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Residents' willingness to invest in sanitation: evidence from rural China

Simei Wu[a,*], Hanliang Fu[b,c], Huimi Li[a], Chao Ding[d], Mengmeng Wang[c]

[a]*School of Civil Engineering, Xi'an University of Architecture and Technology, Yanta Road 13, Xi'an 710055, China, Tel. +86-029-82202947; Fax: +86-029-82205014; email: SimeiWu@foxmail.com (S. Wu), Tel. +86-029-82205014; email: li_huimin2005@126.com (H. Li)*
[b]*School of Management, Xi'an University of Architecture and Technology, Yanta Road 13, Xi'an 710055, China, Tel. +86-029-82202947; Fax: +86-029-82205014; email: hfu1234@ilstu.edu (H. Fu)*
[c]*Department of Technology, College of Applied Science and Technology, Illinois State University, Turner 5100, Normal, IL 61790, USA, Tel. +86-029-82202947; email: mwang42@ilstu.edu (M. Wang)*
[d]*School of Civil Engineering, Inner Mongolia University of Science and Technology, Baotou 014010, Tel. +86-029-82202947; email: dckinger@imust.edu.cn (C. Ding)*

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ABSTRACT

Sanitation is generally poor in the rural areas of China, leading to serious pollution and posing a health hazard to inhabitants. To achieve a level of sanitation that is effective and appropriate, respondents are urged to participate in funding the solution. This study is intended to determine the factors that can affect residents' willingness to pay for upgrading the sanitation facilities in their villages and the main reasons behind their choices. Data were collected in Shaanxi from November 2016 to August 2017. A total of 353 respondents were chosen at random. The results show that sanitation education, water pollution, and dissatisfaction with the current state of sanitation, could increase respondents' willingness to invest in sanitation facilities. Moreover, respondents who organized village activities were more likely to contribute. Females who suffered from health hazards also revealed a positive attitude towards investing in sanitation. Furthermore, results indicated that the government should note the importance of awareness, of dispensing relevant information and the exemplary role played by respondents who organize communal activities in villages.

Keywords: Sanitation; Willingness; Attitude; Rural

1. Introduction

More than one billion people in the rural areas of developing countries live without effective sanitation, which severely impedes the quality of life, public health, and economic development [1–3]. In 2018, 85% of Chinese villages lacked centralized sewage treatment [4]. Today, inadequate sanitation systems still threaten groundwater and human health in the rural areas of China [5]. In response, the Chinese government, in collaboration with many non-governmental organizations [6], launched its "Beautiful Countryside" plan to upgrade sanitation in rural areas [7]. Local governments attempted to replace damaged pipes, expand pipelines and introduce sewage treatment equipment. However, the population and districts of rural China are so large that the escalating costs of upgradation have delayed the plans. Therefore, local governments need villagers to contribute funds to implement these plans. To further the installation of sanitation systems, local governments have begun to raise funds directly from their constituents. But, the number of respondents willing to contribute is few, which, in turn, has delayed upgradation. Without inputs from villagers, it is very difficult to upgrade sanitation in rural areas. Therefore, it is important to have a deeper understanding of the factors that can impact villagers' attitudes towards investing in sanitation. For this purpose, we undertook to estimate the villagers' "willingness to pay" (WTP) factor for upgrading sanitation.

* Corresponding author.

The respondents' willingness to pay is the key to upgrading sanitation [8]. Bolaane et al. [9] found that income levels, existing sanitation facilities and perceptions about sanitation had a significant impact on respondents' WTP for better facilities. Houtven et al. [10] used meta-analysis to measure the WTP of respondents and found that the respondents' attitudes were affected by the magnitude of improvement, income and elicitation method. Gross and Günther [11] suggested that low income, high upgradation costs, and fear at night could affect the attitudes of respondents towards paying for sanitation. On the other hand, McMichael [12] found that social pressure and contaminated drinking water could arouse villagers' WTP. Santos et al. [13] found that the status of the house, accessibility, privacy and health attributes were determinants for sanitation adoption. Coffey et al. [14] suggested that villagers who had a higher level of education, or better income levels, were more positive about building sanitation facilities. Villagers who lived in a house that needed improvement had more motivation to build sanitation than the others. Dickin et al. [15] suggested that the reuse of nutrients could arouse the villagers' willingness. Scott et al. [16] pointed out that tenure security could significantly impact the respondents' decision to invest in sanitation. Kennedy-Walker [17] found that trust, cooperation, and communication were the key factors that could statistically impact respondents' willingness to upgrade sanitation, while Davis et al. [18] showed behavior education and public participation were key factors. Novotný et al. [19] stated that payment capacity, added benefits and social pressure could trigger investment in sanitation. Several studies also considered factors such as the presence of child, social pressure and neighbors [20–22]. But there has been very little research that focusses on the rural areas of China – especially on exploring the difference in WTP for sanitation between female and male respondents.

