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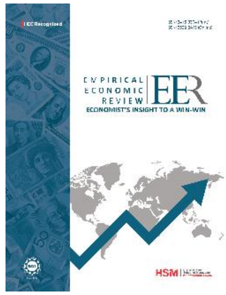

Title:	**An Application of Contingent Valuation Method for Reduction in Risk of Premature Mortality due to Air Pollution: A Case Study of Gujranwala, Pakistan**
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An Application of Contingent Valuation Method for Reduction in Risk of Premature Mortality due to Air Pollution: A Case Study of Gujranwala, Pakistan

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Abstract

In contemporary Anthropocene Epoch air pollution (AP) has crossed the environmental safety standards in most of the urban areas of Pakistan and resulting serious threats to human health. Gujranwala, one of the major cities of Pakistan, also faced many adverse health consequences in terms of respiratory and cardiac diseases, which resulted premature mortality. Contingent Valuation Method (CVM) opted to find trade-off between income and risk of premature mortality. Stratified Random Sampling technique followed to survey 174 respondents in total. Logistic regression was followed for estimation by taking WTP as dependent variable and it was estimated that household's monthly income, health cost, air pollution effects health or not, air pollution result premature mortality or not had significant impact on WTP, while education and employment nature had insignificant impact. The monetary values estimated against each risk reduction option were as follows; PKR 387286 for 1-in1000, PKR 664000 for 5-in-1000 and PKR 931000 for 10-in-1000. A diminishing trend had been observed in trade-off among marginal resources forgone and minimization of risk associated to additional life.

***Keywords*:** Air Pollution, Air Borne Diseases, Premature Mortality, Contingent Valuation Method (CVM), Willingness to Pay (WTP), Simple Logistic Regression, Value of Statistical Life

Introduction

Anthropocene Epoch (Zalasiewicz et al., 2011) is the period in which anthropogenic activities playing dominant role in changing climatic conditions through adverse environmental consequences. Air pollution is among one of the major environmental problems of the urban world resulted by anthropogenic activities (Yasmin, 2002).

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In primary capital cities of Pakistan, air emissions crossed the safe limits set in National Environmental Quality Standards (Ghauri et al., 2007). Greenhouse gases emissions (in terms of CO_2 equivalent) had been increased significantly between the periods 1994 and 2008 in the country (Global Change Impact Studies Centre, 2016), with highest percentage of CO_2 emissions.

Gujranwala, focused area, is an industrial city[1] with congested road traffic. The situation is not different in the Gujranwala than the cities in the rest of the country. Evidence had shown an increasing trend in CO_2 Million Metric Tons emissions. The estimates had also shown that CO and SO_2 exceeded from the National Environmental Quality Standards, while level of Oxygen (O_2) is less than the ambient atmospheric concentration in air[2].

Air pollution leaves its adverse consequences in three ways on human health: acute, chronic and latent. All of them deteriorate health and then leads to premature mortality (Rowlatt et al., 1998; as cited in Dekke et al., 2011) and gradually, atomoshphere is being effectd by many enviraonmental factors (Smith, 1995).

Industrial and domestic air pollution cause serious respiratory and non-respiratory health damage, which leads to premature mortality (Daly, 1959). The pollutant specific CO, SO_2, NO_2, and PM10 related huge cost of morbidity and premature mortality estimated in Iran (Karimzadegan et al., 2008). There is significant respiratory health damage in primary cities of Pakistan only because of particulate matter in air (The World Bank, 2006). In Gujranwala city industrial pollution, especially lead (Pb) and black smoke caused lung, throat and some other respiratory diseases (Yasmin, 2002).

Pakistan had born around PKR 62-65 billion annual health cost because of particulate air pollution in primary capital cities with highest cost of adult premature mortality that was PKR 58-61 billion (The World Bank, 2006).

Air pollution is the result of industrial, domestic and vehicular emissions. It implies that every household, less or more, is contributing in air pollution. To preserve and maintain air quality requires collective efforts and sacrifice of the personal choices of the individuals in the society, in

[1] 6th largest industrial city of Pakistan
[2] Collected personally by visiting EPA's office in Gujranwala

monetary terms. In response to homogenous concentration of air pollution in the atmosphere in the area, everybody at same premature mortality risk.

The objective of the study is to reduce the risk of premature mortality associated with air pollution through individual contributions. For that purpose CVM is opted as a tool to make individuals' to elicit their Willingness to Pay. It is a survey based technique and widely opted by researchers for valuation of small risks (i.e., road accidents, injuries or death risk in factories or coal mines, environmental risks, etc.).

Individuals' WTP then used to find the mean WTP, called as VOSL (Value of Statistical Life). VOSL is the monetized benefit from small risk reduction of premature mortality or it is the trade-off between wealth and small risk reduction in premature mortality. It's important to understand that the estimated value is not the price of a precise life in real terms.

