

## The Impact of Air Pollution on Dementia and Preventive Measures: Two Focus Groups Study in China

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### Abstract

**Background:** Despite research identifying a possible association between air pollution exposure and dementia risk, no study has investigated the perceptions, knowledge, attitude, and experiences of the caregivers of people with dementia on this topic. This article presents a qualitative study to identify these from the dementia caregivers, and also perceptions on measures to reduce the impact of air pollution on dementia from the healthcare professionals in china.

**Methods:** Focus group design was used. Two focus groups were conducted with two semi-structured guides: It includes one with five caregivers of people with dementia and the other with six health professionals. The focus groups were audio recorded, transcribed. Each transcript was analyzed using thematic analysis where codes were generated and assigned by two researchers independently. Similar codes were then grouped and categorized into themes.

**Results:** While some participants thought that pollution may be associated with the risk of developing dementia, they felt the need to discuss the dementia diagnosis process, which indirectly reflected the lack of knowledge on dementia prevention among the general population in China. Most participants considered that the association between air pollution and dementia was indirect. Caregivers of people with dementia appeared to have limited knowledge on dementia prevention. Health professionals identified several modifiable preventive measures to mitigate the impact of pollution on dementia but identified several challenges of sharing this knowledge with the public and eventually changing people's behaviors.

**Conclusion:** Low awareness of dementia and high stigma around dementia must be overcome to help preventive measures against air pollution and dementia in China. Strengthening policy formulation and global cooperation is an important measure to tackle air pollution and its impact on dementia.

**Keywords:** Particulate matters; Dementia; Pollution; DNA

### Introduction

Previous studies have shown that exposure to air pollution increases the risk of cardiovascular diseases and cognitive impairment in older people [1,2]. More recently, there have been a growing number of studies examining the association between air pollution and dementia incidence, with increasing evidence of a positive association [3-7]. Air pollution has multiple biological effects including inflammation, oxidative stress, DNA damage, chromosome damage and DNA methylation, which may underlie the association. There is also increasing evidence from animal studies on inhalation of Particulate Matters (PM), a common pollutant from motorized vehicles and industry, impacting on common marks of dementia such as Amyloid Beta protein (A $\beta$ ) peptides, disruption of the blood-brain barrier, and

microglial activation [8,9]. As such, the Lancet Commission 2020 added air pollution to the list of modifiable risk factors for dementia [10].

In order to develop policies and good practice around improving air quality and reducing exposure to air pollution to reduce its impact on dementia risk, it is essential to understand the knowledge, perception, attitude and experiences of the public, especially healthcare professionals and caregivers of people with dementia. According to the Health Belief Model, the likelihood of taking actions depends upon perceived barriers, perceived threat, perceived benefits, prompts to action and self-efficacy [11]. In a review summarizing the evidence on the knowledge of dementia and dementia risk reduction in the general population, Cations, et al. [12] indicated that knowledge about

the opportunity for dementia risk reduction is poor but may be improving over time. Kim, et al. [13] conducted a focus group study to investigate the knowledge, beliefs and attitudes towards dementia and dementia risk factors in the general population aged 50 years and older and found that both fear of developing dementia and the need to improve dementia knowledge are important motivators for adopting and maintaining a healthier lifestyle for dementia risk reduction. Some studies conducted in China also found that the knowledge of dementia in public was insufficient. For example, Liu, et al. [14] and colleagues conducted an online survey of 10562 participants and found that only 50.8% of the participants could know risk factors of dementia accurately, and people aged over 60 years, with low education and living in rural areas had a lower level of knowledge about dementia. In order to cope with the growing burden of dementia, the Chinese government has formulated relevant prevention and control policies, including increasing the awareness rate of dementia and knowledge of dementia prevention and building collaborative services teams [15].

To our knowledge, there was no study that has investigated the perceptions, knowledge, attitudes, and experience of the caregivers of people with dementia on the association between air pollution exposure and dementia risk. Little was also known of the healthcare professional's perceptions on preventive measures of air pollution and dementia. By understanding how individuals may understand threat of dementia we can better inform people of knowledge and preventions about dementia. To contribute to the development of dementia risk reduction programmes, we carried out two focus groups to investigate the perceptions of caregivers of older people with dementia on the association between air pollution, and healthcare professional's perceptions on measures to reduce the impact of air pollution on dementia.