Understanding the factors that could affect respondents' WTP was an integral part of studying sanitation in rural areas. To describe and identify the variation in awareness levels, we surveyed respondents in rural China. Using surveys and binary logistic regression, we examined the factors affecting respondents' WTP for sanitation. Previous studies showed that females and males might have different attitudes towards green purchase [23]. And, the gender gap in rural areas was impacted by traditional culture and urbanization [24]. Thus, we verified the results by considering subgroups divided by gender. In this way, we hoped to get a better understanding of respondents' attitudes, through the analysis. Besides exploring the factors that could impact respondents' WTP for upgrading sanitation, our research also aimed to explore the reasons why they were willing or unwilling to pay. The results of this study could provide critical information and insights, for policymakers to design proper policies to upgrade sanitation in rural areas.

2. Materials and methods

2.1. Case study area and survey method

The study area is in rural Shaanxi, a typical developing region with 38.13 million inhabitants in 205,800 km^2 [25]. It is a center for grain-producing and animal husbandry [26]. The rural inhabitants in this area suffer from a severe lack of sanitation facilities which results in the increasing contamination of groundwater [27]. During the survey, we found that sewage was being discharged without any treatment in eight of the surveyed villages. Due to the lack of pipelines or damaged pipes, the sewage could not be fully treated in the other seven surveyed villages either. Among all the surveyed villages, in only one village was the sewage adequately treated. This phenomenon has been confirmed in a report by the Chinese national bureau of statistics [4].

In a study that ran from November 2016 to August 2017, we used stratified random sampling to provide precise regional estimates and chose 16 villages from among the regions of Shaanxi [28]. Six typical cities with different climate and economic sources were chosen from Shaanxi. According to the population of each city, we proportionately chose survey villages. Then, 10% of the households in each village were randomly selected. In each household, we randomly picked one household member who was older than 18 years of age. The response rate was 90.25%, and, after factoring out disqualified subjects, we obtained an 88.25% response rate. The final sample was 353 respondents in 16 villages (Fig. 1). This sample size met the requirements of our study, according to the research of Hair et al. [29], Sekaran and Bougie [30].

Eight interviewers were trained prior to the survey. Before the survey, all respondents were notified that participation was voluntary. Each survey lasted 20 min and began by introducing the purpose of the survey and requesting respondents to give their consent. Respondents were informed that the cost of upgrading sanitation only covered the replacement of damaged pipes, expanding pipelines and introducing sewage treatment equipment, but did not cover operational and maintenance expenses. Respondents who were willing to pay were also questioned about how much the household could afford. Throughout the survey, respondents were encouraged to ask questions and request clarification wherever necessary.

2.2. Survey structure

The socioeconomic status, awareness levels among respondents and the local sanitation facilities were investigated during the survey. Contingent valuation method served as a foundation for the questionnaire which was applied to the study area [31]. The survey questionnaire consists of three sections which included: (1) demographic and socioeconomic characteristics, (2) awareness of personal sanitation and pollution, (3) WTP and reason for willingness or unwillingness to pay for upgrading sanitation. An open approach was employed but had rarely useful echo. Our approach allowed for the inclusion of protest responses and avoided selection bias [32,33]. Focus groups have emerged as a suitable tool for new fields of analysis and we decided to use them to get a better understanding of group reactions to particular problems [34]. Thus, we organized four focus groups consisting of experts, local officials, and villagers. Each focus group included five respondents and each session took approximately 1 h. The questionnaire was revised based on these discussions. The questionnaire was then pre-tested