Two set of diseases are considered in this study, (1) cardiovascular diseases: ischemic heart disease (IHD), coronary artery diseases (CAD), Arrhythmia, Hypertension (HTN) and Angina and (2) respiratory diseases: Chronic Obstructive Pulmonary Diseases (COPD), Bronchitis, Asthma and TB. An increasing trend is observed in the cardiac and respiratory diseases in data collected from Divisional Head Quarter Hospital, Gujranwala.

There are some data limitations of the study. First, it was impossible to know that whether cases were acute, chronic or latent cause of non-availability of segregation at hospitals. Second, non-availability of cause-based mortality cases (like air-pollution, food, smoking or other reason behind mortality) were difficult to identify because it was not available too with the hospitals. Third, though data of air pollution was available but source based segregated stats were not available.

The structure of the study is comprised of five sections where the first one is about brief introduction and study objectives. It follows data sources and brief analysis of the data. In third section research methodology is explained. Fourth section incorporates empirical results and final section concludes study findings.

Air Pollution Facts in the Region

This section provides some facts about air pollutant emissions in Gujranwala city over time collected from various resources.

Status of Air Pollutants Emissions in Gujranwala

The level of Carbon Monoxide (CO), Particulate Matter (PM10), Oxides of Nitrogen (NO_x), Sulphur Oxides (SO_x), and level of Oxygen (O) is provided in this section. The hourly average and overall concentration of CO was higher than the National Environmental Quality Standards (NEQS) in the city (Table 1.1 and 1.2). Similarly, the concentration level of SO_2 was also higher than the NEQS but the level of O_2 was less than the normal level in the air. This mean the city is very much polluted. There is exceeding NEQS and it is very harmful for residence.

Table 1

Concentration of CO, O_2 & SO_2 in Gujranwala

Sr. No.	Parameter	Results	NEQS	Remarks
1	CO	16.032 µg/m^3	10 µg/m^3	Exceeding NEQS
2	O_2	19.7%	21%	Less than standard atmospheric concentration in air
3	SO_2	340.28 µg/m^3	120 µg/m^3	Exceeding NEQS

Note. Source: EPA (2011)[3]

Table 2

Concentration of CO in Gujranwala

Time of Observation	Between two Roads Mg/m^3	Middle of the Road Mg/m^3	NEQS for 1 hour Mg/m^3	Remarks
11:00 am	26.33	21.75	10	Exceeding NEQS
12:00 pm	45	23	10	Exceeding NEQS

Note. Source: EPA (2011)[4]

[3] Collected personally by visiting EPA's office in Gujranwala
[4] Collected personally by visiting EPA's office in Gujranwala

Respiratory and Cardiac Hospital Admissions

In this sub-section respiratory and cardiac indoor and outdoor number of admissions and mortality rates collected from DHQH for January 2007-December 2010 are presented. The data collected from DHQH for both respiratory and cardiac patients have shown positive trend for both indoor and outdoor cases. A reverse trend had been observed for both respiratory and cardiac mortality rates, that's cardiac mortality rate was greater than the respiratory ones.

While Siddique Sdiq Memorial Trust Hospital, Gujranwala had provided only the number of deaths for January 2008 to May 2011 and the figures for cardiac mortality rate had shown an increasing trend.

Data

The data was collected from multiple sources to complete the study. The union council-wise population data was collected from the regional office of Punjab Bureau of Statistics, number of registered vehicles data was collected from Excise and Taxation Department in Gujranwala, for survey design the maps were collected from District Council Gujranwala, air emissions data for various pollutants was collected from Environmental Protection Department and respiratory and cardiac diseases related patients record was gathered from Siddique Sadiq Memorial Trust Hospital and District Head Quarter Hospital Gujranwala.

Survey

A questionnaire was developed by using the Contingent Valuation Method to estimate the willingness to pay (WTP) responses. In order to test the feasibility of the questionnaire a pilot survey was conducted. For a representative sample the area under consideration was divided into small strata, whereas for reliable sample each of the respondent was asked standardised set of questions. Further for validity of the main focused question regarding willingness to pay double bounded format was followed.

Contingent Valuation Method

Contingent Valuation Method (CVM) is primary research technique that is widely opted by social scientists to estimate WTP in order to reduce intended risk of premature mortality linked to air pollution (Karimzadegan et al., 2008; Ortiz et al., 2009; Vlachokostas et al., 2011).

In pursuit of preferences of respondents for risk reduction in premature mortality both open and close ended questions were included in questionnaire, where in case of open-ended questions every respondent was enquired to state a particular monetary value from their own choice to avoid intended mortality loss. But there is a problem with this method; if the respondents haven't the exact understanding of the question, they may underestimate or overestimate the problem. So, to avoid this problem double bounded discrete question was selected.

Discrete choice questions opted because of following advantages: (i) respondents had to respond to a given amount instead to state a particular value as per their own choice. It implies that only yes/no response was needed, which facilitates respondents for easy decision making. (ii) They had to state a value from their own choice if the response was no. The rationale behind the selection of double bounded format question was statistical efficiency of welfare estimation.

