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Propensity to Migrate and Willingness to Pay Related to Air Pollution among Different Populations in Wuhan, China

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ABSTRACT

Objective: To understand parents' propensity to migrate and willingness to pay with respect to outdoor air pollution, and to explore related affecting factors.

Methods: This study used a convenience sample and subjects were collected from a community in Wuchang District and Children's Hospital of Wuhan, respectively. A designed questionnaire was used for this study. Univariable and multivariable logistic regression models were applied to analyze the relationship between parents' individual and familial characteristics and related behavioral intensions to air quality improvement. Statistical analysis was done with SAS 9.1.

Results: The questionnaire was completed by 865 subjects (response rate = 86.5%). The number of people with migrant intent was 150(36.4%) from hospital group, and 139(30.7%) from community group. In the hospital group, subjects with higher knowledge of air quality (OR = 6.268, $p < 0.05$) and higher average annual household income (AAHI), which was equal or more than 50,000 Yuan (OR = 2.045, $p < 0.01$), were found to be more intent to migrate. AAHI (OR = 1.939, $p < 0.05$) was also the affecting factor in the community group correspondingly. Those willing to pay for air quality improvement included 297 people (72.1%) from the hospital group and 333 people (73.5%) from the community group, and affecting factors was the public responsibility for air quality improvement (hospital group: OR = 3.380, $p < 0.01$; community group: OR = 4.436, $p < 0.01$).

Conclusions: This study indicated high tendency of propensity to migrate for avoiding poor air condition and willingness to pay to improve air quality in Wuhan. Local governments should pay more attention to parents' knowledge of air pollution and attitudes towards government management of air quality, especially those willing to migrate.

Keywords: Air pollution; Propensity to migrate; Willingness to pay; Income; Responsibility.

INTRODUCTION

World Health Organization (WHO) reported that 7 million people suffered early death worldwide due to air pollution in the year of 2012 (Brunekreef and Holgate, 2002; World Health Organization, 2014). Air pollution is considered to be the most serious environmental health issue (Brunekreef and Holgate, 2002). Notably, industrialization and urbanization in China has exacerbated air pollution problem (Huang *et al.*, 2014). Fine particulate matter with an aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) has become an important indicator of air pollution in China according to reports by Environmental Protection Agency (EPA) (Environmental Protection Agency, 1997). A serious air pollution event occurred in China in 2013, which caused $PM_{2.5}$ concentration far exceed the Chinese pollution standard of 75 μg m^{-3}, with a record-breaking daily concentration of 772 μg m^{-3} in 74 cities. The Chinese State Council subsequently made a response and announced that by the end of 2017, $PM_{2.5}$ concentrations are aimed to be reduced by 25% (China National Environmental Monitoring Center, 2013).

Among all populations, children are most vulnerable to air pollution (Bell *et al.*, 2011), because air pollution can cause severe respiratory diseases (Wright and Brunst, 2013). Wuhan, as the largest city in central China, has 10.22 million permanent residents, whose gross domestic product (GDP) per capita reached 98.4 thousand Yuan in 2014 (Wuhan People's government, 2015). Air pollution in the city is

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more severe than other cities with the similar level of economic development whose annual mean concentrations of $PM_{2.5}$ were 106.5 μg m^{-3} in Wuhan from August 2012 to July 2013 (China National Environmental Monitoring Center, 2013; Wang *et al.*, 2013; Zhang *et al.*, 2015). However, literature on the effect of air pollution in Wuhan is quite limited, especially in the children population. Studies have shown that air pollution is the main cause of respiratory diseases among children; patients aged 5 to 11, occupy 89.4% of all respiratory disease due to worse air quality (Yazdanparast *et al.*, 2013).