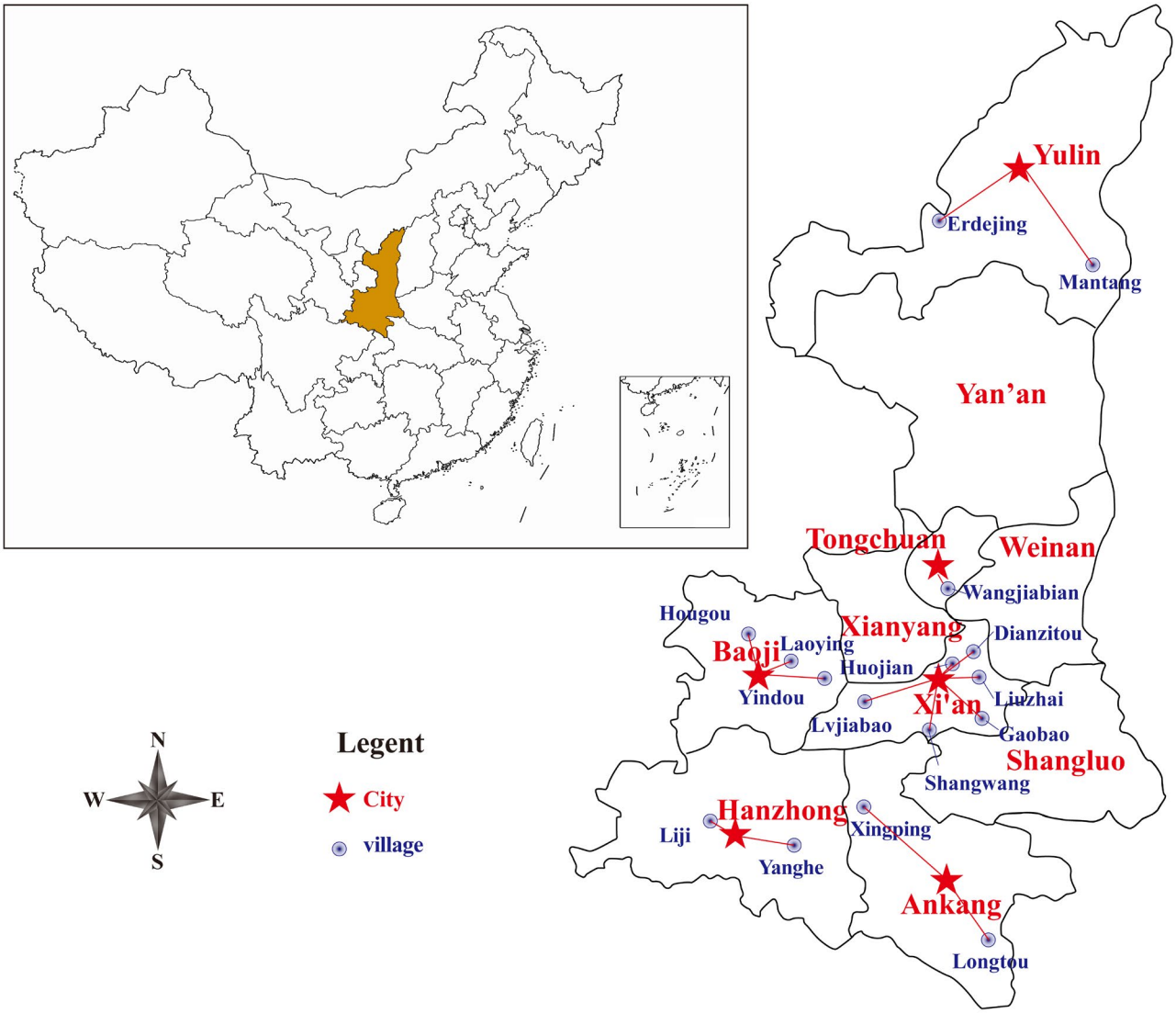

Fig. 1. The study area.

on 40 villagers and revised once again, based on their feedback. There were very few missing values and the quality of the data was excellent. The result of the Kaiser-Meyer-Olkin (KMO) test was 0.72, while the result of the Bartlett test was significant ($p < 0.001$), which meant that the quality of data was good enough for this research.

