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Risk perception of Chinese elderly: An urban study on adaptation to climate change

Pelin Kınay [a], Andrew P Morse[a], Karyn Morrissey [b], Mehmet Refik Yücel[d] and Philip L Staddon[c]

[a]Department of Geography and Planning, University of Liverpool, Liverpool UK; [b]Climate Economics and Risk Management, DTU Management, Technical University Denmark, Denmark; [c]Faculty of Engineering and Architecture, Karadeniz Technical University, Trabzon, Turkey; [d]School of Environment, University of Gloucestershire and Royal Agricultural University, UK

ABSTRACT

Older people are more vulnerable to climate change and with its increasing elderly population, inadequate research on the health impacts of climate change has focused on this particular population in China. This study evaluates climate change and health-related knowledge, attitudes and practices (KAP) of elderly residents in three cities Suzhou, Hefei and Xiamen. This cross-sectional study included 3466 participants. Data analysis was undertaken using descriptive methods (Chi-square test). Results showed that the elderly were most concerned about heatwaves, flooding and drought and the main perceived health risks included heatstroke and respiratory diseases. Finally, over half of the participants from Suzhou city reported that they did not receive enough government assistance in extreme events (56%). Findings from this work provide important insights for new adaptation strategies targeting the elderly population. It is recommended that the government should focus on creating awareness of the necessary adaptations the elderly will need to take to alleviate the impact of climate change on their physical health.

I. Introduction

Climate change is the biggest global health threat of the 21st century (Costello et al., 2009). The health effects will be both direct and indirect (Birat, 2021; Kinay et al., 2019). Direct effects on human health will include those linked to heat stress, flooding, drought, and increased frequency and intensity of storms, while indirectly through adverse changes in air pollution, in water security, the spread of disease vectors, food insecurity, and under-nutrition (Al-Amin et al., 2018; Watts et al., 2015). The Lancet Countdown on human health and climate change have identified that the health effects of climate change in China are gathering momentum, with rising temperatures identified as the most pressing issue (Cai et al., 2021). These changes are already noticeable in Chinese urban areas (Ren, 2015; Yan et al., 2016) in part due to the rapid urbanization of China and the creation of the urban heat island effect (Bicknell et al., 2009; Bigio, 2003; Li et al., 2018). Existing research has largely focused on cities in developed countries (Broto & Bulkeley, 2013; Emilsson & Sang, 2017).

Although the health impacts of climate change will be experienced by all segments of the population (Watts et al., 2020), there is a substantial evidence based on the fact that the impacts of climate change will have far-

reaching health implications for elderly people (people aged 60 years and older) (Filiberto et al., 2009; Lackner et al., 2019). Adaptation measures to address the health impacts of climate change are therefore particularly important (Bonyhady et al., 2010; Osman & Sevinc, 2019). However, understanding the knowledge levels and specific social and behavioral risk factors associated with climate change is crucial for the development of age-appropriate adaptation measures in the future (He et al., 2011; Xiao et al., 2016). As such, a deeper understanding of the perceptions and behaviors of the public is required to design appropriate, and population focused adaptation strategies.

To-date data on the knowledge, practices and perceptions of individuals are typically gathered through various types of cross-sectional surveys, with knowledge, attitude, and practice (KAP) surveys, also called the knowledge, attitude, behaviour and practice (KABP) survey, which is the most popular and widely used method (Green, 2001; Hausmann-Muela et al., 2003). KAP surveys are the studies of a distinctive population in order to collect information on what is known, what is felt or believed (Ojomo et al., 2015). These surveys are easy to design, and include quantifiable data. They have the potential for generalisability of small sample results to a wider population, have

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CONTACT Pelin Kınay ✉ pelin.kinay@liverpool.ac.uk 🖂 Department of Geography and Planning, University of Liverpool, United Kingdom
Reviewing editor: Siming You, University of Glasgow, UK