The main question asked about WTP was: "If intended measures to control air pollution reduce the risk of expected premature mortality to 1-in-1000 or 5-in-1000 or 10-in-1000 over next five years, would you like to contribute the stated amount or not, if not then how much?" Individuals will have to respond to yes if expected benefit is greater than the resources forgone otherwise no. Mathematically it can be expressed as follows;

$$u(Y - WTP, AQ^1, X) - u(Y, AQ^0, X) \geq 0 \quad (1)$$

Where, u indicates indirect utility function, Y is respondents' income level, AQ^0 is current air-quality, AQ^1 is air-quality after improvement, and X depicts individual's personal characteristics.

Probability for a yes response depends on individual's indirect utility (u) to be received from premature mortality risk reduction as a result of improvement in air quality of air or reduction in air-pollution. Indirect utility's observable part is denoted by v.

$$\Pr(Y) = \Pr[v_1(Y - WTP, AQ^1, X) + \varepsilon_1 > v_0(Y, AQ^0, X) + \varepsilon_0] \quad (2)$$

Here, Ɛ is a unobserved and random part of utility, Pr(Y) denotes probability for yes response, while v_0 and v_1 depicts levels of indirect utility associated to current and future air quality conditions. Pr (N) is the probability of a no response which can be written simply by changing the direction of symbol '>' with '<'.

Questionnaire

There are four sections of the questionnaire. (i) Respondent's personal details, (ii) Contains two sub-sections: A, is about the respondent's socio-economic and demographic information while B, provides info about the health status of household. (iii) Third part extracts the understanding of the respondents about the problem. It consists of four types of questions; (a) Knowledge about the air pollution issues? (b) What is major source of air pollution in their opinion? (c) Does air pollution damage health or not? (d) Does air pollution result premature mortality or not? (iv) The major question of the study that was whether interviewee was willing to sacrifice any amount for reduction in risk of premature mortality or not. If yes then how much if not then why not?

Sampling Technique

Stratified random sampling is chosen to conduct Survey and each town was considered as one stratum in the area. One hundred and seventy-four respondents were interviewed at their premises.

Table 3

Towns, UCs and total Population in Each Town, % of Respondents Interviewed

S. No.	Towns of GRW	No. of Union Councils (UCs)	Total Population	% of respondents interviewed
1	Nandi Pur Town	15	372467	22%
2	Khiali Shah Pur Town	14	370450	22%
3	Qila Dedar Singh Town	19	407227	24%
4	Aroop Town	17	416218	25%
5	Gujranwala Cantonment	0	127293	8%

Note. Source: Bureau of Statistics[5], Punjab

[5] Details about the union wise population was collected from said department

Findings of Survey

This section provides descriptive analysis for the primary data collected in survey.

Pilot Survey

In pilot survey respondents from different social classes were considered, and they were asked open ended question. They stated different values in response to the three risk reduction options[6] and those were PKR[7] 650, PKR 1,095 and PKR 1,222, respectively.

The above values then set as bench mark against each risk reduction option and respondents were asked to report to yes or no option. If they want to sacrifice the mentioned amount then respond to yes, if not then state the amount which they could forgo. After adjusting values as a bench mark, the main question was converted to discrete choice format for final survey to attain maximum welfare efficiency.

Final Survey

The final survey was conducted in the month of June 2011 and the details collected are explained and analyzed below:

The first part of the questionnaire provides general information of the respondents including name, cast, religion, union council, name of residential area and enumerator's name. Respondents belong to different casts and average age of the respondents was 37 years.

Second part in questionnaire comprises of respondent's (household) socio-economic and demographic information. This section provides names, gender of all of the family members, their age, relationships with the head of the household, marital status and the level of education of all the family members. Educational level is divided into fourteen different levels[8] according to educational system of the Pakistan. The average family size of the respondents was six and most of the respondents were head of the household. Its advantage was, they stated the exact figure which they can trade off.

[6] 1-in-1000, 5-in-1000, 10-in-1000

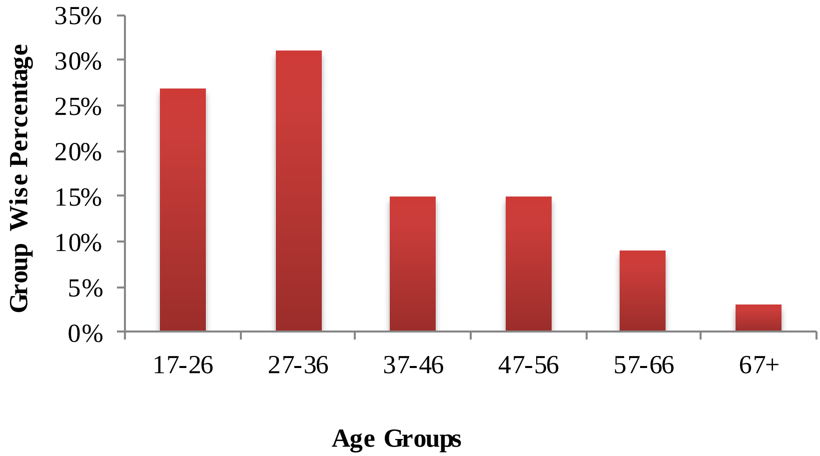
[7] PKR= Pakistan Rupees

[8] These different levels than converted into number of years spent for education.

