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ORIGINAL RESEARCH PAPER

Assessment of willingness to pay for improved air quality using contingent valuation method

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ABSTRACT: Rapid urbanization and severe air quality deterioration in Pakistan have increased citizens's concern towards air pollution. The study aimed to develop relationship between degraded air quality and resident's willingness to pay for improved air quality in city of Lahore, Pakistan through contingent valuation method to quantify an individual's willingness to pay for improved air quality. Hypothetical market was created and 250 respondents, selected through random sampling, were asked to respond to pre tested questionnaire. Results revealed that 92.5% of respondents showed positive willingness to pay and average predicted willingness to pay by each person was $9.86 per month. Respondents were willing to pay $118 per year which was 1.27% of their mean monthly income. Stepwise Regression model was used to develop relationship between independent variables and willingness to pay. Most parameters accompanied by econometric analysis elaborated expected results. Results disclosed that annual household income, symptoms of respiratory diseases and self observed air pollution pointedly impact willingness to pay. It is concluded that despite of the fact that Pakistan is among the lower income countries with no rigid budget allocation for improvement in air quality, people of Pakistan are willing to pay to reduce air pollution load. One of the factor which effected the positivity of willingness to pay is that, a quite large number of people were suffering from pollution related respiratory disorders like asthma, chronic bronchitis, wheezing, cough, and chest congestion. Only 7.5% of respondents were not interested to pay for improved air quality which reported unconcerned attitude and lack of environmental awareness.

KEYWORDS: *Air pollution; Contingent valuation method (CVM); Developing country; Regression model; Respiratory diseases; Willingness to pay (WTP).*

INTRODUCTION

Air Pollution is becoming a menacing threat globally and in most of urban areas, it is surpassing national air quality standards for many air contaminants. Industrial development, urbanization and population explosion has driven economic progression along with environmental deterioration, which requires expenses. Illness and fatality rate strikes a peak when air pollution rises to dangerous level (Peng and Tian, 2003). Air contaminants such as particulate matter, CO_2, SOx and NOx increase in atmosphere primarily due to coal burning activities for energy purposes. 65-70% of total global energy is consumed by coal (Haung *et al.,* 2104). In developing countries outdoor air quality is on the brink of disaster, and is a major cause of many health hazards for common man. Rapid industrialization and inevitable urbanization, in previous decades has worsen the situation (Cohen *et al*., 2005). Additionally excessive fuel combustion and ill planned construction activities are flaring up the situation (Cohen *et al*., 2005). An increase in air pollution level raises public morbidity rate during the past decades (Krupnick *et al.*, 1997; Cropper

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et al., 1997). According to studies 20% of total burden of diseases in developing countries is due to environmental pollution (Cohen *et al*., 2005), whereas Asian countries have highest morbidity rate due to air contamination. China reported 1.2 million premature deaths in year 2010 (Cohen *et al*., 2005; Amer, 2015; Van der Wall, 2015). In low and middle income counties only (Particulate matter) PM is responsible for 88% of respiratory and cardiovascular diseases (Ali *et al*., 2015). In Pakistan, various studies rendered the air quality as being poor and related it to severe health impacts on human health including lungs, optical, skin and other illnesses (Soloman, 2012; Yamamoto *et al*., 2014). In Lahore 1,250 people die because of air pollution (Aziz and Bajwa, 2008). Motor vehicle air pollution is major type of air pollution causing massive morbidities. Motor vehicle emission is comprised on Carbon monoxides (CO), Hydrocarbons (HC), PM_{10}, Nitrogen oxides (NOx), Sulphur oxides (Sox) and Ozone (O_3), (Aziz and Bajwa, 2008). Many metropolitan cities of the country evidenced increased level of PM, SOx, NOx, CO_2 and other greenhouse gases in ambient air (Soloman, 2012; Yamamoto *et al*., 2014). The proportion of theses contaminants varies with traffic density and speed of vehicles whereas the increasing industrialization is exacerbating the situation (Aziz and Bajwa, 2008). The number of registered vehicles in Punjab in 2010 was 7,483,860 whereas the growth rate from 2002 to 2012 was 130.3%. Infrastructure of Lahore included 1244.41 km^2 of metaled roads (Ali *et al*., 2015). As a consequence of this much heavy traffic burden of road the metropolitan city is suffering from poor air quality and increased number of patients paining from respiratory disorders. The relationship of economics and environment has been observed previously through different researches. Due to numerous adverse effects on human health and capital, air pollution has become a matter of great and equal interest to economists and environmentalists (Pearce and Crowards, 1996). Air quality effects the individual's utility of public good and an economic value exists. (Kumar and Rao, 2006). In fact, Willingness to pay (WTP) for clean air is also a key parameter when considering the tradeoff between economic growth and environmental regulations (Greenstone and Jack, 2013). There are many different ways to capture the economic value of public goods, among which contingent valuation method (CVM) is also a one (Arrow *et al*., 1993; Hausman, 1993; Li, 1994; Smith 1992). This method presents consumer with hypothetical opportunities to buy public goods, thus circumventing the absence of a real market for them. The resulting information is very useful to the decision makers since it records both the direction and the strength of a respondent's preferences (Lookwood, 1996). Dose-response method is one of conventional methods to evaluate value of air quality improvement as atmospheric contamination influences community, human health, agrarian productivity and industrial development. This method is often considered unreliable because of the uncertainties in the estimated dose-response relation (Krupnick *et al*., 1997). Since air pollution can affect many aspects of a society such as human health, agricultural yield and industrial production. Hence it is difficult to measure the benefit of air quality improvement by traditional means such as the dose–response method. Contingent valuation method is a useful device to deal with this issue (Afroz, 2005).