For children's safety, many parents often use air purifiers, ask their children to wear a mask, or reduce the time of outdoor activity. However, these passive actions cannot actively decrease air pollution problems fundamentally. In addition, evading air contamination by migrating elsewhere is one of the possible strategies (Renaud *et al.*, 2011) as well as paying for the improvement of air quality. According to Stern's environmental behavior framework, the four aspects factors: habits and routines, attitudinal and perception factors, place and context, and personal capabilities were constituted closely (Stern, 2000). As a result, the subjective perception of parents to air quality and relevant factors such as socio-demographic status, family incomes and health conditions have effects on their potential activities (Yazdanparast *et al.*, 2013).

Previous studies illustrated that propensity to migrate or willingness to pay was affected by multiple factors, including various socio-demographic reasons, incomes, health conditions and attitudes. Research in this area has just been started recently in China due to increasing awareness of the public for air pollution (Liu *et al.*, 2016). From 2014 to 2016, studies mainly focused on factors like degree of concern, attitude to the government managements (Oltra and Sala, 2014; Wang *et al.*, 2015a), personal obligations (Zhang *et al.*, 2014), willingness to pay (Wang *et al.*, 2015b and relationships between these issues and individual and community characteristics (Zhang *et al.*, 2014). However, there have been no such studies conducted in Wuhan.

Based on traditional migration theory, Hunter found that on individual-level, environment hazards might influence residential migration decision-making (Hunter, 2005); on societal-level, migration can represent an exacerbating face with regard to environmental hazards as a result of increasing population density especially in vulnerable locales (Marandola and Hogan, 2007). Besides willingness to pay for air pollution improvement was considered to be a positive behavior (Sun *et al.*, 2016). The purpose of our research is to understand propensity to migrate and willingness to pay due to air pollution of parents in Wuhan, and explore relevant factors. Considering children's health, two parent populations whose health conditions of children may be different were taken into account. We intended to provide baseline data and advices for health administration and assist the establishment of regulations in Wuhan.

MATERIAL AND METHODS

Research Design and Sample

The questionnaire, redesigned by professors from University of Hawaii and Wuhan University based on Air Quality Perception Scale (Deguen *et al.*, 2012), was used to measure parents' propensity to migrate and willingness to pay due to air pollution. Two population groups with disparate health conditions of children were selected by convenience sampling. One group was from the department of respiratory diseases in Children's Hospital of Wuhan which is the largest hospital for children in Hubei province, while another was from a Wuchang community characterized as the cultural and political center of the whole province of Hubei. The inclusion criteria included Wuhan residents aged between 18 to 65 years old who were parents or caregivers of children aged 2 to 10 (Zhang *et al.*, 2014). The 1000 included parents were fully informed about the study and then signed informed consents respectively. The survey was performed for a total of 45 days between April and May in 2014.

Dependent Variables

Two questions were used to measure dependent variables: 1) propensity to migrate if child's health was affected by air pollution: yes = willing, no = not willing; 2) willingness to pay for the improvement for air pollution: yes = willing, no = not willing.

Independent Variables

Individual and Familial Characteristics

Seven individual and familial characteristics were listed: 1) age of child, 2) gender of parent, 3) age of parent, 4) education level of parent, 5) birthplace of parent and 6) AAHI.

Knowledge of Air Pollution and its Effects on Child Respiratory Diseases

Three questions were involved in parents' knowledge of air pollution: 1) the effect of air pollution on children's respiratory system; 2) the relationship between air pollution and children's health; and 3) knowledge of measurements and indicators of air quality. Subjects were assigned a value for each question: 0 = none, 1 = weak or less, 2 = medium or general, 3 = strong or much.