## Materials and Methods

### Study design

An exploratory qualitative study was undertaken in the city of Guangzhou, China, where two focus groups were conducted: one with caregivers of people with dementia on 20th August 2020; and the other with healthcare professionals working with people with dementia on 8th September 2020. Ethical application forms detailing the study proposal, methods, sample and covering ethical considerations of privacy, confidentiality and anonymity, informed consent and invitation letter were submitted to ethics committee boards of the Faculty of Education, Health and Wellbeing, University of Wolverhampton UK and Guangzhou Medical University respectively for reviewing initially on 18<sup>th</sup> November 2019, then the revised application forms were resubmitted for reconsideration on 4<sup>th</sup> January 2020. After we obtained the ethical approval from the University of Wolverhampton (Ref321000) and the Guangzhou Medical University (Ref20200602), we started to recruit the study participants on 11th March 2020.

### Participants

Purposive sampling was used to recruit participants for the focus groups. To ensure the participants could be involved in this discussion, we required that all the participants should at least have nine years of formal study at school, and being a caregiver or family member, or health professionals of dementia care for more than three years. Initially we obtained the details of the caregivers and health

professionals of dementia through searching online. Family members of dementia were initially approached by health professionals in community health services centre to protect privacy, and their details would be passed to the researchers to make contact if the family members of dementia consented to. The researchers then approached the potential participants by telephone or wechat, a recruitment pack was also sent to them, which contained: (1) A cover letter introducing the study; (2) A letter of invitation to join this study; (3) A participant information sheet explaining the study. The potential participants were also given opportunity to have answers to any further questions they may have. If the potential participants were interested in taking part in this study, they would be asked if they were willing to be contacted by the research in two weeks later to determine when and where to conduct this focus group discussion. We totally contacted 11 caregivers, 3 family member and 14 health professionals of dementia. Finally, in the first focus group, 4 caregivers and 1 family member of dementia were recruited to explore their perceptions on any association between air pollution and dementia risk. In the second focus group, we recruited 6 health professionals including physician, public health professional, community health worker, psychiatrist, nurse, social care worker to explore their perceptions on the preventive measures against air pollution and dementia. We included social workers in the 2nd group because they provide dementia care and health management in community.

### Instruments

We used two semi-structured focus group guides, each tailored to access the perceptions of (1) caregivers and (2) healthcare professionals. The questions were developed by the investigators and piloted and revised with the agreement of all investigators as well as a psychiatrist with expertise in dementia management in the community and social work with expertise in dementia care. The caregivers guide focused on exploring their views on the association of air pollution with dementia risk, while the healthcare professionals guide focused on exploring their views on potential measures that could be used for reducing air pollution and minimize its impact on dementia. Main talking points were developed to ensure consistent information was provided to the participants if further understanding was needed to answer the questions. These included the principal investigators definition of air pollution; for example, how air pollution could cause dementia; and an example of possible preventive measures against dementia.

### Procedure and data collection

Before starting the focus group discussion, all participants provided electronically signed consent for their information to be used as part of this exploratory study, and then the moderator provided an initial overview of air pollution and dementia and asked the participants to complete a short questionnaire on demographic information, including questions on age, gender, educational level, occupation, and length of service. The moderator used open-ended questions to facilitate discussions and to provide the opportunity for participants to talk freely. Both focus groups discussions were conducted through the Tencent conference platform, which were facilitated by an experienced male moderator assisted by a trained female researcher who observed and took notes during the focus group discussions. Each focus group session lasted 40 to 60 minutes and was audio recorded with the permission of the participants for analyses.