The objective of the research was to evaluate the public's WTP for 50% reduction in air pollution in an urban area of Lahore. The study was carried out on in Lahore, Pakistan in 2016.

MATERIAL AND METHODS

Study site description

Lahore, the capital of Punjab is located 31.55°N, 74.36°E and is a culturally rich, socially diverse and wealthiest city of Pakistan (Fig. 1), which contributes $58.14 billion to the GDP annually. Samnabad counts among the low income settlement with high population density area of Lahore Pakistan. This region of Lahore is one of the most anciently built zones. Apart from present green belts, high population indicates high number of transport. The major culprits in deteriorating the air quality of Samanabad area are industries, automobiles and ongoing construction project of orange line since October 2015. The major pollutants in the area were NOx, SOx, $PM_{2.5}$ and all were exceeding National Ambient Air Quality Standards (NAAQS), (Raza, 2016).

Due to high population density, the number of people which are exposed to air pollution is quite large. As air pollution causes serious economic loss hence investment in pollution control technologies is increasing while the public pressure on local government is mounting to take immediate mitigation actions to crack down pollutant levels. This significant degradation of air quality is also posing inevitable health impacts on the residents. Hence the area has been chosen for the valuation of household WTP for improved air quality.

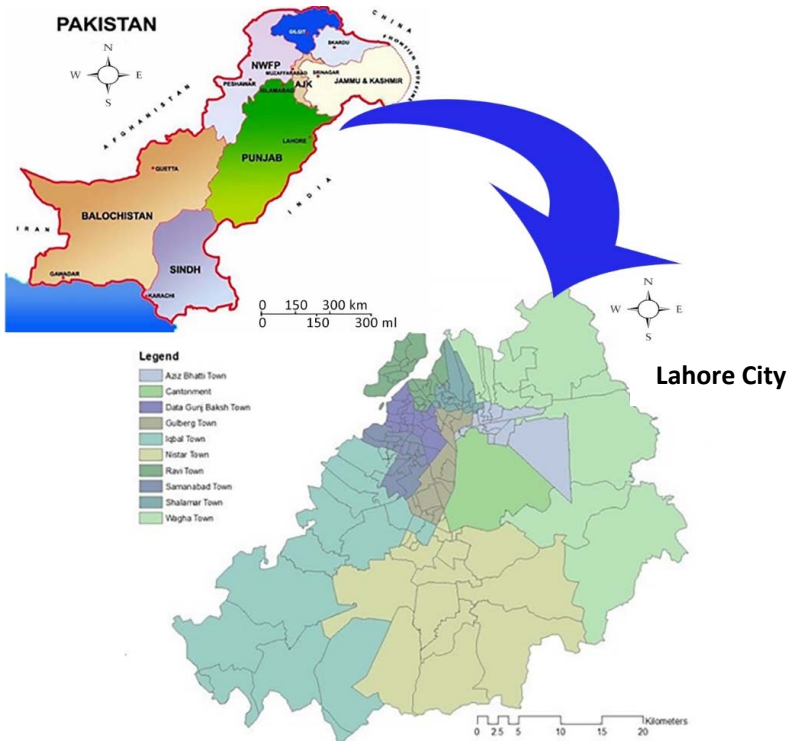

Fig 1: Location map of study area

Questionnaire and survey design

The study was based on face to face survey of randomly selected 250 households. Respondents were required to respond an amended pretested questionnaire (Wang and Zhang, 2009; Gaviria, 2013). The survey was conducted in November 2016. Out of 250, 232 respondents agreed to participate in the study, hence the response rate was 93%. About 32 questionnaires were not filled completely, thus, they were excluded from the study, and the data of 200 respondents were finalized and analyzed.