cross-cultural comparability, and are faster to implement (Bhattacharyya, 1997). KAP surveys can also help identify knowledge gaps, cultural beliefs, and behavioral patterns that may identify needs and problems of the target population, and barriers to help them (Pillay, 2005). Quantitative KAP surveys are well-established methods in the field of climate change (Pidgeon, 2012; Plotnikoff et al., 2004; Seroussi et al., 2019) as a means of understanding the source of individual behaviors (Karami et al., 2017; Thomas & Baptiste, 2018). The level of knowledge, practices and perceptions of the elderly towards climate change risks and how they understand the related health impacts has not been sufficiently assessed in China (Zhang et al., 2016). To address this gap, this study developed and administered a Knowledge, Attitude and Practices (KAP) survey to obtain a better understanding of the elderly residents' knowledge of climate change health impacts, their attitudes to climate change events and their protective practices in the Eastern Chinese cities of Suzhou, Hefei and Xiamen. A focus on cities is important as The Lancet Commission on Human Health and Climate Change has repeatedly identified cities as crucial in addressing climate change and its associated health impacts (Murshed & Saadat, 2018; Yang et al., 2018).

As a means of informing policy-makers and future adaptation strategies, this study focused on four research questions:

> RQ1: What is the knowledge of the elderly regarding climate change health risks? How does this differ between cities?

> RQ2: In what specific ways do the elderly think that climate change will harm their health?

> RQ3: What are the adaptive measures taken by the elderly to prevent the health risks associated with climate change?

> RQ4: What actions, if any, do these findings suggest for public health officials and local governments?

In the following sections, a brief overview of KAP (knowledge, attitudes, and practices) and its use in climate change and health research will be provided, and an outline of the design and implementation of KAP will be provided. Following the methods, the results of the study will be presented for the three cities. These results will be discussed in detail in light of previous research.

II. Approach

Research design

This study employed a descriptive, cross-sectional design with face-to-face questionnaires to assess the level of knowledge, attitudes, and practices to climate change. Cities were chosen based on the similarities and differences including the climate, local customs and socioeconomic conditions. Hefei is the provincial capital of Anhui Province, a former manufacturing city with economic transition. Heavy manufacturing causes heavy pollution in this city. Suzhou, the economic center of Jiangsu Province, ranks number one in terms of city development in China. Environmentally, this is a city surrounded by channels; people live by the water so that this may influence their perceptions regarding climate change impacts (river flooding). The relatively good social development level across three cities guarantees the citizens' awareness of their living quality. With its coastal location Xiamen is in a good position in order to measure the early impacts of climate change. There are already several signs of climate change affecting Xiamen: severe weather, increased pollution, and rising sea-levels (Lin et al., 2018).

Sampling and analysis

The survey questions were aligned with previous studies undertaken around the world on KAP (Akerlof et al., 2010; Whitmarsh, 2005) and climate change and adapted to Chinese culture for some of the demographic questions (questions related to income level were excluded as the elderly were reluctant to answer this specific question). In total 3466 elderly participants were surveyed across public areas including parks and community centers where many elderly citizens gathered for exercising, relaxing, playing board games and square dancing (Suzhou (n = 1200), Hefei (n = 1200), Xiamen (n = 1066)). However, due to the continuous precipitation in Hefei, shopping malls and nursing houses were also visited. In order to increase participation, a small notebook and pen were provided to each participant as a thank-you. The study area in each city was restricted to urban zones. For the management and statistical analysis of the data IBM SPSS (Bodzin & Fu, 2014; Field, 2013) software was used, and completed questionnaires were digitally coded using Microsoft Excel. Chi-Square test was used to analyze the data and to test the relationships between categorical variables.

To address the knowledge, attitude and practice of our sample, this study has eight separate outcome variables of interest. These include:

- "Have you heard of climate change?" (Knowledge)
- "How would you define climate change impacts?" (Knowledge)

- "Do you think climate patterns have changed in the last 20 years?" (Knowledge)
- "Which one of the below impacts you noticed changes?" (Knowledge)
- "Which of the following ways climate change threatens your health?" (Knowledge)
- "Do you think climate change threatens your health?" (Attitude)
- "Do you think your government is doing enough to inform-warn you about climate change and its health impacts?" (Attitude)
- "For each of the below health impacts what would you do to manage your health?" (Practices)
  - Heatstroke and exhaustion
  - Respiratory diseases
  - Infectious diseases
  - Injuries

Ethical considerations

There were several types of ethical issues, which had to be taken into consideration for the data collection. Collecting written consent in China from the population, in our case "the elderly", is not possible in China. Most people are happy to answer questions but not to provide any personal information. Indeed, during pilot survey studies and data collection, most of the elderly were hesitant to sign any kind of form (they often reacted uncomfortably, with the majority refusing to give any kind of personal information), yet they were still willing to answer the questions without signing the consent form. Thus, it was decided that verbal consent of the elderly would be sought. The respondents provided oral consent before taking part in the study. All the participants were informed in advance about the purposes of the research. No personal data was obtained such as name, address or phone number. The model consent form presented to the elderly is attached in the "Appendix" and was used to elicit consent to participate in the survey.