## Data analysis

After audio recordings of the focus group discussions were transcribed verbatim, a six-stage process of thematic analysis was conducted based on Braun and Clark's [16] article. In the first instance the principal investigator and research assistant, began familiarisation with each transcript separately and then on both transcripts together through repeated readings. The transcribed data was then coded by identifying what appeared to be interesting and meaningful data to both researchers followed by a discussion and re-working for standardization. The third step was to review the codes in respect to the problem statement and research questions that guided the focus groups and to begin to integrate codes together in potential themes, the two researchers integrated the data of the two focus groups by following the following a thread approach proposed by Moran-Eills, et al. [17]; First we entailed each dataset being initially analyses to lead to emergent findings and further analytic questions; Second, we focused on identifying a promising finding within a dataset which could be pick up as a thread to be followed through into the other datasets; Third, we then created a data repertoire by juxtaposing the datasets of emergent findings, categories, and codes concerning the thread. Fourth, we synthesised the findings from a particular thread which was generated previously with other threads which were similarly picked up and followed. The fourth step was to revise these interrelationships to refine the potential themes and to work towards internal theme consistency. The fifth step in the process was to name and describe the themes. The final step was to analysis the selected extracts and writing up a report. The moderator principal investigator and the research assistant analysed the demographic questions. Consensus among all researchers was obtained through in-depth discussions so that the group unanimously agreed upon the themes.

## Results

Characteristics of the participants, Five caregivers participated in the Group 1 focus group which centered on association between air pollution and dementia, and six professionals participated in the Group 2 focus group on preventive measures against dementia and air pollution. The characteristics of the participants are presented in Table 1.

Group	Respondent	Sex	Age range	Education level
1	1	Female	61-70	Senior high school
1	2	Male	25-30	College
1	3	Female	31-40	College
1	4	Female	51-60	Senior high school
1	5	Male	41-50	Senior high school
2	6	Male	25-30	Master of public health
2	7	Male	31-40	Master of clinic medicine

2	8	Male	41-50	college
2	9	Male	41-50	Doctor
2	10	Female	41-50	Master of public health
2	11	Male	31-40	Master of clinic medicine

**Table 1:** Characteristics of the participants (N=11).

Three themes were identified from the analysis (a) linking air pollution and dementia; (b) reducing dementia risk; (c) preventive measures against air pollution. Each theme is described in the following sections.

### Linking air pollution and dementia

**Views on association between air pollution and dementia:** Most participants including caregivers and health professionals (10/11) thought that air pollution was associated with dementia, and the perception was not varied, regardless of their age, gender, and educational level. The risk of dementia is increasing with age increased, also it is associated with genetic and some unhealthy lifestyle, including obesity, smoking; it could be consequent of other diseases, like stroke, Parkinson and deaf. Therefore, air pollution may associate with dementia (C3 and H10). However, one caregiver was unsure about the association between air pollution and dementia, due to lacking related knowledge or experience: I am not sure whether air pollution is associated with dementia, from my understanding, air pollution may cause respiratory disease but not dementia (C4).

**Knowledge on association between air pollution and dementia:** Most caregivers of dementia lack knowledge on association between air pollution and dementia. Some of them perceive the association between air pollution and dementia based on their clinic health education: I did not realize that air pollution is associated with dementia until my doctor told me that air pollution may increase the risk of stroke, which is associated with dementia (C1). While some perceive this association based on their own direct experience of observing that people who have dementia live near a busy highway or main road (which is proxy of air pollution), or whose working environment suffers from air pollution: I know an older people with dementia who lives very close to main road, but she may be 90 years old (C2). Health professionals have more knowledge than caregivers on the association between air pollution and dementia, some of healthcare professionals have a more complex conception of the causes of dementia than other. In particular, their knowledge of the interrelationship between lifestyle and environmental factors appeared to be based on their experiential, academic or professional knowledge: Many factors contribute to dementia, and the relationship between these factors are complex, in clinical practice, stroke is one of the main etiologies of dementia, while previous study has suggested stroke is associated with air pollution (H6). An environmental scientist reported that in fact, smoking is common type of air pollution, which is a risk factor for dementia (H9). Despite of this, all the caregivers and health professionals thought that air pollution is not cause, or not the main and direct cause of dementia, I think air pollution may have impact on dementia risk, but its impactation may be indirectly (C5).