2.3. Method of analysis

Logistic regression is good for correlated statistics [35]. Zemo and Termansen [36] used logistic regression to analyze influential factors that could impact the farmers' WTP for biogas. Binary logistic regression was used by Urpelainen and Yoon [37] to investigate respondents' WTP for solar home systems in rural India. The dependent variable of this study is binary, and the analysis needs a nonlinear approach. Thus, binary logistic regression was chosen to analyze respondents' WTP. The regression formula is as Eq. (1) respondents [37]:

$$P = \frac{1}{1+\exp\left[-\left(B + B_1X_1 + B_2X_2 + \cdots B_nX_n\right)\right]} \quad (1)$$

where P is the probability of a "yes" answer; B is the regression constant term; B_i is the regression coefficient of X_i i and varies from 1 to n.

For each group, an alpha of 0.05 was used to designate the significance of variables. The odds ratio (OR) was computed for the variables and confidence interval (CI) of 95%. All statistical analyses were conducted using SPSS for Windows version 25.0. To account more properly for confounding variables, hierarchical regression was used to examine the variables. All the socioeconomic variables contained in Table 1 were put in the first block of the model (model 1). Then, soil pollution, water pollution, air pollution, and satisfaction were block entered in model 1 (model 2). Results showed that variables of pollution and satisfaction could improve the R^2 of model 1. Thus, we only presented

Table 1
Descriptive statistics of socioeconomic characteristics

Variables	Questions		N(%)
			353 (100.00%)
Age	Age	18–25	21 (5.95%)
		26–35	72 (20.40%)
		36–45	71 (20.11%)
		46–55	85 (24.08%)
		Above 56	104 (29.46%)
			353 (100.00%)
Gender	Gender	Male	201 (56.94%)
		Female	152 (43.06%)
			353 (100.00%)
Education level	Education level	Primary school	122 (34.56%)
		Secondary school	121 (34.28%)
		High school and above	110 (31.16%)
			353 (100.00%)
Sanitation education	Experience of receiving sanitation education	No	222 (62.89%)
		Yes	131 (37.11%)
			353 (100.00%)
Sanitation knowledge	Knowledge of harmful effects of lack of sanitation	No	130 (36.83%)
		Yes	223 (63.17%)
			353 (100.00%)
Health status	Health status	Unhealthy	56 (15.86%)
		Healthy	297 (84.14%)
			353 (100.00%)
Child	Child	No	190 (53.82%)
		Yes	163 (46.18%)
			353 (100.00%)
Occupation	Occupation	Farmer	124 (35.13%)
		Service personnel	11 (3.12%)
		Migrant worker	121 (34.28%)
		Other work	97 (27.48%)
			353 (100.00%)
Village activities	Experience of organizing village activities	No	339 (96.03%)
		Yes	23 (6.52%)
			353 (100.00%)
Income	Annual household income	<2,962.96 USD	64 (18.13%)
		2,962.96–5,925.93 USD	57 (16.15%)
		>5,925.93 USD	232 (65.72%)

Note: All exchange conversions to USD are at a rate of 6.75, as data was collected mainly in 2017.

the results of model 2 which included all the variables in Tables 1 and 2 for a succinct description.

3. Results

3.1. Socioeconomic, pollution and sanitation characteristics of the respondents

The demographics and background characteristics of respondents and the questionnaire data are presented in Table 1 (n = 353). Of the respondents, 5.95% were 18–25 years old. The low proportion of young respondents may be due in part to the young rural residents being students or migrant workers who need to study or work in the cities. In our survey, 56.94% of the participants were male. This imbalance arose as female respondents showed more diffidence than male respondents in taking part in the survey. We found that 62.89% of respondents had never received sanitation education. It appears that there was not enough education being imparted in the study area. 32.28% of the respondents were migrant workers.