The respondents are divided into six age groups with the gap of ten years. The highest number of respondents were in 27-36 group[9].

Figure 1

Percentage of Respondents in Different Age Groups



In Gujranwala people have stringent attitude in matter of respect of women and their protection is their religious obligation. In such premises it was very difficult to get access to female respondents, so only few of the women respondents were interviewed.

In following sub-part of the section-II, the respondents were asked about their income level and earning resources. Most of the interviewees didn't provide the monthly income of individual family members but they had provided aggregate figure. The average monthly income in sample was PKR 55,000.

Section-2, part-B, provides respondents health cost incurred for treatment[10] of respiratory and cardiac diseases and it varied in between PKR 101,000 and PKR 400, with an average of PKR 5,000.

In response to first question in third section, only 9% said that they had no knowledge or very little knowledge of air-pollution issues, while 91% of

[9] Labor Force Survey divided the population with the same gap of 10 years

[10] Health facilities available were include: Public and Private Hospital, Private Clinics, Hakeems, Mystic People

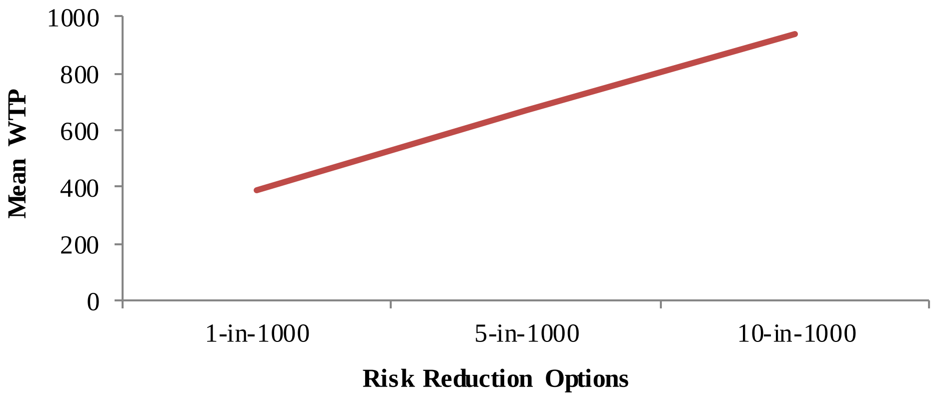
the respondents had sufficient understanding. Against second question 68% respondents were responded that industry is the major source for air pollution. Ninety two percent respondents responded positively against third question and in response to last question 95% of the respondents said that air pollution cause premature mortality.

Relationship between Mean WTP and Risk of Premature Mortality

The relationship between mean WTP and risk reduction options is shown in the Fig II 2. The WTP values considered to observe the relationship are average values. There is a positive relationship between mean WTP and reduction in level of risk of premature mortality. This implies that respondents were willing to sacrifice more resources with higher level of risk of premature mortality.

Figure 2

Mean WTP against the Risk Reduction Options



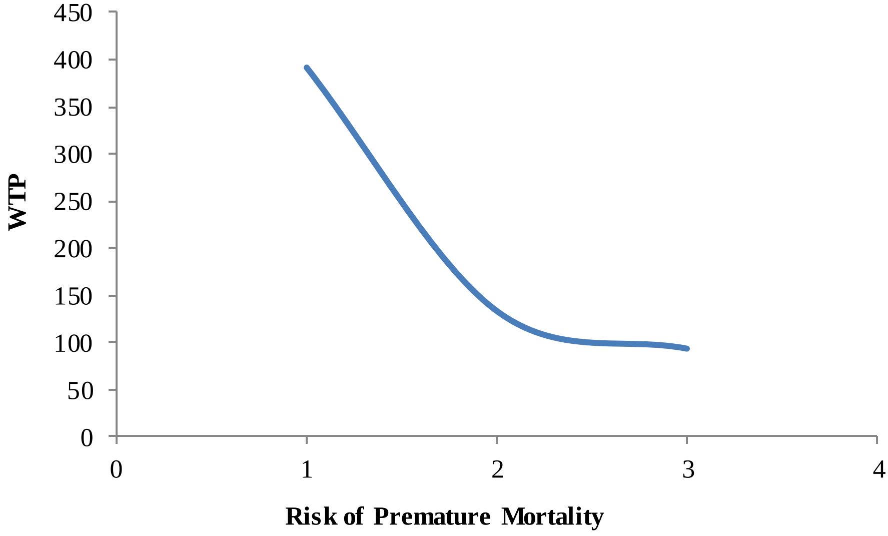
Relationship between Marginal WTP and Risk of Premature Mortality

The marginal WTP and risk of premature mortality's relationship is depicted in Figure 4.16. The estimated relationship in marginal WTP and level of risk is negative which implies that there is less contribution[11] for each subsequent person who is at risk of premature mortality.