III. Results

Characteristics of the elderly

Table 1 presents the descriptive statistics for each of the three cities. Across each of the three cities, males accounted for 53% of the sample in total. Some participants were aged between 65 and 69 years old, 36% of the participants had "less than high school" education and 60% of the sample selected "other" in job categories,

with 13% selecting "engineering". Note that most respondents were retired so the job question relates to their main career before retirement.

Knowledge of climate change

With regard to knowledge of climate change across the whole sample, 73% reported that they had heard about climate change (n = 2502) (Table 2). Participants defined climate change with heatwaves (56%, n = 1933), drought (40%, n = 1350), storms (36%, n = 1244) and flooding (33%, n = 1136). The majority of respondents (86%, n = 2338) in the overall sample reported that the climate patterns changed in the last 20 years; with increases in heat (90%, n = 2271), droughts (47%, n = 1082) and storms (44%, n = 1005) identified (Table 2). Relating the impact of climate change to respondent health, 46% reported experiencing heatstroke and 33% reported respiratory problems.

Table 2 also presents descriptive statistics for the three cities. In Suzhou, 74% of the respondents noted that they heard about climate change (n = 889). When asked to define climate change, 58% of the participants in Suzhou city defined climate change with increased heatwaves, with 86% reporting that they had observed changes in climate patterns in the past few years. Heatstroke was reported as the most threatening health impact of climate change in Suzhou (50%). Sixty-five percent of the elderly in Hefei had heard about climate change (n = 768). Fifty-seven percent and 37% of the respondents defined climate change as "heatwaves" and "drought", respectively, as a defining factor of climate change. Hefei participants thought that climate patterns had changed in the last years (89%, n = 717). In Xiamen, 80% of the respondents had heard about climate change (845). Fifty-nine percent defined climate change as heatwaves and 40% chose "storms" as a defining factor of climate change. Participants in Xiamen also reported that climate patterns in the city had changed in the last years (83%, n = 757). Similar to respondents in Xiamen, Hefei participants referred to "heatstroke" (39%, n = 471) as one of the most threatening health impacts of climate change (Table 2).

Attitudes and perceptions of the elderly to the health impacts of climate change

When government assistance-related questions asked, 55% of the overall participants thought that the government was not doing enough to protect or warn them from the negative impacts of climate change on their health; however, this varied between cities.

Table 1. Demographic characteristics of the elderly respondents in Suzhou, Hefei and Xiamen cities, with variables presented as; gender, age, education and occupation