The questionnaire was divided into 3 sections. Section I consisted of questions regarding demographics including gender, age, monthly income, marital status, number of household members, profession. Section II comprised of respondent's subjective view about the air quality of their area, and their respiratory health. While the final section contained the contingent valuation question. As is well known, these type of questions have been often discussed in CVM literature (Arrow *et al.,* 1993; Hanemann, 1994). Following CVM question was asked. There are several measures that could be taken in order to improve the level of air quality in Samanabad, Lahore. Among possible measures are; the installation of catalytic converters on all gasoline cars built 1990 and later, the creation of non-traffic areas, the elaboration of gasoline without lead, the use of green buses, improved road infrastructure etc. As mentioned earlier, the applications of these measures cause a cost which directly or indirectly will be paid by us. This payment could be through: more expensive cars, increased fuel (gasoline and diesel) prices and public transport fares. Suppose the authorities presented a program which would decrease the level of atmospheric contamination by 50%. Considering the monthly household income is respondent is willing to pay the cost so that the aim can be achieved?

What is the maximum amount one would be able to pay to improve air quality?

a) Yes b) No

Statistical tool and methods

Statistical package SPSS 20.0 was applied to calculate the relationship between WTP and influential factors. After initial statistical analysis, linear regression was used to identify the variables that effect the respondent's final decision on WTP. Afterwards stepwise linear regression model was constructed to determine the amount of positive WTP and to predict mean value of WTP.

RESULTS AND DISCUSSION

About 64.5 % respondents were female while 35.5% were male. Average age was 27.37, the mean education was 12 years, about 59.5% people were single, average number of children was 1.13 and mean number of family members was 5.60, while the average monthly income was $776.04 (Table 1). In short the respondents were more likely to be female, young, more educated, with more family members and relative average monthly household income.

Factors effecting negativity and positivity of WTP

Out of total 200 valid respondents, 185 responded positively (WTP>0) to valuation response question. Hence the positive response rate was 92.5%. The study area is among the most polluted areas of Lahore, with significant number of automobiles and ongoing mega-construction projects which are not managed well. Hence the extremely high level of PM, and other pollutants affects the daily life of people who live there, work and walk in the area for several reasons; therefore

Table 1: Demographic results of selected respondents

Characteristic	Frequency	Percentage %	Mean ± S.D
Gender			
Male =1	71	35.5	1.64±0.47
Female =2	129	64.5	
Age			
14-20	64	32	
21-26	60	30	27.37±10.75
27-33	31	15.5	
34-40	13	6.5	
41-47	17	8.5	
48-53	15	7.5	
Educational years			
5=1	15	8	3.27±3.23
8=2	57	28.5	
12=3	17	8.5	
16=4	81	40	
18=5	30	15	
Marital Status			
Married=1	79	39.5	3.39±1.95
Divorced=2	2	1.0	
Single=3	119	59.5	
Number of Children			
0-1	133	66.5	
2-3	46	23	1.13±1.72
4-5	17	8.5	
6-7	4	2	
Number of House members			
1-5	111	55.5	
6-10	87	43.5	5.60±1.92
11-15	1	0.5	
16-20	1	0.5	
Monthly Income			
<500$	90	45	
<1000$	84	42	Mean: $776.04
<1500$	7	3.5	
<2000$	11	5.5	
<2500$	3	1.5	
>2500$	5	2.5	
Self-reported air pollution			
*Severe Air Pollution =1	181	90.5	
(Easily observable)	19	9.5	0.90±0.29
Other =0			
Respiratory Disease	90	45	
Yes = 1	110	55	0.45±0.49
No = 0			

*Pollution which can be observed by a common person, even without the proper knowledge about pollution. Significant properties are blue vision, feeling of congestion, and throat irritation .e.g. smog

most of the individuals were concerned for air quality and its consequences on their health. The respondents were split into seven groups, which were based on the money they would be willing to pay (Table 2).