Table 2 gives details regarding pollution, sanitation, and WTP. Descriptions of all variables were collected, including counts and percentages (n = 353). A minority of respondents

Table 2
Descriptive statistics of pollution and sanitation characteristics

Variables	Questions		N(%)
Soil pollution	Do you recognize the signs of soil pollution in your village?		353 (100.00%)
		No	276 (78.19%)
		Yes	77 (21.81%)
Water pollution	Do you recognize the signs of water pollution in your village?		353 (100.00%)
		No	263 (74.50%)
		Yes	90 (25.50%)
Air pollution	Do you recognize the signs of air pollution in your village?		353 (100.00%)
		No	265 (75.07%)
		Yes	88 (24.93%)
Satisfaction	Level of satisfaction with current sanitation in your village		353 (100.00%)
		Lowest	107 (30.31%)
		Low	69 (19.55%)
		Moderate	68 (19.26%)
		High	86 (24.36%)
		Highest	23 (6.52%)
Willingness	Are you willing to pay for upgrading sanitation?		353 (100.00%)
		No	166 (47.03%)
		Yes	187 (52.98%)

recognized signs of pollution in their villages. 30.88% of respondents were satisfied with their current sanitation. 52.98% of respondents were willing to pay for upgrading sanitation (RWP). 47.03% of respondents were unwilling to pay for upgrading sanitation (RUWP).

In Fig. 2 we show what percentage form the RWP group and what they consider to be affordable costs. The majority of the RWP group indicated that they would accept a cost less than USD 37. The percentage of respondents who were willing to pay over USD 74 was 25%. 7% of the RWP said they would accept a price of USD 111. Only 5% of the RWP could afford a cost of over USD 148. The mean WTP of upgrading sanitation is USD 56.67 per household.

3.2. Factors shaping attitudes

Additionally, we added two questions to determine the strongest reasons for being willing or unwilling to pay. As shown in Fig. 3, the dominant reason for paying was convenience. It should be noted that 49.86% of respondents were not satisfied with their existing sanitation (Table 1). Hygiene and pollution factors too had a crucial part to play in the decision to invest in upgrading sanitation. Only three respondents were willing to pay because of social pressure. Among the RUWP, the majority of them thought that upgrading was unnecessary because they were satisfied with the current state of affairs, although they acknowledged that spending on upkeep might be necessary.

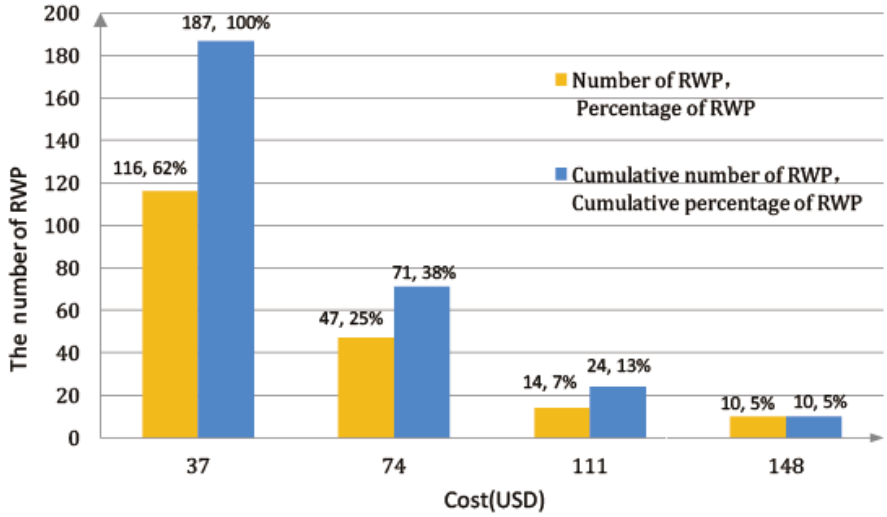

Fig. 2. The percentage of RWP (n = 187).