	Total n = 3466	Suzhou n = 1200	Hefei n = 1200	Xiamen n = 1066	*p value
	n (%)	n (%)	n (%)	n (%)	
Gender					p < 0 · 001
Male	1843 (53 · 2)	673 (56 · 1)	574 (47 · 8)	596 (55 · 9)	
Female	1623 (46 · 8)	527 (43 · 9)	626 (52 · 2)	470 (44 · 1)	
Age					p < 0 · 001
55–59	534 (15 · 4)	227 (18 · 9)	128 (10 · 7)	179 (16 · 7)	
60–64	753 (21 · 7)	217 (18 · 1)	294 (24 · 5)	242 (22 · 7)	
65–69	895 (25 · 8)	305 (25 · 4)	337 (28 · 1)	253 (23 · 7)	
70–74	768 (22 · 2)	288 (24 · 0)	246 (20 · 5)	234 (22 · 0)	
75 and older	516 (14 · 9)	163 (13 · 6)	195 (16 · 3)	158 (14 · 8)	
Education					p < 0 · 001
Less than high school	1030 (36 · 2)	483 (40 · 9)	233 (31 · 0)	314 (34 · 4)	
High school	566 (19 · 9)	247 (20 · 9)	124 (16 · 5)	195 (21 · 4)	
Some university	445 (15 · 7)	168 (14 · 2)	126 (16 · 8)	151 (16 · 6)	
University graduate	251 (8 · 8)	109 (9 · 2)	41 (5 · 5)	101 (11 · 1)	
Postgraduate	25 (0 · 9)	14 (1 · 2)	6 (0 · 8)	5 (0 · 5)	
No schooling	526 (18 · 5)	159 (13 · 5)	221 (29 · 4)	146 (16 · 0)	
Occupation					p < 0 · 001
Business, consulting, management	231 (9 · 6)	143 (12 · 2)	38 (7 · 2)	50 (7 · 0)	
Accounting, banking, finance	145 (6 · 0)	94 (8 · 0)	14 (2 · 7)	37 (5 · 2)	
Design	54 (2 · 2)	16 (1 · 4)	8 (1 · 5)	30 (4 · 2)	
Engineering	305 (12 · 6)	122 (10 · 4)	21 (4 · 0)	162 (22 · 6)	
Healthcare	76 (3 · 1)	27 (2 · 3)	10 (1 · 9)	39 (5 · 4)	
Law	23 (1 · 0)	7 (0 · 6)	7 (1 · 3)	9 (1 · 3)	
Sales and marketing	115 (4 · 8)	38 (3 · 2)	8 (1 · 5)	69 (9 · 6)	
Other	1466 (60 · 7)	724 (61 · 8)	421 (79 · 9)	321 (44 · 8)	

*p < 0 · 05 is considered as significant.

In Suzhou city 76% of the elderly thought that climate change threatens their health. Fifty-six percent believed that government had offered "no help" (advising the elderly, or educating them) in climate change warning (Table 3). In Hefei and Xiamen, 60% and 64% of the participants reported that they believed that climate change has a strong negative impact on human health. Compared to Suzhou city, 54% and 55% of the participants reported that the government is doing enough to protect-warn the elderly from the health impacts of climate change.

Practices to protect against the health impacts of climate change

Regarding individual practices to protect from the health impacts of climate change (during moments of heatstroke or exhaustion) most of the participants reported drinking more water (44%, n = 1520) or staying indoors (34%, n = 1178), while 23% used air conditioning, and 25% noted that they avoided going out in stormy weather (Table 4).

Respondents in Suzhou reported that to mitigate heatstroke and exhaustion, their preference is to consume more water (60%, n = 721). However, a much smaller percentage of respondents in both Hefei (30%, n = 362) and Xiamen (41%, n = 437) reported a preference for drinking more water to mitigate harming

effects. In Suzhou, 39% of the respondents reported avoiding exposure to pollutants to mitigate the impact on their respiratory system. In contrast, to mitigate respiratory problems, respondents in Hefei expressed a preference to use masks for protection (22%, n = 259), while 13% of the participants preferred to use air purifiers. To prevent injuries that may occur due to stormy weather, 48% of Suzhou participants would prefer to stay indoors (Table 4). However, this percentage was much lower in Hefei and Xiamen, where only 14% of the respondents preferred to "stay indoors" to protect themselves from injuries during stormy weather (Table 4). In Suzhou, 35% of the elderly reported that their preference is to disinfect their homes to lessen the impact of infectious diseases. However, in Hefei and Xiamen, respondents expressed a preference for being vaccinated (14% and 11%, respectively), if there is a risk of infectious diseases.

IV. Discussion

The health impacts of climate change will be experienced by all (Watts et al., 2020). However, there is a substantial evidence base that the impacts of climate change will have far-reaching health implications for elderly people, while cities have been highlighted as a key space in the fight against climate change (Filiberto et al., 2009; Lackner

Table 2. Knowledge-related questions and Chi-square results in Suzhou, Hefei and Xiamen cities assessing the knowledge level of the elderly