The share of negative WTP the true zeros (WTP=0) is quite smaller, only 7.5% of total respondents were not willing to pay a penny to improve air quality of study area. There can be various explanations, the major justification which true zeroes gave in open ended question was that the government should take active actions to overcome pollution, the other explanation in their view is that the polluter should pay to mitigate air pollution. In the answer of a question, who should be most concerned to clean air? About 27% of people responded that it is the duty of Authorities including federal and provincial government. Surprisingly about 65.5% people agreed that to keep the air clean is the responsibility of every citizen. Only 7.5% of people responded that it should be the duty of contamination combating and controlling departments including Environmental Protection Agencies etc. The other explanation for negative response is unawareness or insensitivity of people regarding air pollution and other environmental issues and low monthly income as well. A possible explanation is that people think that as they are paying taxes, the authorities should manage to control air pollution rather than to ask for more money to improve air quality. Unexpectedly a large proportion of respondents were willing to pay for improved air quality, the major explanation was the excessive smog during the period of survey. The smog comprised of PM, SOx and NOx due to several factors, including vehicular emissions, residual crop burning and mismanaged construction caused 48 hours of heavily polluted atmosphere on 7-8 November, 2016 (Raza, 2016). Pak EPA took rapid action and sealed 56 furnace, and re-rolling mills in Lahore (Raza, 2016).

T test, regression models are often used to check the effects of various independent variables on dependent factor. T test can only determine the relationship of one independent and dependent variable. Hence, simple linear regression was applied to determine the relationship of several independent factors on positive WTP. The independent variable expected to have effect on respondent's WTP were age, gender, education level, monthly income, number of household members, number of children, respiratory diseases and self-reported pollution in the city (Akhtar *et al.*, 2017). Statistical analysis (Table 3) demonstrated the results of linear regression, which revealed statistically significant positive association with monthly income ($P \leq 0.05$), self-reported air pollution ($P \leq 0.01$), and one's suffering from air pollution ($P \leq 0.01$). It is assumed that individuals with higher monthly income, better socio-economic conditions were more willing to pay for emission reductions, reducing pollution load and improved air quality as compared to those with less income and poor socio-economic conditions which conforms to economic theory (Wang *et al*., 2006). It was also observed that due to virtuous educational status people of Samanabad were employed in high paying jobs. Airborne illnesses like asthma and other obstructive respiratory illnesses increases people WTP for improved air quality. (Alberini and Krupnick, 2000; Choe *et al*., 1996). The results were similar to another study conducted in Mashhad, Iran where the respondents suffering from asthma were more willing to pay for improved air quality (Shahnoushi *et al*., 2010). Surprisingly the factors which were hypothesized to increase probability of positive responses such as number of household members and number of children were negatively associated with probability of willingness to pay, while other factors like gender, age, education level, and marital status were statistically

Table 2: People WTP for improvement in Air quality in Samanabad, Lahore City

WTP/month ($)	Frequency	Percentage
0	15	7.5
1-5	57	28.5
6-10	64	32
11-15	27	13.5
16-20	25	12.5
21-30	5	2.5
>30	7	3.5
Total	200	100

Table 3: Linear regression model of positivity of WTP

Variables	Coefficient	S. E
Gender	.021	.020
Age	.004	.002
Education level	.004	.009
Marital Status	.000	.009
Number of children	-.014	.009
Number of household members	-.001	0.005
Suffering From Disease	.016	0.020**
Monthly income	.012	.001*
Air Quality of Area	.077	.032**

*$P \leq 0.05$; **$P \leq 0.01$

insignificant. The results were similar to another study conducted in Mexico where the increasing number of adults in the house were inversely relating to people's WTP (Filippini and Martínez-Cruz, 2016). Hence people with high monthly income, symptoms of respiratory illnesses and who observed severe deterioration of air quality were more likely willing to pay for improved air quality.

Determinants Amount of WTP

Regression models have been widely used in environmental valuation studies to predict the outcomes (Maloma, 2014). To determine the amount of WTP stepwise regression model was constructed using Statistical package SPSS 20.0 to define the most essential independent variables in prediction equation, ($Y= \beta_0+\beta_n X_n$). Variables having a significant impact on positive WTP included monthly income, self-reported air pollution and symptoms of respiratory diseases with significance level of 0.05 (Table 4).

Analysis of the results shown that residues of WTP were normally distributed forming a normal P-P Plot hence explaining a better estimation of WTP value.

The prediction Eq. 1 is:

WTP=-243.973+811(Respiratory disease symptoms) +779.407(Self-reported air pollution) +0.003 (Monthly income) (1)

WTP=9.86/ month

Hence predicted mean value obtained from the model (equation 1) is $9.86/ month the range lies $-1.42 to $27.96

Hence keeping in view the above values annual WTP can be calculated.