Attitude Towards Governmental and Individual Managements of Air Quality

Two questions were related to subject's attitude towards managements of air quality: 1) What position should the government place the task of tackling air pollution? (yes = very important, no = ordinary) and 2) Is improving air quality the responsibility of every citizen? (yes or no)

Quality Control

This research originates from the Office of Public Health Studies, University of Hawaii at Manoa. The design of the questionnaire was reviewed and approved by the Institutional Review Board committee of the University of Hawaii at Manoa and the survey was completed collaboratively by the University of Hawaii at Manoa and Wuhan University. Investigators selected from graduate students of Wuhan University received strict training on the topic. To ascertain that all the questions could be correctly interpreted and

rationally answered, two rounds of pre-surveys were conducted prior to the actual survey with 60 people. During the survey, 10% of the questionnaires were randomly selected to check for missing questions or errors.

Data Analysis

Epidata3.1 was used to construct the database and questionnaires were logged using the double-blind method. SAS 9.1 was used to analyze the data. The alpha level was set at 0.05 to determine statistical significance. Data analysis consisted of the following two parts: firstly, parent knowledge variables, which were rated on a scale of 0 to 9 (0 to 3 = low, 3 to 6 = fair, 6 to 9 = high), were calculated according to responses to relationship between air pollution and children's respiratory systems. Individual and familial characteristics, including knowledge of parents of the two groups were descriptively analyzed; a chi-squared test was used to compare disparities between these two groups. Secondly, based on correlation analysis between independence variable (See Tables S1–S2 in supplements) and the yes or no categories of two behavioral intentions, we have employed two models (univariable logistic regression model and multivariable logistic regression model) to evaluate the correlations between two behavioral intentions and the parents' individual and familial variables and their attitudes towards air pollution. Crude odds ratios (OR) value and 95% confidence interval (CI) were obtained from univariable logistic regression models, meanwhile, adjusted OR value and 95% CI from multivariable logistic regression models were also presented.

Ethical Consideration

This study has been approved by the Institutional Review Board of Human Studies Program at the University of Hawaii at Manoa. Surveys were only conducted if subjects were fully informed of the content and aim of our research and were willing to cooperate. In addition, the survey was conducted anonymously and respondents' information was kept confidential and only for the use of scientific examination.

RESULTS

Description of Independent Variables (Individual and Familial Characteristics)

Each 500 questionnaires were sent to the hospital and community group populations, and the response rate was 82.4% and 90.6% respectively. The total response rate was 86.5%. Table 1 illustrates the individual and familial characteristics of participant parents. There is statistically significant difference between two groups in variables including age, education level, birthplace, etc., but not gender.

Description of Dependent Variables

As showed in Table 2, 150 (36.4%) parents in the hospital group would consider migrating to other cities due to air pollution and 262 (63.6%) would not. In the community group, 139 (30.7%) parents would consider migrating while 314 (69.3%) would not; and there is no significant difference between these two groups. In the hospital group, the number of parents willing to pay for improving air quality was 297 (72.1%) while the number of those unwilling was

Table 1. Individual and familial characteristics of the interviewees.

Characteristics	Hospital (n = 412)	Community (n = 453)	Total
	n (%)	n (%)	n (%)
Gender			
Male	187 (45.4)	181 (40.0)	368 (42.5)
Female	225 (54.6)	272 (60.0)	497 (57.5)
Age (years) [#]			
18-29	160 (38.9)	20 (4.4)	180 (20.8)
30-39	188 (45.6)	263 (58.1)	451 (52.1)
≥40	64 (15.5)	170 (37.5)	234 (27.1)
Educational Level [#]			
≤Primary school	35 (8.5)	28 (6.2)	63 (7.3)
Middle school	263 (63.8)	85 (18.8)	348 (40.2)
≥College	114 (27.7)	340 (75.0)	454 (52.5)
Birthplace [#]			
Countryside	229 (55.6)	52 (11.5)	281 (32.5)
City	183 (44.4)	401 (88.5)	584 (67.5)
AAHI (RMB) [a, #]			
<50000	206 (50.0)	80 (17.7)	286 (33.1)
≥50000	206 (50.0)	312 (68.9)	518 (59.9)
Missing	0	61 (13.4)	61 (7.0)
Knowledge of air pollution [#]			
Poor	16 (3.9)	17 (3.7)	33 (3.8)
General	174 (42.2)	153 (33.8)	327 (37.8)
Good	222 (53.9)	283 (62.5)	505 (58.4)

[a] AAHI = Average annual household income.