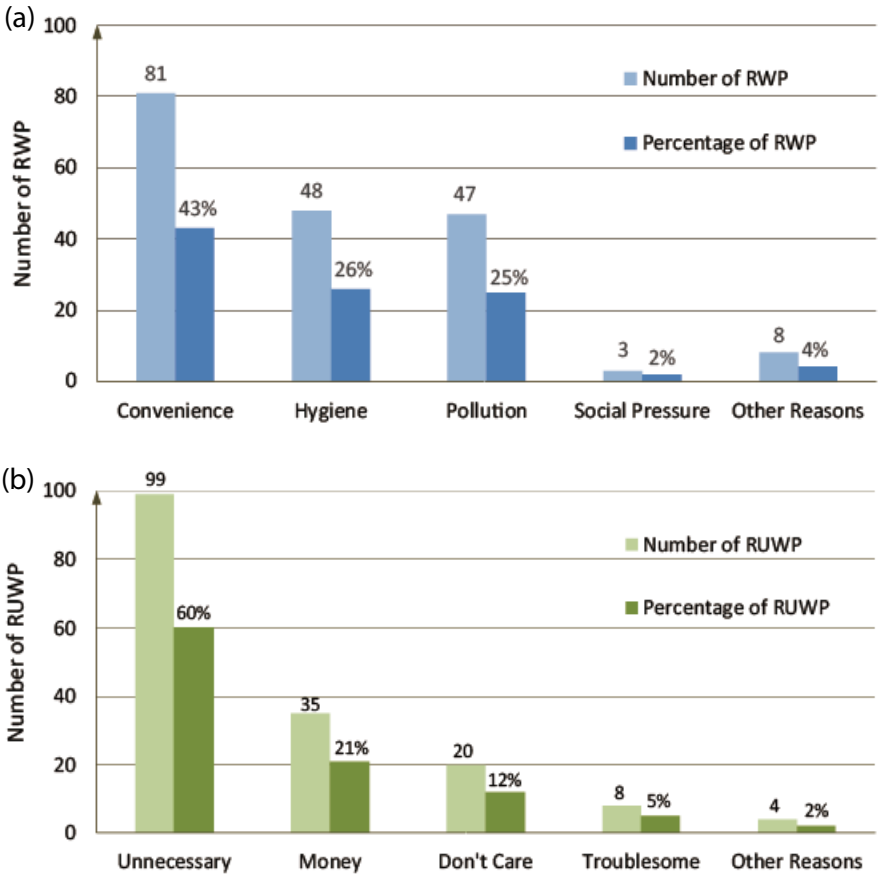

Fig. 3. Reasons for choice: (a) reasons of RWP (n = 187) and (b) reasons of RUWP (n = 166).

3.3. Regression analysis

The survey assessed 353 respondents to analyze the impact of variables in WTP for upgrading sanitation. Jin et al. [38] suggested that females and males might have different attitudes towards environmental behavior and these attitudes may be influenced by different factors. Thus, for a deeper understanding of respondents' attitudes, we verified the results by dividing them into subgroups based on gender. The omnibus tests were used to check whether the model could explain more explained variance than unexplained variance [39]. The results of the omnibus tests showed that the models of total respondents (total model), female respondents (female model) and male respondents (male model) were highly significant ($p < 0.001$), which means that these models were generally fit their data set. Hosmer–Lemeshow (HL) tests were used to estimate whether the model was apt [40]. The results of the HL tests showed that the total model, female model, and male model were adequate. Then, R-square tests were used to estimate the explanatory power [41]. The results of the R-square showed that the total model, female model, and male model were adequate to generalize from. Table 3 displays the OR and 95% CI of WTP for upgrading sanitation.

Respondents who had received sanitation education showed a greater interest in upgrading sanitation facilities. The OR of respondents who had never received sanitation education was 0.25 and the 95% CI was 0.13–0.47. Respondents who were not involved in organizing village community activities showed a negative attitude towards upgrading sanitation (OR: 0.13; 95% CI: 0.04–0.49). Respondents were unlikely to pay if they did not recognize the signs of water pollution; the OR for respondents who did not recognize the signs of water pollution in their villages was 0.21 (95% CI: 0.09–0.47). Respondents who were satisfied with their sanitation showed less interest in paying for upgrading. The OR of the lowest level of satisfaction with sanitation was 6.80 (95% CI: 2.17–21.30), that of a low level was 3.85 (95% CI: 1.18–12.53), that of a moderate level was 1.79 (95% CI: 0.54–5.92), and that of a high level was 1.45 (95% CI: 0.45–4.67). Apart from village activities, the results of the male group mirrored those of the total group. Apart from health status, the results of the female group mirrored those of the total group. Females suffering from poor health were more willing to invest in upgrading sanitation than healthy females (OR: 5.09; 95% CI: 1.51–17.21).

4. Discussion

This article analyzed respondents' awareness of and WTP for sanitation in the rural areas of Shaanxi. The study explored the disparity of WTP in different groups. Through this, we hoped to further understand respondents' perceptions about upgrading sanitation.