## Reducing dementia risk

Although there is no known cure for dementia, most participants believed that dementia is preventable, or at least the onset of dementia could be delayed through appropriate interventions. The participants perceived these preventive measures for dementia should be similar to other chronic diseases: Like other preventive measures of non-infectious chronic diseases, dementia prevention measures can also be divided into three levels (H6). Firstly, etiology prevention, which refers to reducing exposure to risk factors from genetic, environment and lifestyle. The majority of caregivers of patient with dementia know little about aetiology preventive measures of dementia: I only know dementia came about with age increase (C4), however, most health professionals reported that lifestyle factors can be modified to reduce the risk of dementia: Based on the current knowledge, some lifestyle may contribute to dementia, such as keep exercise, healthy body mass index, quit smoking, etc. (H6). Most health professionals believed that some traditional Chinese cultural practices could reduce the risk of dementia, including mahjong, tai-chi, chess: I know many older people who are not dementia but they exposure to many risk factors, including smoke, diabetes and hearing loss, I found they play mahjong or chess every day, so I think these activities may be preventive against dementia. (H11). Most participants also felt that living with younger people could reduce dementia risk: keeping young physique and mind, including take exercise, living with young, more communicate with the young could be preventive against dementia (H7).

Most participants knew that early detection of dementia is helpful in preventing the progress of dementia: we did memory test for people who are older than 65 years every year for screening dementia or cognitive impairment, people who at early stage of dementia or cognitive impairment could be intervened to delay the progress (H7). However, health professional perceived many people who screened to have dementia symptoms were not further diagnosed, which deprived them of access to health management: we managed people who have been cognitive impairment or dementia to slow down their disease progression, but these people need further tests to determine their condition before regular management was provided (H7). Caregivers felt there is more and more dementia who are looking after by health professionals: Ten years ago, family members take care of the patient with dementia at home, but more and more patients with dementia are send to dementia care center (C4).

In clinical practice, health professionals prescribe health education for the patients with dementia other than medicine, however health education is not seen as specific to dementia: 2020 report of the lancet commission has pointed that there are 11 specific potentially modifiable risk factors for dementia. However, in clinical practice, the health education prescription does not incorporate for all these risk factors, as we do not have powerful evidence, and the deep-seated causes of many risk factors may be the fundamental problems of society, which we cannot solve them (H11).

## Preventive measures against air pollution

All participants felt that air quality is associated with the health status of human beings. Some of participants reported that unhealthy socio-economic development contributed to air pollution at community, city or national levels: industrialization has led to rapid economic development, but some factories produce a lot of air pollutants (H6). Thus, to reduce against air pollution, factories that

produced air pollutants should be restricted in government level: factories that produce air pollution should be restricted regardless of their contribution to economic development (H9). Participants pointed out that some small companies or private companies need to further strengthen supervision especially in the coastal areas of the country including Guangdong: it has reported that there were some small companies in Dongguan (the city near Guangzhou) emitted air pollutants at night illegally (H9).

The second preventive measure against air pollution is to reduce car exhaust and domestic exhaust emissions. Most participants agreed that car emissions are associated with air pollution in most cities of China, although there are strict emission requirements for automobile exhaust: There are about 3 million cars in Guangzhou, which are one of the main air pollution sources. Additionally, in some rural area, coal is still used for heating and burning, which also is one of the main air pollution sources (H9). Thus, to reduce car and domestic exhaust emissions that could prevent against air pollution, measures including using more public transport, bicycle, and walk instead of private cars, and using gas for heating and burning: In some large cities, like Guangzhou and Shenzhen, in China, whether a vehicle can travel on weekdays depends on the license plate number. In some rural areas, gas is already being used to replace firewood and coal. Those measures could contribute to improving air quality (H9).

The third preventive measure against air pollution mentioned by participants was to develop new energy that produces less air pollutants: more and more new energies are replacing traditional energy to reduce air pollution, such as solar, photovoltaic, and wind energy (H9). Fourthly, increasing the self-purification capacity of the environment was also seen as an important way to prevent air pollution: increasing vegetation cover, planting more tresses are help to prevent air pollution (H9). Additionally, participants reported that to strengthen awareness of environmental protection, the government should develop more polices and advocate low-carbon travel and encourage the development of new low-polluting energy sources. Finally, a key point made in the focus groups was to strengthen global cooperation to jointly control air pollution as one participant said, All life on earth is a community of destiny, and we only have one earth, thus, to prevent against air pollution, global cooperation is very important (H6).

## Discussion

In this study of investigating caregivers of older people with dementia and healthcare professionals perceptions of the association of air pollution with dementia and perceptions of preventive measures to reduce the impact of air pollution on dementia, the findings suggested few participants were aware of uncertainties about the possibility of reducing the risk of developing dementia, because they thought dementia is a normal part of aging, rather than a disease of aging. By discussing on dementia diagnosis, the caregivers or family members of people with dementia adopted a more positive attitude towards participation in discussing around others views on the association of air pollution with dementia and preventive measures.