$9.86* 12

WTP/ annum= $118

Hence concluded that people of Samanabad Lahore are willing to pay $118 per annum to improve air quality. The predicted WTP per household per month is 1.27% of the mean monthly income of people of Samanabad, Lahore. Similar results were found in another study conducted in Sweden, the mean WTP for 50% reduction of harmful contaminants was about $227.66 per annum (Carlsson, Johansson-Stenman, 2010). The study conducted in Maxico concluded that people were willing to pay to reduce pollution load was about $262 per annum (Filippini and Martínez-Cruz, 2016). The study conducted in Cotonou, Benin, which is among less income countries, reported WTP of per person per year to improve air quality was $1.04 (Gbinlo, 2006). Despite of the difference in economic, political, cultural and educational status between Pakistan and other developed countries such as United States, the public's attitude toward the improvement of air quality are similar. The city district government can take steps by investing in increasing the number smoke free areas, introducing efficient environment friendly city transport system, improving the mass transit system of the city so congestion could be reduced, and introducing ecofriendly car engines. Hence in this way the air quality of the system can be improved.

CONCLUSION

This survey included open-ended CVM to measure individual's WTP for air quality improvement. In Samanabad, Lahore and disclosed appealing results regarding WTP of residents for air quality betterment.

Among 250 questionnaires that were filled by residents, 93% showed positive response as they were in favor of WTP for improved air quality and this showed their great concern about this rising issue. Only 7% of respondents were not willing to pay the cost for improvement in air quality. Most of negative respondents seemed to be unaware of environmental conservation as they raised this concern that it is duty of government to pay for cost. Important factors including household income, symptoms of respiratory illnesses and opinions on current air quality governed respondent's decision to pay. The analysis disclosed that gender, age and household size differences did not govern and influence

Table 4: Stepwise linear regression model

Model	Explanatory variables	Coefficient	SE	T	Sig.
1	(Constant)	636.364	78.577	8.099	.000
	Suffering From Disease	925.859	117.135	7.904	.000
2	(Constant)	44.444	151.411	.294	.769
	Suffering From Disease	733.307	119.729	6.125	.000
	Air Quality of Area	784.471	174.306	4.501	.000
3	(Constant)	-243.973	161.181	-1.514	.132
	Suffering From Disease	811.987	116.606	6.963	.000
	Air Quality of Area	779.407	167.516	4.653	.000
	Monthly income	.003	.001	4.160	.000

a. Dependent Variable: Amount willing to pay for improved air

on chances of a positive WTP which were hypothesized to explain the results. The results revealed that CVM is applicable in urban Pakistan and the features of urban resident's WTP gained from this study is quite beneficial since the resulting information records both the direction and the strength of a respondent's priorities. Despite of the fact that Pakistan is among the lower income countries with no rigid budget allocation for improvement in air quality, people of Pakistan are WTP for improvement in air quality. One of the factor which effected the positivity of WTP is that, a quite large number of people were suffering from pollution related respiratory disorders like asthma, chronic bronchitis, wheezing, cough, and chest congestion. The results were quite surprising as compare to other developing countries where due to several socioeconomic factors general public is least concerned about environmental pollution. The results can give essential implications to influence researchers and decision-makers to choose improved air pollution control projects. The results can provide important implications to convince researchers and decision-makers to select better air pollution control projects and practical intuitions about implementation of environmental policies effectually and proficiently. More researchers are required to pay attention on air pollution and growing demand for improved air quality and to develop relationship between degraded health and air pollution in Pakistan.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

ABBREVIATIONS

CO_2	Carbon dioxide
CO	Carbon monoxide
CVM	Contingent valuation method
E	East
e.g.	example
EPA	Environmental protection agency
Eq.	Equation
GDP	Gross domestic production
N	North
NAAQS	National Ambient Air Quality Standards
NOx	Nitrogen oxides
O_3	Ozone
P (value)	Statistical significance
Pak	Pakistan
PM	Particulate matter
PM2.5	Particles less than or equal to 2.5 micrometers in diameter
PM_{10}	Particles less than or equal to 10 micrometers in diameter
SE	Standard error
SD	Standard deviation
Sig	Significance
Sox	Sulfur oxides
SPSS	Statistical package for social scientists
Std	Standard
U.S	United States
WTP	Willingness to pay
$	Dollar
%	Percentage

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