[11] For 1-in-1000, 392/1=392
For 5-in-1000, 669/5≈133
For 10-in-1000, 940/10≈94

Figure 3

Marginal WTP for Reduction in Risk of Premature Mortality



Who didn't Want to Contribute?

Fourty three percent were not interested to contribute. Out of these respondents, 32% said that it's the responsibility of government, 2% believed that air pollution didn't cause premature mortality and 9% thought that they had insufficient income.

Research Methodology

For estimation of mean WTP, quantification of yes/ no response is required. That is, the estimation of probabilities for acceptance or rejection of offered price or bid of reduction in mortality risk. It is assumed here that the probability function has a logistic distribution[12]. The probability of accepting the offer was estimated by using the *Logistic Function*[13]. Individuals accept offer, if derived utility from reduction in risk of premature mortality with controlled air pollution is greater than the

[12] It is with heavier tails than normal distribution which increases the robustness of the results

[13] It important because it accepts any value from $-\infty$ to ∞ as input and confines output to 0 & 1.

monetary resources forgone. It implies that the response will be yes if $\boldsymbol{v_1} > \boldsymbol{v_0}$ and no otherwise.

$$\Pr(Y) = \frac{1}{(1 + e^{-\Delta v})} \tag{3}$$

The probability of rejection will be estimated simply by reversing negative sign with positive one.

$$\Pr(N) = \frac{1}{(1 + e^{\Delta v})} \tag{4}$$

Where, Pr(Y) and Pr(N) denotes probabilities for accepting and rejecting offer. $\boldsymbol{v}$ is the observable part of indirect utility and is the function of socio-economic characteristics of the respondents.

$$v = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + u_i \tag{5}$$

Where, β_0 = Intercept and it's utility level while taking the effect of all other regression coefficients zero

β_i = Regression coefficeints of independent variables ($i = 1,2, \ldots\ldots, 8$)

X_1 = Education level of the respondent

X_2 = Household's monthly income

$$X_{3i} = \begin{cases} 1 & \text{AP[14] cause premature mortality} \\ 0 & \text{Doesn't cause} \end{cases}$$

$$X_{4i} = \begin{cases} 1 & \text{AP deteriorate health a little} \\ 0 & \text{Doesn't deteriorate health} \end{cases}$$

$$X_{5i} = \begin{cases} 1 & \text{AP deteriorate health moderately} \\ 0 & \text{Doesn't deteriorate health} \end{cases}$$

$$X_{6i} = \begin{cases} 1 & \text{AP deteriorate health too much} \\ 0 & \text{Doesn't deteriorate health} \end{cases}$$

X_7 = Treatment cost[15]

X_8 = Total health cost[16]

[14] AP=Air Pollution

[15] It includes medication cost, doctor fee but not travel cost to hospital.

[16] Treatment cost+ Travel cost to hospital

u_i = Error term with logistic distribution

Δv is variation in indirect utility and $\Delta v = \boldsymbol{v_1} - \boldsymbol{v_0}$. $\boldsymbol{v}$ is increasing along the reduction in risk of premature mortality. From equation(1), $\overline{WTP}$ will be calculated which is the area under the probability density function and $WTP_{mean} \geq 0$.

$$\overline{WTP} = \int_0^\infty \frac{1}{(1 + e^{-\Delta v})} dw \tag{6}$$

Where; $\boldsymbol{v} \neq \mathbf{0}$ and $\mathbf{1} + \boldsymbol{e}^{-\Delta v} > 0$ and $\overline{\text{WTP}}$ is mean willingness to pay.

$$\overline{WTP} = -\frac{1}{\beta} \ln\left|1 + e^{\beta X}\right| \tag{7}$$

By using above equation-6**,** mean willingness to pay will be estimated. Here, it is important to note that reason behind $0 \to \infty$ limit, is $\overline{\boldsymbol{WTP}}$ cannot be negative. Due to same reason, negative sign will be omitted in equation 7**.**

Value of Statistical Life

VOSL, a trade-off between wealth and reduction in risk of premature mortality, is widely used to measure the expected benefits of WTP to avoid premature mortality due to air pollution (Sommer et al., 1999; Svensson, 2009; Zhang, 1999). Following formula is used to calculate the value of statistical life;

$$VOSL = \frac{\sum_{i=0}^{n} [{WTP}/{n}] \times Scale\ of\ variable^{17}}{\#\ of\ risk\ reductions} \tag{8}$$

Where, 'n' is number of respondents interviewed.