	Total n = 3466	Suzhou n = 1200	Hefei n = 1200	Xiamen n = 1066	*p value
KNOWLEDGE QUESTIONS	n (%)	n (%)	n (%)	n (%)	
Q1. Have you heard about climate change?					p < 0 · 001
Yes	2502 (72 · 9)	889 (74 · 5)	768 (64 · 9)	845 (80 · 1)	
No	930 (27 · 1)	305 (25 · 5)	415 (35 · 1)	210 (19 · 9)	
Q2. How would you define climate change?					
Flooding	1136 (32 · 8)	602 (50 · 2)	190 (15 · 8)	344 (32 · 3)	p < 0 · 001
Drought	1350 (38 · 9)	577 (48 · 1)	442 (36 · 8)	331 (31 · 1)	p < 0 · 001
Storms	1244 (35 · 9)	565 (47 · 1)	245 (20 · 4)	434 (40 · 7)	p < 0 · 001
Wildfires	569 (16 · 4)	316 (26 · 3)	114 (9 · 5)	139 (13 · 0)	p < 0 · 001
Heatwaves	1933 (55 · 8)	693 (57 · 8)	687 (57 · 3)	553 (51 · 9)	p < 0 · 001
Q3. Do you think climate patterns changed in last 20 years?					p < 0 · 001
Yes	2338 (85 · 9)	864 (86 · 4)	717 (88 · 6)	757 (83 · 0)	
No	383 (14 · 1)	136 (13 · 6)	92 (11 · 4)	155 (17 · 0)	
Q4. Which one of the following impacts you noticed changes?					
More storms	1005 (43 · 7)	519 (58 · 4)	194 (25 · 6)	292 (44 · 6)	p < 0 · 001
More floods	773 (33 · 8)	469 (53 · 6)	136 (17 · 9)	168 (25 · 8)	p < 0 · 001
More droughts	1082 (47 · 0)	484 (54 · 9)	403 (52 · 8)	195 (29 · 7)	p < 0 · 001
More heat	2271 (90 · 5)	861(90 · 2)	708 (92 · 7)	702 (88 · 7)	p < 0 · 001
More cold	506 (22 · 7)	303 (35 · 0)	117 (15 · 5)	86 (14 · 2)	p < 0 · 001
Q6. Which of the following ways climate change threatens your health?					
Heatstroke-exhaustion	1582 (45 · 6)	603 (50 · 3)	471 (39 · 3)	508 (47 · 7)	p < 0 · 001
Respiratory problems	1160 (33 · 5)	569 (47 · 4)	358 (29 · 8)	233 (21 · 9)	p < 0 · 001
Infectious diseases	634 (18 · 3)	340 (28 · 3)	176 (14 · 7)	118 (11 · 1)	p < 0 · 001
Injuries	516 (14 · 9)	295 (24 · 6)	115 (9 · 6)	106 (9 · 9)	p < 0 · 001

*p < 0 · 05 is considered as significant.

Table 3. Attitude-related questions and Chi-Square results in Suzhou, Hefei and Xiamen cities showing perceptions and attitudes of the elderly on climate change health impacts and government assistance

	Total n = 3466 n (%)	Suzhou n = 1200 n (%)	Hefei n = 1200 n (%)	Xiamen n = 1066 n (%)	p value*
ATTITUDE QUESTIONS					
Q5. Do you think climate change threatens your health?					p < 0 · 001
Yes	1880 (67 · 4)	776 (76 · 5)	533 (60 · 1)	571 (64 · 4)	
No	908 (32 · 6)	239 (23 · 5)	354 (39 · 9)	315 (35 · 6)	
Q8. Do you think your government is doing enough to protect-warn you from the health impacts of climate change?					p < 0 · 001
Yes	1180 (45 · 4)	302 (30 · 2)	418 (54 · 3)	460 (55 · 5)	
No	1014 (39 · 0)	563 (56 · 4)	252 (32 · 7)	199 (24 · 0)	
I am not sure	404 (15 · 6)	134 (13 · 4)	100 (13 · 0)	170 (20 · 5)	

*p < 0 · 05 is considered as significant.

et al., 2019). Adaptation and mitigation planning and initiatives are the matters that the elderly population has been insufficiently involved in (Kinay et al., 2019; Kokoye et al., 2019). Research has highlighted factors such as reduced mobility, changes in physiology and more limited access to resources as the main factors for affecting the adaptive capacity of the elderly (Akhtar & Palagiano, 2018; Allex et al., 2013; Filiberto et al., 2009). At the same time, whilst being particularly vulnerable to the health impacts of climate change, adaptation efforts have not taken into account the specific needs or capacity of older people (Kumar, 2019). To fill this important

information gap, this study focused on the knowledge, attitudes, and practices of the elderly participants on climate change and its associated health impacts.

