Valuing health impacts of the workers in Bangladesh due to air pollution

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VALUING HEALTH IMPACTS OF THE WORKERS IN BANGLADESH DUE TO AIR POLLUTION

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ABSTRACT
This paper deals with valuing health due to air pollution in Bangladesh. Human capital is an important asset in economic development. From air pollution human capital can not be utilized properly and gross domestic product (GDP) of a country decreases. Willing to pay (WTP) to avoid 1 and 14 additional days is important both for workers, factory authorities and the government of a country. It provides financial supports to mitigate respiratory related diseases which are mainly caused by air pollution. Since no WTP is yet established in the labor sector of Bangladesh, so that this paper will show new way to the workers, factory owners and the government of this country.
Keywords: Air pollution, health, respiratory symptoms, WTP

INTRODUCTION

As like education human capital is an important asset for economic growth and social welfare. Obviously environmental pollutions effect human capital seriously. We have to take various steps to keep health service facilities in the workers to the development in economic sector. One of the different steps willing to pay (WTP) system is a positive step to the workers and factory owners and also for the government of a country. Since factory owners are not capable to pay all the medical expenditures for the workers. Healthy human capital gives optimal product in the society and decreases all kinds of medical expenditures related to pollutions. As a result society gains rich economy. Densely populated and industrial areas, where more vehicles move and a majority of people smoke, the air remains in pollution dangerously. As a result most of the workers of that area suffer in respiratory related diseases. Such respiratory sick people can not work properly and hence economic growth of the country damages. All the environment pollutions are harmful for health but in this paper we consider only effects of air pollution and show the survey reports of WTP to avoid additional days with one or more symptoms of the workers of Bangladesh. In this paper we discuss valuation of health impacts of Bangladesh following Navrud (2001) and Tolley et al. (1994). A survey on garments workers of Bangladesh is conducted about WTP to avoid 1 and 14 additional days due to respiratory related illnesses. Unfortunately in Bangladesh no WTP system is established, we hope our paper will encourage the government and environment specialists to see the aspects of WTP. WTP is a beneficial system where workers will pay annually an amount willingly and the factory owners will provide free medical services from this amount and workers can enjoy leave with pay during illness. In this system factory owners will be careful to the workers and workers will be more sincere in their working. So that WTP will be beneficial both for the workers and factory owners which will create healthy working sector and as a result the economy of the country will enrich.

Mohajan et al. (2012) discuss that environment pollution decreases economic development of a country. They stress that net national product decreases due to environment pollution. Mohajan (2011) shows that the optimal environmental tax should be less than the marginal environmental damages; since the presence of pre-existing distortionary taxes, increasing the welfare costs is associated with the overall tax code. The reduction of pollution causes

the benefits of health by supplying maximum labors to create benefit-side tax interactions, which will tend to reduce the optimal environmental taxes.

THE MODEL

In this section we follow the models of Navrud (2001) and Tolley et al. (1994). Healthy persons are the human asset of a country. A country is developed if she has a healthy nation and can export products with continuous production. Social welfare is maximized when both producers and consumers maximized their utility in healthy way. Air pollution causes disutility, and the disutility of pollutants, in the form of "pain and suffering" can be alleviated with inputs for healthcare and mitigation (Huhtala and Samakovlis 2003). A person is uncertain about her health. She can not surely demand that her sickness is of course due to pollution; even she does not know when she will die. But scientifically it is proved that the cause of some diseases such as sinus congestion, tightness in chest, headache, asthma etc. is due to air pollution. It is of course true that where air pollution is very high symptom of respiratory diseases and patients increase there. Green accounting research project (GARP II 1999) found that morbidity impacts in terms of symptom days and restricted activity days to make up to 30% of the total health impacts from air pollution (EC DG XII 1996). Here we consider that a person's utility depends on the state of health and consumption of products, so that the utility can be expressed as,

$$U = U(C, Q),$$

where U is utility, C is consumption and Q is a vector of health characteristics. The probability density function for health characteristics h can be expressed in the form,