Empirical Results

This section explains the output obtained by using Logit model. The response variable WTP is binary, which carries two possible outcomes[18] 1 and 0. The outcome measure is level of WTP and we are going to see the existence of its relationship with the following variables: respondent's education level (X_1), household's monthly income level (X_2), air pollution

[17] Scale of variable means that population considered at risk (e.g., 1-in-1000, or 5-in-1000). Here 1000 is taken as population at risk. "1" or "5" is size of risk

[18] if 1 then yes and if 0 then no

cause premature mortality[19] versus doesn't cause (X_{3i}), air pollution deteriorate health a little[20] versus no affect (X_{4i}), air pollution deteriorate health moderately versus no affect (X_{5i}), air pollution deteriorate health too much versus no affect (X_{6i}), treatment cost (X_7), total health cost (X_8).

$$logit\ WTP = \beta_0 + \beta_1.X_1 + \beta_2.X_2 + \beta_3.X_3 + \beta_4.X_4 + \beta_5.X_5 + \beta_6.X_6 + \beta_7.X_7 + \beta_8.X_8 + \varepsilon_i$$

Iteration 0	log likelihood = -112.08833
Iteration 1	log likelihood = -96.943196
Iteration 2	log likelihood = -93.784369
Iteration 3	log likelihood = -91.737975
Iteration 4	log likelihood = -91.348423
Iteration 5	log likelihood = -91.331897
Iteration 6	log likelihood = -91.331854

Logistic Regression

Number of obs = 174

LR chi2(8) = 41.51

Prob > chi2 = 0.0000

Log likelihood* = -91.331854

Pseudo R2 = 0.1852

Iteration Log Likelihood

Iteration is a mathematical formula that produces a series of solutions with betterment. Likelihood function measures an event's probability or its odds that how likely it is in favor. While the log-likelihood is natural logarithm of the likelihood function. Logarithm is monotonic (monotonically increasing) function. Both log-likelihood and likelihood function achieve maximum value at the similar point.

[19] dummy variable with yes (1) or no (0) response

[20] is a categorical variable and indicates possible response levels of respondents (not at all, a little, moderately, quite, too much)

In the log-likelihood listing, the Iteration 0 considered no predictors also known as null or empty model. In the next iterations log-likelihood considers predictors. Here, objective is to increase the value of log-likelihood. With each next iteration, it increases and stops when the difference between the two consecutive iterations is very small. At that stage model is said to be converged and STATA displayed results.

The log-likelihood* is the fitted model's value. It is basically used in LR Chi-square test to check whether predictors regression coefficients of predictors in the model are zero at a similar point in time.

The total numbers of observations are 175. STATA delete incomplete cases by default and doesn't consider incomplete cases in the analysis. Here, the numbers of observations displayed in result sheet are 174, one less than the total.

LR Chi2 (8)- In case of Ordered logistic regression likelihood ratio chi-square test is used to test the hypothesis whether all βs zero against the alternate that at least one of the predictors is not zero. 14 is the degree of freedom (number of predictors of chi-square distribution) used in chi-square test statistic. The LR Chi2 can be calculated manually too by opting the deviance formula[21]. It can be computed by taking difference between null (only constants with considering no predictors) and alternative model (with considering at least one predictor). D tells how estimated model fits the likelihood.

Prob > Chi2- is the probability of finding the chi-square statistic with null hypothesis[22] true OR it is probability of getting 41.51 chi-square statistic with considering no effect of the predictor variables on the targeted or dependent variable. Then to check the overall statistical significance of the model, this p-value is equated to a critical value 0.05 or 0.10. Here the model can be said as statistically significant because the p-value is lesser than 0.0000.

Pseudo R^2- Many researchers struggling to get R^2 similar to OLS, in estimation of logistic regression. But no one reached to such conclusive value; while some of the researchers claimed that conceptually Pseudo R^2 is nearest to one. Pseudo R^2 also called as McFadden's R^2, it's STATA,

[21] D= -2*ln(likelihood for null model/ likelihood for alternative model)

[22] All regression coefficients are equal zero.

which called it as Pseudo R^2. If its value is equal to one then the model is said to be perfectly fit but if zero then it implies that all of the regression coefficients are zero. The statistical value of this statistic has not same meaning R-square[23] has in OLS.

Parameter Estimates

In Table 4 regression results WTP[24], is the response variable and the variables given in first column are predictor variables in the Logit model.

Table 4

Regression Results

WTP	coefficient	Standard error	*z*	*p*>|*z*|	[95% Conf. Interval]	
X_1	0.0418861	0.0389161	1.08	0.282	-0.034388	0.1181602
X_2	0.0000135	0.00000715	1.88	0.060	-0.000001	0.0000275
X_3	3.04223	1.233436	2.47	0.014	0.6247394	5.459721
X_4	-3.014402	1.021914	-2.95	0.003	-5.017317	-1.011486
X_5	-1.202714	.7646787	-1.57	0.116	-2.701457	0.2960288
X_6	-1.553203	.6810883	-2.28	0.023	-2.888111	-0.2182945
X_7	0.0007445	0.0003776	1.97	0.049	0.0000047	0.0014845
X_8	-0.0004663	0.0002647	-1.76	0.078	-0.0009852	0.0000525
β_0	-2.106129	1.195389	-1.76	0.078	-4.449048	0.2367906

Coefficients: these all are the coefficients of logistic regression used to predict the response variable from the independent variables, and they are in log-odds form. These estimates tell about the relationship among the coefficients of response and predictor variables, the response variable is on the Logit scale. The estimates of regression coefficients tell the amount of change (increase or decrease) in the values of predicted log-odds of WTP, which would be predicted by a unit change (increase or decrease) in the predictor, while treating rest of the predictor variables as constant in the

[23] The proportion of variance is explained by predictor variables.