## Dementia diagnosis in China

Although the research aim was to evaluate the perceptions of the association of air pollution with dementia and perceptions of preventive measures of air pollution and dementia, participants discussed the topic of dementia diagnosis, intervention, and stigma in

China before they were able to discuss the topics in the guide. Participants underlined the importance of dementia diagnosis because, as Zoe has identified, dementia diagnosis is associated with peoples knowledge, attitudes and behaviours about dementia prevention. Previous studies have shown that the diagnosis of dementia is very low in china; giving the illusion that dementia is not an important health concern in China [18-20]. For dementia diagnosis and care planning, it is recognized that the optimal approach is early diagnosis giving access to assessment and dementia treatments and supports based on the dementia subtype identified. Early diagnosis also improves investigation of range of biological, lifestyle and environmental cause of dementia, comorbidities and initiates early interventions [21]. Findings in the present study suggested that there are social, economic, and political barriers to accessing diagnosis, treatment and other interventions for people living with dementia in China, which is consistent with our previous study [19]. Considering this finding, it is critical to address these barriers to obtain early dementia diagnosis.

### **Perceptions on the association between air pollution and dementia**

We found that caregiver's perceptions on the association between air pollution and dementia were mainly based on their personal direct or vicarious experiences or observations, and their knowledge of dementia risk factors was limited. Most participants thought that dementia is a part of aging rather than a disease of aging. Caregivers of people with dementia were uncertain whether air pollution is associated with dementia or thought that air pollution is not the main or direct cause of dementia, suggests they lack knowledge on dementia risk factors, especially concerning the most up-to-date knowledge. A previous study conducted in china supports this finding, indicating that the Chinese general public awareness and knowledge of risk and protective factor for dementia are insufficient. The participants in the current study also had suspicions about whether regular exercise, obesity, and depression is associated with dementia, because these factors are not specific to dementia, but being associated with a range of other diseases and conditions. Although strong and sufficient evidence for air pollution and other factors is still lacking, most studies support that air pollution can play a role in the development of dementia [22-24].

This lack of knowledge may form a barrier towards lifestyle changes for dementia risk reduction on both an individual and population level. Individuals with more knowledge about dementia might be more likely to adopt healthy behaviors. Therefore, promoting dementia awareness should especially be considered for caregivers of people with dementia since this group is at risk of dementia. And knowledge of the role of air pollution could help to modify their lifestyle or behaviors. Improved knowledge by taking precautions to avoid the worst air pollution in their home or community. Therefore, such knowledge is helpful for both caregivers as well as people with dementia themselves.

### **Preventive measures against dementia**

Health professionals in the current study perceived that dementia is preventable. According to the principle of prevention and the treatment of chronic diseases, they perceived three pathways towards reducing the prevalence of dementia. As for primary prevention, health professionals proposed some measures derived from Chinese traditional culture, which are additional to modifiable factors proposed

by previous studies [22,23]. However, most caregivers of people with dementia in the current study know little about primary preventive measure of dementia. This finding suggested that health education focused on dementia should be strengthened in the general population, especially in caregiver contexts and with family member of people with dementia, since it is helpful to form awareness of primary prevention and promote behavior change. Previous studies also suggested that caregivers or family members of people with dementia have a positive effect on their own motivation to adopt a healthy lifestyle [24-26]. Whether primary preventive measures that come from Chinese traditional culture were effective in reducing the risk of dementia needs further study, although some previous studies have suggested its effectiveness [27,28].

Early screening and diagnosis were considered as another measure to reduce the risk of dementia. However, dementia diagnosis rate is very low in China, which forms a barrier to obtaining better health management for people with dementia or mild cognitive impairment. Therefore, further studies are warranted to determine how to improve the rate of diagnosis of dementia and to provide health management service for people who are at early stage of dementia. Rehabilitation services for dementia patients to improve their quality of life are also one of the preventive measures for dementia. Currently, most of these services focused on daily caring, which are usually prescribed by health professionals. For example, a previous study indicated that passive exercise can be an efficient alternative for physical activity for patients not able to be or stay involved in active physical exercise, which could benefit patients cognitive and physical functioning and health quality of life [29].