Table 3
The output of the model

Variable	Total (n = 353)	Male (n = 201)	Female (n = 152)
Age (18–25)	3.95 (1.00–15.63)	2.28 (0.29–17.78)	11.5 (0.86–154.51)
Age (26–35)	1.52 (0.61–3.81)	0.97 (0.21–4.44)	3.00 (0.58–15.42)
Age (36–45)	1.14 (0.48–2.67)	1.21 (0.28–5.14)	0.63 (0.12–3.43)
Age (46–55)	1.55 (0.76–3.18)	1.4 (0.42–4.67)	1.55 (0.47–5.18)
Age (above 56)	RG	RG	RG
Education level (Primary school)	1.12 (0.49–2.57)	2.29 (0.61–8.68)	0.71 (0.16–3.07)
Education level (Secondary school)	1.28 (0.63–2.63)	1.71 (0.64–4.59)	0.71 (0.20–2.59)
Education level (High school and above)	RG	RG	RG
Sanitation education (No)	0.25[a] (0.13–0.47)	0.28[a] (0.12–0.68)	0.13[a] (0.04–0.44)
Sanitation education (Yes)	RG	RG	RG
Sanitation knowledge (No)	0.59 (0.33–1.08)	0.60 (0.26–1.39)	0.42 (0.13–1.36)
Sanitation knowledge (Yes)	RG	RG	RG
Health status (Unhealthy)	1.49 (0.71–3.16)	0.50 (0.15–1.72)	5.09[a] (1.51–17.21)
Health status (Healthy)	RG	RG	RG
Child (No)	0.69 (0.39–1.22)	0.75 (0.35–1.64)	0.38 (0.12–1.24)
Child (Yes)	RG	RG	RG
Occupation (Farmer)	1.17 (0.58–2.37)	0.88 (0.34–2.27)	2.16 (0.56–8.35)
Occupation (Service personnel)	0.39 (0.08–1.80)	0.64 (0.07–5.92)	0.15 (0.01–2.63)
Occupation (Other work)	1.06 (0.52–2.15)	1.31 (0.52–3.30)	0.68 (0.16–2.90)
Occupation (Migrant worker)	RG	RG	RG
Village activities (No)	0.13[a] (0.04–0.49)	0.16 (0.02–1.34)	0.06[a] (0.01–0.49)
Village activities (Yes)	RG	RG	RG
Income (<2,962.96 USD)	0.54 (0.23–1.25)	0.32 (0.10–1.07)	1.00 (0.19–5.17)
Income (2,962.96–5,925.93 USD)	0.76 (0.37–1.56)	0.47 (0.17–1.27)	1.8 (0.45–7.09)
Income(>5,925.93 USD)	RG	RG	RG
Soil pollution (No)	1.98 (0.78–5.03)	1.89 (0.54–6.58)	1.27 (0.19–8.49)
Soil pollution (Yes)	RG	RG	RG
Water pollution (No)	0.21[a] (0.09–0.47)	0.15[a] (0.05–0.49)	0.10[a] (0.02–0.48)
Water pollution (Yes)	RG	RG	RG
Air pollution (No)	0.64 (0.27–1.52)	0.59 (0.17–2.02)	0.76 (0.17–3.42)
Air pollution (Yes)	RG	RG	RG
Satisfaction (Lowest)	6.80[a] (2.17–21.30)	7.34[b] (1.31–41.26)	8.15[b] (1.13–58.58)
Satisfaction (Low)	3.85[b] (1.18–12.53)	2.56 (0.43–15.21)	5.45 (0.69–42.76)
Satisfaction (Moderate)	1.79 (0.54–5.92)	3.00 (0.48–18.73)	0.40 (0.05–3.37)
Satisfaction (High)	1.45 (0.45–4.67)	1.68 (0.28–10.02)	0.59 (0.08–4.62)
Satisfaction (Highest)	RG	RG	RG
R^2	0.40	0.39	0.57

Note: [a]$P < 0.01$, [b]$P < 0.05$.
RG: reference group. The dummy variable was established through assigning "reference group" to 0.00. R^2 is the result of Nagelkerke R square.