[24] Is dichotomous variable (with only two values 0,1)

estimated model. The logistic equation can be written as well in form of log-odds[25].

X_1- educational level of the respondent; its coefficient is 0.418861 which implies that a one unit increase in level of education results expected increase of 0.418861 in log-odds of WTP, with rest of the predictor variables in the model are given constant. If alpha (α) is set to be 0.05 we fail to reject null hypothesis because α is less than the p-value 0.228. It clearly implies that X_1's regression coefficient is not found to be statistically different than zero with given all of the other predictor variables in the model zero.

X_2- monthly income of the household; its coefficient is 0.0000135 which implies that for one unit increase in the monthly income level of the household, the expected increase in the log-odds of the response variable WTP is 0.0000135, with rest of the predictor variables in the model constant. If we set α here 0.05 then we fail to reject null hypothesis. But if α is to be set at 0.10 instead of 0.05, then coefficient of X_2 is considered as statistically different than zero. It implies that coefficient of logistic regression coefficient for this specific variable is significant at 90% confidence interval provided rest of the predictor variables as constant.

X_3- air pollution cause premature mortality or not[26]; the coefficient for this variable is 3.04223. This implies that for one unit increase in the respondents' response in favor of argument, the log-odds of WTP are expected to increase by 3.04223, while all other predictor variables are given constant. Its p-value is lower than 0.05, which means that the coefficient of X_3 is significantly different than zero provided all other variables as constant. It's significant at 95% confidence interval.

X_4- air pollution does affect health a little versus no affect. This variable has different interpretation because of respondents' response in distinct levels[27]. The coefficient for this variable is -3.014; this implies having argument that air pollution deteriorates health a little versus no impact decreases the log-odds of WTP by 3.014, given all the other predictor variables constant. The coefficient for X_4 is significant at 95% confidence

[25] $\log(\frac{p}{1-p}) = \beta_0 + \sum_{i=0}^{n} X_i + \varepsilon_i$

[26] "1" for yes response and "0" for no response

[27] distinct levels are: no effect, a little, moderate, quite and too much

interval because p-value is less than 0.05 provided all other predictor variables as constant.

X_5- air pollution effect health moderately versus no effect. The coefficient for this variable is -1.2027; this implies that having argument in favor of the argument that air pollution deteriorate health moderately versus the no impact of air pollution on health decreases the log-odds of WTP by 1.2027, given all the other predictor variables constant. It's statistically not different than zero because p-value is greater than α=0.05 as well 0.10.

X_6- air pollution has effect on health too much versus no effect. The estimated coefficient for this variable -1.5532; this implies that having argument that air pollution deteriorate health too much versus no impact on health decreases the log odds of WTP by 1.5532, while all the other predictor variables given constant. The coefficient for this variable is not significant at 95% confidence interval because its p-value is greater than α 0.05. Hence, we can say that it's not statistically different than zero.

X_7- is the treatment cost[28] incurred by the respondent or any of his family members; the estimated coefficient for this variable is 0.0007445. It means that for a one unit increase in the treatment cost the log-odds of WTP are expected to increase by 0.0007445, providing all the other predictor variables constant. The logistic regression coefficient for this variable is statistically significant at α 0.05, as its probability value is less than the set value for α. This implies that provided all other predictor variables coefficients equal to zero, it is statistically significant at 95% confidence interval.

X_8- is the total health cost[29] incurred by the respondent; the estimated coefficient for this variable is -0.0004663. This implies that for a one unit increase in the total health cost the log-odds of WTP are expected to decrease by a factor of 0.0004663, while all the other predictor variables given as constant. If we α is to be set at 0.05 level, then it is to be said that the regression coefficient for this variable is not different than zero. While if we compare the p-value with α 0.10 then the coefficient for this variable is said to be statistically significant provided all other predictor variables constant.

[28] Include cost of medication and doctor fee.

[29] In addition to other costs, travel cost is also included in it.

Constant (β_0) – it is the estimated value of log-odds of WTP while considering rest of the variables zero. This value is not realistic to take and it is meaningless in logistic regression.

Standard Errors- these are the estimated standard errors of the regression coefficients which are used for testing significance of the parameters of regression[30]. These standard errors also used for calculation of the confidence intervals of the regression coefficients.

z and p>|z|- are the statistics for z-test and p-value, and they are used to test robustness of a particular regression parameter with considering rest of the predictor variables zero in the model. z-statistic has normal distribution and it is useful in testing null against a two-tailed alternative hypothesis, which means that the estimated parameter statistic is not equal to zero. Most of the time two critical values of alpha 0.05 (5%) and 0.10 (10%) are considered by researchers for comparison of probability values to verify the individual variable's statistical significance.