### **Preventive measures against air pollution**

Health professionals in current study suggested that preventive measures against air pollution should target the sources of air pollution, which aim to reduce emission of air pollutant, including developing policies that restrict emissions, transfer traditional energy into new and green energy. They also suggested strengthening the self-purification capacity of the environment, including planting more trees and increasing vegetation. Additionally, because air pollution is a global problem, strengthening cooperation to tackle air pollution is also an important preventive measure. These findings suggested that health professionals in China have formed appropriate strategies for air pollution prevention and control at social and economic levels. Previous study has also suggested that air quality has been improved in recent years in China [30]. However, air quality should further be improved with innovative measures, such as developing new energy if the reduction of dementia risk is to be encouraged [31].

### **Strengths and limitations**

The strengths of this exploratory study are, firstly, new knowledge has been generated which sheds light on caregivers and healthcare professionals perceptions of the association between air pollution and dementia and perceptions of preventive measures to reduce the impact of air pollution on dementia. Findings from this study could enrich our quantitative study on the association between air pollution and dementia and could provide important information for policy makers. A second strength is that the study was conducted from a cross cultural perspective with both Chinese and Western influences shaping preventive measures of dementia and air pollution. This is a strength because both dementia and air pollution are global concerns and related

to sociocultural factors, which need develop appropriate preventive measures according to the actual situation of the locality and learn to each other.

Some limitations of this study should be acknowledged. First, all participants in the caregiver focus groups lived in the same geographical location and the majority of participants were male, which may affect the representativeness of the research subjects. The group was also small and only one caregiver group was convened so that a diverse range of different caregiver conceptualizations may not have been accessed. Although qualitative focus groups provide a mean to gather insights from the population of interest, such a small, homogeneous sample limits generalization of the results to larger populations of individuals. The limitation of representativeness of the sample also applies to the healthcare professional group. While the study findings provide valuable insights into caregiver and health professionals perceptions, this information is based on participants own personal observation and further work is needed to develop more robust data with large sample size. Krueger, et al. [32] recommend a minimum of three to four focus groups with an ideal focus group size of five to eight participants. The two focus groups in the current study were convened for identification of preliminary understandings of caregiver and health professional's perceptions of the association between air pollution and dementia and perceptions of preventive measures to reduce the impact of air pollution on dementia. Future studies can include further qualitative and introduce quantitative data to enrich and substantiate the findings from this study. Nevertheless, the insights gained in this study already enlighten understanding of caregiver and healthcare professional perception on the association between air pollution and identify a range of measures to reduce the impact of air pollution on dementia. Further discussion around the barriers to accessing health knowledge on dementia prevention would be useful.

## Conclusion

Both caregivers and health professionals understand the potential link between air pollution and dementia but may not see it as a direct cause and therefore this may weaken their understanding of the threat that air pollution can cause to risk of dementia. There was openness to the idea that dementia can be prevented which could lead to positive behaviors around air pollution exposure, though strategies should be mindful of cultural beliefs around traditional strategies within the community that individuals may prefer to depend upon rather than making more radical and difficult lifestyle changes. Health professionals acknowledge that health education prescription could be improved. Caregivers of older people with dementia had a good understanding of some of the key measures for reducing air pollution, though it is recognized that some of these must be done at a government level and identifying those that individual can do to modify their own risk is important to promoting healthy behaviors. However, in China there also remains low awareness of and high stigma around dementia which must be overcome for preventive measures against air pollution to be successful. From this exploratory research, we recommend a qualitative study to be conducted with an aim to gain an in depth understanding of barriers such as the stigma associated with dementia with a view to develop more informed public health knowledge to help prevent greater dementia cases and reduce the intake of air pollution.

## Declarations

### Ethics approval and consent to participate

Ethical approval was obtained from University of Wolverhampton (Ref321000) and Guangzhou Medical University (Ref20200602). Participants provided electronically signed consent prior to data collection and all personal rights were protected. All methods in the study were carried out in accordance with the Helsinki guidelines and declaration or any other relevant guidelines.

### Consent for publication

All participants provided electronically signed consent before participating in the study, which included consent to publish anonymous quotes from individual participants.

### Competing interests

The authors declare they have no competing interests.

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