[#] p value for difference between the two groups, $p < 0.05$ ($\alpha = 0.05$).

Table 2. Outcomes between Hospital and Community groups.

Outcomes	Hospital (n = 412)	Community (n = 453)	χ^2	*p*-value
	n (%)	n (%)		
Propensity to migrate			3.117	0.075
Yes	150 (36.4)	139 (30.7)		
No	262 (63.6)	314 (69.3)		
Willingness to pay			0.221	0.639
Yes	297 (72.1)	333 (73.5)		
No	115 (27.9)	120 (26.5)		

115 (27.9%). In the community group, 333 (73.5%) parents were inclined to pay while 120 (26.5%) were not. The difference between these two groups was also not statistically significant.

Factors Affecting the Propensity to Migrate

Table 3 shows differences between the two groups' propensity to migrate on relevant factors. In the hospital group, two factors affected the subjects' propensity to migrate: AAHI and knowledge of air pollution. Parents with incomes ≥ 50,000 Yuan were more inclined to migrate than those with an incomes < 50,000 Yuan (OR = 6.286, 95% CI 1.324–29.668). Subjects with more knowledge related to air pollution had a greater tendency to migrate than those with less knowledge (OR = 2.045, 95% CI 1.311–3.189). However, in the community group, AAHI (OR = 1.939, 95% CI 1.045–3.597) and personal responsibility of reducing air pollution (OR = 0.366, 95% CI 0.169–0.795) affected subjects' propensity to migrate.

Factors Affecting Willingness to Pay

As showed in Table 4, factors affecting willingness to pay were also inconsistent in the two groups. In the hospital group, compared with respondents who did not see improving air quality as a personal responsibility 12 (4.0%), those who did 285 (96.0%) were more willing to pay for improvement of air quality (OR = 3.380, 95% CI 1.467–7.787). But in the community group, not only personal responsibility for improving air quality (OR = 4.436, 95% CI 2.024–9.724) had affect on parents' willingness to pay, but also compared parents' age between 18–29, those older parents whose age between 40–65 were less willing to pay for improving air quality (OR = 0.119, 95% CI 0.014–0.998). And parents who were born in the city had more willing to pay for reducing air pollution than those born in the countryside (OR = 2.104, 95% CI 1.019–4.343).

DISCUSSION

There were significant differences between hospital and community groups in most individual and familial characteristics except gender. Compared with hospital group, subjects of the community group were generally older, and most of them were born in the city with higher income and education level. Notably, the number of subjects with a college-level education in the community group (75.0%) was about 3 times as many as subjects from the hospital (27.7%). Hence, the community group was a special population with education level, while parents in hospital group represent another special population who may focus on more children's health and have greater impact on personal behavioral intentions.

Our study showed relatively high tendency of propensity to migrate and willingness to pay to improve air quality among two populations in Wuhan (See Table 2). The propensity to migrate and willingness to pay were less affected by existed socio-demographic factors patently. Although empirical study in five European countries (United Kingdom, Finland, German, The Netherlands and Spain) just showed that social-demographic variables were not statistically significant associated with willingness to pay (Istamtol *et al.*, 2014), some social-demographic variables remain related to two behavioral intentions showed by multivariable regression models (See Tables 3–4).