Extant literature has generally acknowledged that there is a connection between relevant education and WTP [42]. Sujitra [43] found that relevant knowledge had a positive correlation with WTP for waste management. In our study, similar concerns about education on sanitation were voiced by the subjects. The experience of receiving sanitation education had a positive effect on respondents' WTP. We can interpolate, therefore, that the relevant education should be imparted to inform villagers of the dangers of inadequate sanitation so that they will realize the urgent need to upgrade sanitation and show greater enthusiasm.

A sense of duty could play an active role in respondents' WTP [44]. In our study, the experience of organizing communal activities in the village had a positive effect on respondents' WTP, especially for female respondents. One possible reason for this can be that those respondents who organize village activities are more altruistic and socially responsible than other villagers. So, they have a more open attitude regarding environmentally friendly behavior that could benefit the community and the environment [45]. But this factor had a less significant impact on the male group. This may be because males own more opportunity

to organize activities than females. As a result, males pay less attention to the experience of organizing activities than females. Thus, village activity had no significant impact on the male group.

Various studies have indicated that pollution can impact respondents' WTP [46]. Zhiyong [47] found that villagers who perceived pollution had a more positive attitude towards paying for waste management. Istamto [46] found that respondents' willingness changed with different kinds of pollution. The results of our study indicated that the respondents who recognized the signs of water pollution were more willing to invest in better sanitation, across all groups. This may be because the absence of sanitation has a greater effect on water pollution than on soil or air pollution. Thus, water contamination provokes respondents into upgrading sanitation, more than soil pollution and air pollution do.

Unsatisfactory sanitation facilities have been considered a key factor impacting respondents' WTP [48]. Results indicate that satisfaction is associated with unwillingness to pay for upgrading sanitation. It is quite understandable that respondents who are satisfied with the current level of sanitation will lack the motivation to upgrade [49]. Thus, it is the unsatisfied respondents who express an interest in upgrading sanitation.

The respondents' willingness to invest in a cleaner environment and better sanitation infrastructure can also be impacted by health status [21]. Our findings indicate that poor health status has a positive effect on respondents' WTP for upgrading sanitation, in the female group. One possible reason for this can be that unwell females attribute their health problems to poor sanitation. And unwell females need conveniently improved sanitation more than good females. But this phenomenon was not reflected in the male group or in the total group. This may be because females undertake more housework and use sanitation more often than males in rural areas. As a result, poor sanitation causes more inconvenience to unwell females than to unwell males. Thus, the status of their health had no significant impact on the male group or the total group.

This study has its limitations. Firstly, some of the young villagers in the study area migrate to work in cities and towns. Thus, 26.35% of respondents in our survey were younger than 35 years old which may be a limitation as the proportion of young respondents was low. Secondly, only 43.06% of respondents were female, a shortfall which may be due to the limitations of traditional culture. Sex distribution was not equal in this survey which may cause potential bias. Further, the study area is typical of a developing area, thus, the findings of this study need to be corroborated to see if they hold good for developed areas.

5. Conclusions

The absence of sanitation is a critical social problem in rural areas. Our research focuses on the factors which can impact respondents' attitudes to investing in sanitation. The results of this research suggested that water pollution and sanitation education could increase respondents' interest in upgrading sanitation. Satisfaction with the current sanitation facilities discourages an interest in investing in improving sanitation. Playing a role in organizing communal activities also had a significant impact on the attitudes of female respondents, and the total group. But this factor did not make a difference to the male group. Females suffering from poor health were more open to investing in sanitation than healthy females. The mean WTP of respondents for promoting sanitation was estimated to be USD 56.67 per household.

The results also indicate that education on sanitation needs to be enforced. Governments should create awareness on the negative effects of poor sanitation, connecting the absence of sanitation to different kinds of pollution, contamination and health hazards. In this way, governments can avoid the biases that stem from ignorance about sanitation. Also, governments should utilize people who organize communal activities to galvanize the enthusiasm of villagers towards the construction of sanitation facilities.

This study focusses on the attitudes of villagers to upgrading sanitation. In order to promote sanitation and create practical polities in rural areas, further studies could be conducted studying the impact of relevant policies on villagers' behaviors. The results between the gender-based subgroups did not show much difference which might due to the limited sample size. Thus, further studies could examine the effects of gender with a larger sample size. Additionally, the villages in developed areas and other ethnic areas need to be covered in future research. The researchers should explore respondents' behavior in different ethnic cultures and get deeper information on the attitudes of the villagers there.

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