This unique dataset found that while the majority of respondents had heard about climate change; however, they only had a very basic understanding of climate change. That is, climate change is not elderly's everyday language (Cumiskey et al., 2019; Lickiss & Cumiskey, 2019). The majority of the participants stated that they have observed climate change-related changes in their communities including changes in weather patterns, air temperatures and other changes in the environment

Table 4. Practice-related questions and Chi-Square results. Elderly practices when in danger of heatstroke and exhaustion, respiratory problems, injuries and infectious diseases

	Total n = 3466 n (%)	Suzhou n = 1200 n (%)	Hefei n = 1200 n (%)	Xiamen n = 1066 n (%)	*p value
PRACTICE QUESTIONS					
Q7. For each of the below how do you manage your health?					
Heatstroke or exhaustion					p < 0 · 001
Drink more water	1520 (43 · 9)	721 (60 · 1)	362 (30 · 2)	437 (41 · 0)	p < 0 · 001
Stay in the shade	1148 (33 · 1)	544 (45 · 3)	322 (26 · 8)	282 (26 · 5)	p < 0 · 001
Stay indoors	1178 (34 · 0)	541 (45 · 1)	340 (28 · 3)	297 (27 · 9)	p < 0 · 001
Use AC	804 (23 · 2)	371 (30 · 9)	227 (18 · 9)	206 (19 · 3)	p < 0 · 001
Respiratory problems					p < 0 · 001
Use masks	790 (22 · 8)	402 (33 · 5)	259 (21 · 6)	129 (12 · 1)	p < 0 · 001
Use air purifiers	815 (23 · 5)	432 (36 · 0)	246 (20 · 5)	137 (12 · 9)	p < 0 · 001
Avoid exposure with pollutants	832 (24 · 0)	468 (39 · 0)	232 (19 · 3)	132 (12 · 4)	p < 0 · 001
Infectious diseases					p < 0 · 001
Get vaccinated	697 (20 · 1)	409 (34 · 1)	173 (14 · 4)	115 (10 · 8)	p < 0 · 001
Stay at home if you have signs of infection	677 (19 · 5)	413 (34 · 4)	165 (13 · 8)	99 (9 · 3)	p < 0 · 001
Disinfect the hot zones in your residence	660 (19 · 0)	421 (35 · 1)	154 (12 · 8)	85 (8 · 0)	p < 0 · 001
Wash your hands often	602 (17 · 4)	404 (33 · 7)	125 (10 · 4)	73 (6 · 8)	p < 0 · 001
Injuries					p < 0 · 001
Avoid going out in stormy weather	864 (24 · 9)	581 (48 · 4)	129 (10 · 8)	154 (14 · 4)	p < 0 · 001
Avoid staying in the sun	834 (24 · 1)	571(47 · 6)	136 (11 · 3)	127 (11 · 9)	p < 0 · 001
Ready a first aid kit for physical injuries	553 (16 · 0)	368 (30 · 7)	117 (9 · 8)	68 (6 · 4)	p < 0 · 001
Use sun protection if working outside	462 (13 · 3)	347 (28 · 9)	96 (8 · 0)	19 (1 · 8)	p < 0 · 001

*p < 0 · 05 is considered as significant.

such as colder or hotter weather. Respondents also noted that these changes are impacting their environment (less greenness, more and more heat); however, respondents did not possess knowledge on the underpinning processes associated with climate change, i.e. a buildup of excess carbon dioxide and other greenhouse gases in the atmosphere, as the root cause of climate change. With regard to the perceived impact of climate change on health, residents across all three cities reported that their health will be impacted by climate change. In Suzhou participants reported that climate change would impact their health via heatstroke (50%); however, residents across the three cities also reported concerns about respiratory/breathing problems, and infectious diseases. This study also found that the survey respondents were willing to take action to prevent or lessen the impact of climate change (adaptation) on their health. Personal adaptation measures included performing changes in daily life such as drinking more water during extreme heat events or staying indoors. Comprehensive knowledge of climate change risk and the underlying processes associated with climate change is a key component of effective personal and community adaptation management (Monroe et al., 2019). All age groups can adapt to climate change, yet it is important for individuals to have more knowledge on climate change (Cumiskey et al., 2019; Lickiss & Cumiskey, 2019) so that they can lessen their impact (Bi et al., 2020; Knutti, 2019; Lackner et al., 2019). A recent study in Thailand found an association between participants' knowledge about climate change and the level of education (p < 0 · 01) (Rahman et al., 2021). It was also found that participants' attitudes towards climate change were associated with their status of residence (rural or urban) and their internet use (p < 0 · 05); and climate change-related practices were associated with educational level (Rahman et al., 2021). Without adequate education and awareness among the elderly, there will continue to be a disconnection between what is actually occurring in their communities.