As far as factors affecting propensity to migrate in two groups. In the hospital group, subjects with higher AAHI (OR = 2.045, 95% CI 1.311–3.189) had a greater tendency to migrate, and AAHI was also associated with propensity to migrate in the community group (OR = 1.939, 95% CI 1.045–3.597). Hunter's research (2005) showed that among those disturbed by environment contamination for a long period, environmental issues played an important role in causing them to migrate. Moreover, high-income families living in areas with high particulate concentrations were disturbed by the pollution, and had a greater willingness to act due to environmental changes (Elliott *et al.*, 1999). When facing serious contamination issues, migration is considered a viable option but is also difficult to go through with. This is because migration is linked with family structure, community residence and occupational conditions (Renaud *et al.*, 2011) which are closely related to income. Some empirical research also suggested that the factor of income was also important in ecological migration (Mou *et al.*, 2009). Families with high income are more possibly able to pay for migration. Particularly, due to the registered permanent residence policy in China, many parents may not be able to obtain not only pure air but also well education and health care though successfully migrate (Liang and Chen, 2007; Peng *et al.*, 2010; Gong *et al.*, 2012). Another Los Angeles Metro Region Study (Sieg *et al.*, 2004) also confirmed our research and documented that when the application of the Clean Air Act successful reduced the smog level in certain communities, it attracted richer people living in inferior air condition to move to such area finally.

In the hospital group, the more knowledge on air pollution parents had, the more they preferred to migrate (OR =

Table 3. Individual and familial characteristics associations with propensity to migrate.

	Hospital (n = 412)				Community (n = 453)			
	Yes	No	Crude	Adjusted	Yes	No	Crude	Adjusted
	n (%)	n (%)	OR (95% CI)	OR (95% CI)	n (%)	n (%)	OR (95% CI)	OR (95%CI)
Gender								
Male	68 (45.3)	119 (45.4)	Ref.	Ref.	46 (33.1)	135 (43.0)	Ref.	Ref.