95% Confidence Interval (CI)[31]- is the 95% CI of the regression parameter of an individual variable. It is useful because it supports in understanding the higher and lower limits of the under considered population. It further helps to understand whether variable is true and 95% of the population lies in the range of upper and lower limits of CI. It is equivalent to z-statistic and its advantage is, it provides a range in which the true regression coefficient may lie.

Value of Statistical Life Estimates

VOSL, a tradeoff between wealth and small reduction in risk of premature mortality, monetary valuation of preferences of corresponding people whom at risk. It is not the value of any specified person's life; it's the statistical addition to the existing life. VOSL is also called as the value of marginal additional life. Its concept applied to the additional lives saved not to the percentage of present mortality cases.

Table 5 represents the VOSL estimates against different risk reduction options. Respondents' average monthly willingness to pay is given in

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[30] $z = \frac{x-\mu}{\sigma}$; Where, μ (=0) is population mean while σ is the standard deviation of under considered population.

[31] $Coef. \pm z_{\alpha/2} * (\sigma)$, where, σ is the value standard deviation while $z_{\alpha/2}$ is the critical value on the scale of standard normal distribution.

Column 3, in column 4 WTP is measured for an individual expected victim of air pollution by dividing with number of persons at risk of premature mortality out of the total population assumed at risk and the monthly statistical value of life is measured in column 5 for each risk reduction option, and in the last column annual statistical value of life is calculated.

Table 5

WTP for Reduction in Risk of Premature Mortality and Implied VOSL Estimate

	Risk Reductions	$\overline{WTP}$ PKR (Monthly)	$\overline{WTP}$/No. of Risk Reductions PKR (Monthly)	VOSL[32] PKR (Monthly)	VOSL PKR (Annual)
1	1-in-1000	387	387	387,286	4,647,429
2	5-in-1000	664	132.714	132,714	1,592,571
3	10-in-1000	931	93.1	93,100	1,117,200

The average WTP is increasing with the increase in risk of premature mortality but with the decreasing rate. For one person at risk the willingness to pay is PKR. 387 while willingness to pay is 664 and 931 for 5 and 10 persons at risk respectively (Column 3). Whereas, the willingness to pay estimates per person are decreasing with higher risks of premature mortality associated to air pollution (Column 4).

The VOSL is estimated in each case is for one person at risk of premature mortality (Column 4). It is calculated by multiplying values in column 4 with the population assumed at risk i.e., 1000. The monetary value of small risk to life is higher for one person in comparison to other two cases. It indicates that with higher risks the communal value decreases. In first case the VOSL is PKR 4.647 million per annum. While for other two risk reduction options the values are PKR 1.592 million and PKR 1.117 million, respectively.

The value of statistical life estimates are inversely related to size of risk of premature mortality. However, willingness to pay is independent of size

[32] Column 4 is multiplied with scale of variable (i.e., 1000) to get VOSL estimates.

of risk (Alberini et al., 2006). Similar results found in Canada and USA for 1-in-1000 and 5-in-1000 risk reduction options. WTP was less for higher risks.

Conclusion

Many of the pollutants crossed the safe limits in Gujranwala set in the National Environmental Quality Standards. The rising level of air pollution in the city causing adverse health consequences, as the data collected from various health agencies had shown an increasing trend.

In the prevailing scary situation of air pollution and its damages this study was carried out to monetize the risk of premature mortality. For that purpose, WTP approach is opted. This is a survey-based practice followed to ask respondents about their WTP for trade off: between the probability of risk of reduction in premature mortality and the wealth.

The respondents, who were interviewed, selected from various income groups, age groups, marital status and diverse employment. It was found that the human beings respiratory and cardiac systems were the most vulnerable to risks of air pollution.

Respondents were asked for valuation of three risk reduction options. They valued according to their attitude towards risk, understanding of the issue and level of income. The estimates of value of statistical life in this study for all three risk reduction options were: PKR 4.647 million, PKR 1.592 million, and PKR 1.117 million. A negative relationship between VOSL and the base line risk of premature mortality.

The results of the study had shown that respondents' level ofsampl education didn't have any significant impact on valuation. However, the valuation depends significantly on monthly household income level, air pollution does affect health and it cause premature mortality. At the same time, their valuation considerably relied on the cost of health they incurred in terms of respiratory and cardiac health damage.

The respondents' major concern was only with the transparent use of the resources for the said purpose. If transparency was assured to them, then they will contribute without any reason.

Policy Recommendations

Most of the respondents were familiar about adverse consequences of air-pollution on their health and interested to contribute to pay for clean environment. It is suggested that the local bodies, like Gujranwala Development Authority, should have to intervene and take necessary steps to work for clean environment to improve the quality of life of people. This research work can be used to take guidance about the positive behavior of people towards a community participatory approach.

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