In terms of practices, the elderly participants in this study reported that they would drink more water to protect themselves from the health impacts of climate change during moments of heatstroke or exhaustion. Results from one study in China showed that the majority of the participants reported that they "altered their behaviors" in order to cope with extreme heat (Zhang et al., 2016). The most commonly adopted adaptive behaviors for rural older people involved wearing lightweight clothes (93%), reducing time outdoors (73%) and staying indoors (72%). For older urban residents, the most commonly adopted adaptive behaviors were staying indoors (84%), wearing light clothes (79%), and reducing physical activities (58%) (Zhang et al., 2016). Future educational efforts need to focus on increasing the knowledge of the specific risks associated with each climate change hazard for human health. Given the expected increase in temperatures in China over the next 100 years, it is particularly important to strengthen heatwave awareness. Strengthening health services and community support mechanisms to

ensure that older people receive targeted support during heatwaves are needed. The elderly being spending most of their quality time outdoors, in parks, or in their communities are in need of shelter from extreme heat, and facilities in gathering areas are insufficient (no free water, nothing to cool off with) to help them for protection in extreme heat events. Drinking fountains or means of free accessible water in gathering areas of the elderly could be another initiative/incentive to be considered by local governments-municipalities for better adaptation of the elderly to climate change risks (Allex et al., 2013; Dadson, 2019; Vukmirovic et al., 2019).

To date there is limited social science research on the ways in which people—in any country—understand the health risks associated with climate change. The development of standardized measures of climate health beliefs, risk perceptions and adaptation actions would provide a criterion by which comparisons can be more easily made at all levels and by teams of researchers working independently. A more effective public health outreach campaigns on climate change at all levels—local, regional, national and international are required. The impact of climate change needs on human health needs to be promoted at the local level.

Elderly: Focus for local governments and policymakers

Adaptation action is more frequently reported in developed nations, and it is evident that there are limited sources reporting on adaptation implications being developed focusing on women, the elderly, or children (Berrang-Ford et al., 2011). The elderly proportion is projected to increase in the next 20 years creating significant challenges for the cities to prepare for and build resilience to predicted climate extremes including heat waves, coastal flooding, and the risk of major storms (Kabisch & Van Den Bosch, 2017).

China's climate change policies should be further investigated by researchers and study findings could be used as a reference point to its urban climate strategies for vulnerable populations. For China to improve its adaptation strategies to climate change, urban data and a cross-disciplinary impact evaluation is necessary. There should be communication among those working in different disciplines on problems related to climatic variations in order to provide a common platform to reflect on perspectives and experiences concerning vulnerable populations in local communities. As global policy-makers are figuring out the implementation of mitigation commitments for the Paris Agreement

meeting, knowing the attitude and perception of vulnerable populations is important to support their decision makings (Bere-Semeredi & Bere-Semeredi, 2020; Li, 2021; Wang & Zhou, 2020).

A study in Japan associated five-year survival rate with having access to green space suitable for taking a walk and with parks and tree-lined streets near the residence (Takano et al., 2002). Policy framed so far in all around the world for elderly is showing that urban living spaces of elderly is significant, and green space planning can improve public health (Ji et al., 2020; Qiu et al., 2021; Zhu et al., 2019). In China, climate change can and should be further internalized as a priority issue for local governments, and strengthening care for the elderly should be the very core of the policy measures (Yang et al., 2018). Local responses to climate change, and local initiatives (initiatives in urban infrastructure, in parks, in local communities) must also be the focus of the central government (Qi et al., 2008). Health systems are to be incorporated for the elderly to protect elderly health, by adopting early monitoring and preventive measures based on climate change (Liu et al., 2020; Lowe et al., 2011; Mayrhuber et al., 2018). Health professionals and health organizations must join the growing global community of science-based advocates working to achieve the goal of the Paris Agreement (Banwell et al., 2018; Maibach et al., 2021). This can be the greatest contribution to the health and wellbeing of vulnerable populations who are most fragile to the impacts caused by climate change (Leal Filho et al., 2019; Maibach et al., 2021).