Female	82 (54.7)	143 (54.6)	1.003 (0.697–1.445)	0.870 (0.564–1.343)	93 (66.9)	179 (57.0)	1.525 (1.004–2.316) [#]	1.506 (0.959–2.364)
Age (years)								
18–29	62 (41.3)	98 (37.4)	Ref.	Ref.	9 (6.5)	11 (3.5)	Ref.	Ref.
30–39	71 (47.3)	117 (44.7)	0.959 (0.649–1.417)	0.775 (0.481–1.248)	84 (60.4)	179 (57.0)	0.574 (0.229–1.437)	0.571 (0.213–1.536)
40–65	17 (11.4)	47 (17.9)	0.572 (0.317–1.032)	0.578 (0.287–1.165)	46 (33.1)	124 (39.5)	0.453 (0.176–1.165)	0.515 (0.186–1.428)
Educational Level								
≤ Primary school	8 (5.3)	27 (10.3)	Ref.	Ref.	10 (7.2)	18 (5.7)	Ref.	Ref.
Middle school	86 (57.3)	177 (67.6)	1.640 (0.752–3.574)	1.382 (0.572–3.336)	19 (13.7)	66 (21.0)	0.518 (0.205–1.308)	0.453 (0.173–1.184)
≥ College	56 (37.4)	58 (22.1)	3.259 (1.452–7.311) [##]	2.351 (0.892–6.198)	110 (79.1)	230 (73.3)	0.861 (0.385–1.927)	0.718 (0.298–1.730)
Birthplace								
Countryside	77 (51.3)	152 (58.0)	Ref.	Ref.	15 (10.8)	37 (11.8)	Ref.	Ref.
City	73 (48.7)	110 (42.0)	0.310 (0.910–1.886)	0.847 (0.514–1.395)	124 (89.2)	277 (88.2)	1.104 (0.584–2.086)	0.987 (0.479–2.037)
AAHI (RMB) [a]								
< 50,000	56 (37.3)	150 (57.1)	Ref.	Ref.	16 (11.5)	64 (20.4)	Ref.	Ref.
≥ 50,000	94 (62.7)	112 (42.7)	2.248 (1.548–3.266) [##]	2.045 (1.311–3.189) [##]	102 (73.4)	210 (66.9)	1.943 (1.070–3.529) [#]	1.939 (1.045–3.597) [#]
missing					21 (15.1)	40 (12.7)	2.100 (0.981–4.495)	2.088 (0.925–4.716)
Knowledge to air pollution								
Poor	2 (6.0)	14 (2.7)	Ref.	Ref.	2 (2.9)	15 (4.1)	Ref.	Ref.
general	46 (40.0)	128 (43.5)	2.238 (0.935–5.359)	2.937 (0.615–14.038)	41 (26.6)	112 (37.0)	2.746 (0.602–12.530)	3.194 (0.679–15.028)
Good	102 (54.0)	120 (53.8)	0.916 (0.629–1.335)	6.268 (1.324–29.668) [#]	96 (70.5)	187 (58.9)	3.850 (0.863–17.183)	4.388 (0.957–20.126)
Attitude 1 [b]								
No	15 (10.0)	46 (17.6)	Ref.	Ref.	33 (9.9)	10 (8.3)	Ref.	Ref.
Yes	135 (90.0)	216 (82.4)	1.917 (1.030–3.567) [#]	1.683 (0.861–3.290)	300 (90.1)	110 (91.7)	1.159 (0.577–2.331)	1.128 (0.537–2.367)
Attitude 2 [c]								
No	11 (7.3)	15 (5.7)	Ref.	Ref.	15 (10.8)	15 (4.8)	Ref.	Ref.
Yes	139 (92.7)	247 (94.3)	0.767 (0.344–1.717)	0.521 (0.212–1.280)	124 (89.2)	299 (95.2)	0.415 (0.197–0.874) [#]	0.366 (0.169–0.795) [#]