$$h(Q : X, E),$$

where X is preventive expenditure and E is any exogenous variable such as a change in concentration of air pollution. The product depends on the surviving in the service for time t, so that

$$t = t(Q).$$

If M is the medical treatment due to pollution and depends on health characteristics Q, then we can write,

$$M = f(Q).$$

Therefore incorporating above conditions we can express the maximize expected utility in the form of as (Navrud 2001),

$$\max E(U) = \int_{-\infty}^{\infty} U(C,Q)t(Q)h(Q : X, E)dQ \qquad (1)$$

subject to the income constraint,

$$I = C+X+Z = C+X+f(Q) \text{ i.e., } C = I - X - f(Q), \qquad (2)$$

where I is income in the absence of any cost due to illness symptoms. Hence (1) can be written as,

$$\max E(U) = \int_{-\infty}^{\infty} U[I - X - f(Q), Q]t(Q)h(Q : X, E)dQ. \qquad (3)$$

For simplicity let us consider that the probability density function $h(Q : X, E)$ depends on the presence or absence of a deleterious condition. If $Q = 1$, then $h(Q : X, E) = H(X, E)$, where $H(X, E)$ is the probability of contracting the disease, if $Q = 0$, then

$h(Q:X,E)=H'(X,E)=1-H(X,E)$; since $H+H'=1$ i.e., $H'=1-H$. Hence continuous max $E(U)$ of (3) for discreteness of Q becomes,

$$\max E(U)=U_0 P_0(1-H)+U_1 P_1 H \qquad (4)$$

which is the sum of utilities in the absence and in the presence of the deleterious health condition, where

$U_0 = U(I-X,0)$ is the utility in free of the disease,

$U_1 = U(I-X-Z,1)$ is the utility with the disease,

$P_0 = t(0)$ is the probability of survival without disease, and

$P_1 = t(1)$ is the probability of survival with disease.

Differentiate (4) with respect to X, then for maximization we get,

$$U_0'P_0(1-H)-U_0 P_0 H_X + U_1'P_1 H + U_1 P_1 H_X = 0 \qquad (5)$$

where H_X is the change in the probability of contracting the disease resulting from an extra amount (in dollar) spent on prevention, U_0' and U_1' indicate the marginal utilities of income where $Q=0$ and $Q=1$ respectively. Now equation (5) can be expressed as;

$$\frac{U_0 P_0 - U_1 P_1}{U_0'P_0(1-H)+U_1'P_1 H}=\frac{1}{H_X}. \qquad (6)$$

The totally differentiated expected can be solved for the change in income which would be required to keep the expected utility constant when there is an exogenous improvement in health risks. Taking the expected utility constant by setting $dE(U)=0$, one can solve for WTP as follows (Navrud 2001 and Tolley et al. 1994):

$$-\frac{dM}{dE}=-\left[\frac{U_0 P_0 - U_1 P_1}{U_0'P_0(1-H)+U_1'P_1 H}\right]H_E - \left(1-\frac{U_0 P_0 - U_1 P_1}{U_0'P_0(1-H)+U_1'P_1 H}.H_X\right)\frac{dX}{dE}$$

i.e., $\quad -\frac{dM}{dE}=-\left[\frac{U_0 P_0 - U_1 P_1}{m}\right]H_E - \left(1-\frac{U_0 P_0 - U_1 P_1}{m}.H_X\right)\frac{dX}{dE} \qquad (7)$

where $m=U_0'P_0(1-H)+U_1'P_1 H$ is a weighted average of the expected marginal utility when healthy and the expected marginal utility when ill, with the weights being the probabilities of being healthy or ill. Using (6), equation (7) can be written as;

$$-\frac{dM}{dE}=-\frac{H_E}{H_X}. \qquad (8)$$

Equation (8) indicates that the WTP measure to be expressed, not in terms of the unobservable utility function, but instead in terms of the health risk function, H. If H_X is negligible then (7) can be expressed as;

$$-\frac{dM}{dE}=-\left[\frac{U_0 P_0 - U_1 P_1}{m}\right]\frac{dH}{dE}-\frac{dX}{dE}. \qquad (9)$$