This study highlighted a number of important educational areas including what is climate change, how it is caused, and how it is affecting/can affect the elderly in China in near future. Respondents felt that the government assistance with regard to climate change was insufficient. It is therefore important that any educational initiatives by governments, community organizations and community leaders should take more visible actions to include elderly voices in the planning of any adaptation measures (Bicknell et al., 2009; Sumi et al., 2010; Zahran et al., 2008). Importantly, with regard to the three-city analysis, important differences in the KAP of elderly residents were observed, as such future adaptation measures need to account for both age and location. Based on this varying KAP of participants across the three cities of interest, we suggest the replication of this survey at a nation-wide level. This would allow a more nuanced understanding of what is driving perceptions and behavior. Such an approach would be particularly helpful in understanding how the elderly perceive their own role in climate change adaptation.

This information would need to be considered in the development of a comprehensive climate change adaptation strategy.

V. Concluding remarks and recommendations

Older people are already profoundly affected by the impacts of climate change (Benevolenza & DeRigne, 2018; Zhang et al., 2016). These impacts are set to increase due to a combination of exacerbating factors from climate change to current environment-driven health risks leading to increased mortality, and poorer health for the global ageing population. Understanding human behaviors and perceptions can help adaptation strategies to be developed more effectively. This study gained an important understanding of on the knowledge, attitudes and practices (KAP) in relation to climate change of a large sample of the elderly respondents across three cities in East China. The adverse health impacts of climate change can be minimized or avoided with well-planned and well-applied adaptation strategies (Ireland & Clausen, 2019). The insights from the data analysis can be used to identify acceptable adaptation solutions for the elderly residents given the health impacts of climate change associated with this age group. Specifically, a key finding is that to be effective new adaptive strategies targeted at the elderly requires careful consideration of their vulnerabilities and capacity to adapt. Local governments and researchers must focus on risk communication and perception, and on cultural, behavioral, and socio-demographic influences on adaptation to climate change in vulnerable populations.

Data sharing statement

The study is carried out under privacy protection. The data owner confirmed that the data cannot be made available to the public due to privacy reasons.

Disclosure statement

All author(s) confirm that no conflicts of interest exist and there is nothing to disclose.

Notes on contributor

Dr. **Pelin Kinay** is a University of Liverpool graduate from the Faculty of Science and Engineering. Her research focus is generally being climate change and health, she is also researching in both the nature of climates – local, regional or global – and the natural or human-induced factors that cause climates to change, and factors leading to effective climate adaptation. While her interest is growing in greenness and climate change health co-benefits, she is also maintaining focus in the areas of carbon neutrality and climate change interactions.

ORCID

Pelin Kınay http://orcid.org/0000-0002-3869-1797
Karyn Morrissey http://orcid.org/0000-0001-7259-1047

PUBLIC INTEREST STATEMENT

Over the next few decades, societies will be challenged by climate change exacerbated health impacts. Climate change will also adversely impact some areas and populations more or less intensely than others. With its rapidly increasing aging population, China should pay specific attention to the elderly for they are vulnerable to climate change and to the health impacts that climate change may exacerbate. In this research knowledge, attitude and practices of the elderly were assessed, and recommendations were provided for the elderly as the population focus for climate change adaptation strategies. This work provides important insights for new adaptation strategies targeting the elderly, looking into their knowledge, attitude and practices in extreme climates. It is crucial to create awareness of the necessary adaptations the elderly will need to take to lessen the impact of climate change on their health that must be the focus of the local governments and health officials.

Contributors

Dr. Kinay drafted the initial manuscript, conducted literature research and review, and designed the data collection instruments. Dr. Kinay acquired, analyzed, and interpreted the data. Prof. Morse, Dr. Staddon and Prof. Morrissey guided and advised on the project. Dr. Staddon secured the funds from XJTLU for this work. Mr. Yücel assisted in the final proofreading and editing of the manuscript, including the final reference checking. All co-authors assisted in interpreting the results, reviewing and revising the manuscript.

All authors who have accessed verified the underlying data.

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