preventive behavioral intention. In addition, PM$_{2.5}$ preventive behavioral intention has a significant difference in gender ($P<.05$). The PM$_{2.5}$ air pollution preventive behavioral intention of females was higher than that of males (Table 6). The long-term household work of females (intention question 2: Cooking and using detergent to produce indoor air pollution) causes increased PM$_{2.5}$ levels,\textsuperscript{[43]} and their health effects were higher than those of the male respondents.\textsuperscript{[44]} Therefore, the long-term exposure to the domestic work of females would enhance their indoor PM$_{2.5}$ preventive behavioral intention. Thus, housework women have higher PM$_{2.5}$ preventive behavioral intention.

The age and education of the elderly influence PM$_{2.5}$ preventive behavioral intention. PM$_{2.5}$ preventive behavioral intention has a significant difference in age ($P<.05$) (Table 6); the older the age group, the lower the PM$_{2.5}$ preventive behavioral intention. Relevant literature had pointed out that young people’s willingness to buy electric vehicles was higher than that of the elderly because young people have a deeper understanding of the government’s environmental policies and green consumption. Those are important factors to affect their behavior intention in their willingness to buy electric vehicles.\textsuperscript{[45]} In our study, the convenience provided by metropolitan transportation is what the elderly are concerned about in northern Taiwan. Because the older age group the elderly has less mobility in their daily life, their intention to take metropolitan transportation is low compared with the elderly in the younger age group. Preventive behavioral intention has a significant difference in education level ($P<.001$) (Table 6). Highly educated people are more likely to buy electric cars than less educated people,\textsuperscript{[35]} and such results are similar to our results. Compared to those with higher education level, the elderly with lower education level has insufficient understanding of PM$_{2.5}$ knowledge or do not know how to search relevant information, thus, they cannot have correct PM$_{2.5}$
prevalent behavioral intention. Therefore, the higher the education level of the elderly, the stronger the PM$_{2.5}$ preventive behavioral intention.

Many studies have found that PM$_{2.5}$ may cause cardiovascular diseases, respiratory diseases, and depression, while few pieces of literature mentioned elderly patients with chronic diseases and the correlation of PM$_{2.5}$ knowledge, PM$_{2.5}$ preventive attitude, and PM$_{2.5}$ preventive behavioral intention to diseases. Our results show that there is no significant difference between the elderly with chronic diseases and those without chronic diseases in terms of PM$_{2.5}$ knowledge, PM$_{2.5}$ preventive attitude, or PM$_{2.5}$ preventive behavioral intention. The reason may be that the current health education for the elderly with chronic diseases focuses on the pathogenesis of diseases and the improvement of daily living habits, such as sleep, diet, exercise, and weight loss while ignoring the adverse impact of air pollution on the health of the elderly.

4.1. Limitations

The results of this study came from a cross-sectional questionnaire survey of the elderly in communities in Taipei City and New Taipei City, Taiwan. It may not be inferred to people of all ages or elderly people in other areas with different education level. Our research results are not as inferable as the results from longitudinal studies.

5. Conclusions

PM$_{2.5}$ knowledge and PM$_{2.5}$ preventive attitude can affect PM$_{2.5}$ preventive behavioral intention. When the elderly with different education level has a different understanding of PM$_{2.5}$ knowledge, their PM$_{2.5}$ preventive behavioral intention will also be different. In addition, the elderly with different education level has different PM$_{2.5}$ preventive attitude and PM$_{2.5}$ preventive behavioral intention. Therefore, the elderly with low education level should be given different education methods, such as pictures, videos, and animations, to convert words that are difficult to understand or abstract (eg, knowledge question 1: PM$_{2.5}$ is particles with a diameter of less than 2.5 microns) into simple picture language, and the elderly can actually understand PM$_{2.5}$ knowledge. The elderly with low education level have low PM$_{2.5}$ preventive attitude, and they can improve their health through living habits (eg, attitude question 1: I think more public transportation should be used to reduce PM$_{2.5}$, and attitude question 5: I think we should worship ancestors in an environmentally friendly way) and maintain the health of others (eg, attitude question 3: I think my environmental actions have a good impact on the health of Taiwanese), to improve PM$_{2.5}$ preventive attitude for those with low education level. The elderly with low education level has low PM$_{2.5}$ preventive behavioral intention, and they can change their life behaviors to improve their health (eg, intention question 3: When the air quality is poor, I will wear a mask to prevent inhaling dirty air, and intention question 4: I will open the window to keep air circulation when the indoor air quality is poor), to improve PM$_{2.5}$ preventive behavioral intention for those with low education level. In addition, the existing health education content for the elderly focuses on maintaining good living habits and alleviating their own chronic diseases, while little attention is paid to the impact of air pollution on the health of the elderly, which results in the elderly with chronic diseases ignoring the threat of air pollution to their health. Therefore, in the future, health education for the elderly should be promoted in terms of PM$_{2.5}$ knowledge, preventive attitude, and preventive behavioral intention, to improve the health of the elderly.

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