[a] AAHI = Average annual household income.
[b] Attitude 1 = Attitude towards priority of air pollution in government management.
[c] Attitude 2 = Self-responsibility attitude in individual management.
[#] p value < 0.05, [##]p value < 0.01.
Note: Crude OR (95% CI) and Adjusted OR (95% CI) were calculated from univariable logistic regression model and multivariable logistic regression model respectively.

Table 4. Individual and familial characteristics associations with willingness to pay.

	Hospital (n = 412)				Community (n = 453)			
	Yes	No	Crude	Adjusted	Yes	No	Crude	Adjusted
	n (%)	n (%)	OR (95% CI)	OR (95% CI)	n (%)	n (%)	OR (95% CI)	OR (95% CI)
Gender								
Male	134 (45.1)	53 (46.1)	Ref.	Ref.	132 (39.6)	49 (40.8)	Ref.	Ref.
Female	163 (54.9)	62 (53.9)	1.040 (0.675–1.602)	0.962 (0.614–1.506)	201 (60.4)	71 (59.2)	1.051 (0.687–1.608)	0.991 (0.623–1.576)
Age (years)								
18–29	119 (40.1)	41 (35.6)	Ref.	Ref.	19 (5.7)	1 (0.8)	Ref.	Ref.
30–39	135 (45.4)	53 (46.1)	0.878 (0.545–1.413)	0.781 (0.474–1.290)	190 (57.1)	73 (60.8)	0.137 (0.018–1.042)	0.123 (0.015–1.020)
40–65	43 (14.5)	21 (18.3)	0.705 (0.375–1.326)	0.636 (0.323–1.254)	124 (37.2)	46 (38.4)	0.142 (0.018–1.090)	0.119 (0.014–0.998) [#]
Educational Level								
≤ Primary school	24 (8.1)	11 (9.6)	Ref.	Ref.	23 (6.9)	5 (4.2)	Ref.	Ref.
Middle school	187 (63.0)	76 (66.1)	1.128 (0.526–2.416)	0.918 (0.412–2.045)	62 (18.6)	23 (19.2)	0.586 (0.199–1.724)	0.450 (0.145–1.393)
≥ College	86 (28.9)	28 (24.3)	1.408 (0.613–3.233)	1.054 (0.418–2.657)	248 (74.5)	92 (76.6)	0.586 (0.216–1.587)	0.423 (0.143–1.253)
Birthplace								
Countryside	161 (54.2)	68 (59.1)	Ref.	Ref.	35 (10.5)	17 (14.2)	Ref.	Ref.
City	136 (45.8)	47 (40.9)	1.222 (0.790–1891)	1.151 (0.688–1.926)	298 (89.5)	103 (85.8)	1.405 (0.755–2.615)	2.104 (1.019–4.343) [#]
AAHI (RMB) [a]								
< 50,000	142 (47.8)	64 (55.7)	Ref.	Ref.	60 (18.0)	20 (16.7)	Ref.	Ref.
≥ 50,000	155 (52.2)	51 (44.3)	1.370 (0.889–2.111)	0.790 (0.499–1.252)	224 (67.3)	88 (73.3)	0.848 (0.483–1.490)	0.794 (0.441–1.429)
missing					49 (14.7)	12 (10.0)	2.100 (0.981–4.495)	1.203 (0.507–2.856)
Knowledge to air pollution								
Poor	11 (3.7)	5 (4.3)	Ref.	Ref.	12 (3.6)	5 (4.2)	Ref.	Ref.
General	121 (40.7)	53 (46.1)	1.038 (0.344–3.134)	0.992 (0.301–3.263)	112 (33.6)	41 (34.1)	1.138 (0.378–3.429)	1.143 (0.367–3.565)
Good	165 (55.6)	57 (49.6)	1.316 (0.438–3.950)	1.124 (0.340–3.717)	209 (62.8)	74 (61.7)	1.177 (0.401–3.453)	1.201 (0.507–2.856)
Attitude 1 [b]								
No	43 (14.5)	18 (15.7)	Ref.	Ref.	33 (10.0)	10 (8.3)	Ref.	Ref.
Yes	254 (85.5)	97 (84.3)	1.096 (0.603–1.993)	0.881 (0.462–1.680)	300 (90.0)	110 (91.7)	0.826 (0.394–1.733)	0.678 (0.304–1.511)
Attitude 2 [c]								
No	12 (4.0)	14 (12.8)	Ref.	Ref.	13 (3.9)	17 (14.2)	Ref.	Ref.
Yes	285 (96.0)	101 (87.2)	3.292 (1.474–7.354) [##]	3.380 (1.467–7.787) [##]	320 (96.1)	103 (85.8)	4.063 (1.909–8.648) [##]	4.436 (2.024–9.724) [##]

[a] AAHI = Average annual household income.

[b] Attitude 1 = Attitude towards priority of air pollution in government management.

[c] Attitude 2 = Self-responsibility attitude in individual management.

[#] p value < 0.05, [##]p value < 0.01.

Note: Crude OR (95%CI) and Adjusted OR (95%CI) were calculated from univariable logistic regression model and multivariable logistic regression model respectively.

6.268, 95% CI 1.324–29.668). In terms of the correlations between income and education (Oltra and Sala, 2014), people with higher income is likely to get good education resources and obtain well education easily. Additionally, people with higher education level may focus more on social events including air pollution rather than self-cases. Hence, income factor may be positively correlated with knowledge of air pollution, thus the parents' knowledge of air pollution could lead to the migration intention potentially. Nevertheless, it would be interesting to found that in the community group, parents prefer not to migrate because of their self-responsibility for air quality improvement in Wuhan (OR = 0.366, 95% CI 0.169–0.795). Take the perspective from government of Wuhan, trust in government air pollution controlling has been established within people's lives.

Concerning paying behavior, 72.8% (630/885) of parents were willingness to pay in our research. Similar studies conducted in other regions revealed various percentage for willingness to pay, like 66.4% (911/1371) in Beijing (Wang *et al.*, 2006), 59.9% (546/912) in Shanghai (Wang *et al.*, 2015a), 59.7% (787/1319) in Jinan (Wang and Zhang, 2009), 78.5%(566/721) in Nanchang (Zhang *et al.*, 2014) and 48.3% (233/482) in Chongqing (Wang and Mullahy, 2006). The result of our study is similar to those conducted in Nanchang and Beijing, but higher than that of Shanghai in 2014. The difference may be due to different air pollution levels. According to the 2013 Shanghai Environment Bulletin, there were 124 polluted days out of 365 measured by Air Quality Index (AQI) in Shanghai. The main contaminant was $PM_{2.5}$ with an annual average daily value of 62 $\mu g\,m^{-3}$ which is lower than Beijing (Annual average concentration of $PM_{2.5}$ was 90.1 $\mu g\,m^{-3}$) and Nanchang (Annual average concentration of $PM_{2.5}$ was 69.1 $\mu g\,m^{-3}$) in 2013 (Shanghai Environment Bureau, 2013; Wu *et al.*, 2016). People migrating from city to city cannot obtain certain local government benefits (Wang *et al.*, 2014), that they may invest more in self-protections. The reason why few people were willing to pay in Jinan and Chongqing may because individual-level, societal-level living environment and surrounding air condition lead to different behavioral perception compared with Beijing and Shanghai.

With regard to affecting factors found in willingness to pay between the two groups. In the community group, a greater willingness to pay was associated to younger respondents (OR = 0.119, 95% CI 0.014–0.998). And parents who was born in city had more willing to pay for reducing air pollution than those born in countryside (OR = 2,104, 95% CI 1.019–4.343). Similarities were found in study of Lera-Lopez *et al.* (2012), it has been reported that youngest people mildly or seriously affected by air pollution both had correlation with a greater willingness to pay to mitigate air pollution. In additional, they found that people living in urban areas suffering higher pollution will pay more. Newly finding from Nanchang among common population also proved that willingness to pay is associated with younger ones whose age are between 18 and 29 (Liu *et al.*, 2016)

Moreover, our results showed that parents who believed that it is their responsibility to improve air quality had a stronger willingness to pay (hospital group: OR = 3.380, 95% CI 1.467–7.787; community group: OR = 4.436, 95% CI 2.024–9.724). It implied that people in Wuhan may have their own understanding towards air pollution to some extent. Studies which regard personal responsibility as an independent variable are limited, so further research are warranted.

Generally, the higher income the residents had, the more they willingness to pay for air improvement like smog prevention. It should be pointed out that there is strong correlation between education level and income level. Research conducted in Beijing, Nanchang, Jinan, Chongqing and Shanghai showed that AAHI and education level were correlated to willingness to pay. The European research also indicated that people's attitude towards government actions against the issue was strongly related to willingness to pay (Istamto *et al.*, 2014). But our study did not found willingness to pay was statistically significant with factors of AAHI, level of education and attitude towards priority of air quality in government management. This difference may be caused by the diversity of sources of pollution in different regions and various government measures against air pollution.

There are several limitations in our study. One is limited to parents or caretakers with children aged 2–10, while residents with children of other age groups or adults without children who may have different attitudes towards the issue were not included in this study. With respect to the two behavioral intentions, selection bias may existed due to two special populations. Therefore research based on large sample and other different sites are necessary to be conducted in the future.

CONCLUSIONS

This study showed relatively high tendency of propensity to migrate and willingness to pay to improve air quality in Wuhan and most of citizen had the sense of air pollution responsibility. Therefore, parents from both hospital and community groups should considered as the potential populations to protect our air quality. Local governments should pay more attention to parents' knowledge of air pollution and attitudes towards government management of air quality, especially those willing to migrate. In addition, similar studies focusing on propensity to migrate within parents populations have not been conducted before, so further studies combing children's health condition which seems as a interesting factor need to confirm our conclusions.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary data associated with this article can be found in the online version at http://www.aaqr.org.

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