This states that a person's WTP for an environmental improvement can be expressed as the sum of two terms. The first term is the monetary value of the expected difference in expected utilities between being healthy and ill multiplied by the change in health risks due to the change in the environment or other exogenous factors. The second term is the change

in preventive expenditures resulting from the exogenous change. The WTP, $-\dfrac{dM}{dE}$, measures the ex ante compensating variation for the changes in morbidity risk.

Now we assume the pure morbidity case, where $P_0 = P_1 = 1$ that is, there is no possibility of death whether the patient being healthy or ill, so that then (9) can be written as;

$$-\frac{dM}{dE}_{(P_0 = P_1 = 1)} = -\left[\frac{U_0 - U_1}{m}\right]\frac{dH}{dE} - \frac{dX}{dE}.$$

Hence a person's WTP for an environment improvement consists of two terms. The first term is the monetary value of the disutility of illness after mitigating actions have been taken and the second term that reflects the costs of the mitigating activity.

A SURVEY ON THE GARMENTS WORKERS OF BANGLADESH

Bangladesh is a densely populated (population in 2010 is about 160 million) developing country of South Asia. It is an ever green tropical country. About 90% of its populations are poor, so that populations in labor sector are more than enough in Bangladesh. A survey on 500 female garments workers of Bangladesh is conducted in December 2011 to estimate their WTP to avoid additional days of seven light health symptoms and of one major symptom, asthma. The survey was conducted in slum areas of Chittagong City Corporation (CCC) where many garments workers live, who work in different garments of CCC. All of them came from the villages of Bangladesh. In Bangladesh most workers' wages are so low (lowest salary is $42/month) that they do not buy sufficient food to mitigate hunger and never think to buy a royal dress or any luxurious thing. Most of the workers suffer from malnutrition and their physical structures are in skin and bone, and can not work properly. They can not rent a house in a multistoried building due to their low salary. In 2050 (our target) the average age of the labor sector will be less than their present average age if at present various development steps in labor health sector are not taken seriously. Overall environment situations in the slum area are so polluted that a person of the developed country can not imagine how human being survives there. CCC does not take major steps to improve the quality of sanitation and to continuous supply of pure drinking water. Some NGOs take steps to give preliminary education to the children which are insufficient than necessary. Government of Bangladesh ensures free primary education and free book supply but due to poverty and lack of consciousness all the children can not enjoy these rights. In the garments most of the workers are illiterate and have no proper knowledge about health. Workers have to work frequently in factories for 14 hours everyday (from 8.00 am to 10.00 pm), where 8 hours (from 8.00 am to 4.00 pm) formal duty and 6 hours (from 4.00 am to 10.00 pm) duty for (so called) bonus. They work seven days in every week in the factory and 7th day falls in bonus category. Sometimes they have to work days and nights without any interval or rest. Factory owners' strategy of bonus system is to pay low wage and an attempt to give a satisfactory amount (sum of wage and bonus) to the workers at the end of the month, and to increase of production in the factory. Most of the workers often suffer respiratory related diseases but they can not enjoy sick leave with pay. Their payments are discrete basis as like equation (4), that is, they find wage if they work in the factory and find no wage if they absent in the factory, though they often submit their medical certificates of illness. Very few factories pay free medical facilities which are very low and some factories have no free medical services. So that when they go to take for treatment

they can not attend in their jobs. No factory has baby care centre, as a result most of the workers do not go in factory when their babies feel sick. When the sick workers remain absent, the factory owners can not appoint new workers immediately. So that in this case both workers and factory owners remain in lose. After recover they join in the work but after joining at the workplace they can not work efficiently as like they do before the sick. So that due to sickness of the workers, both the workers and factory owners remain in lose, and the country's gross national income decreases. Both government and factory owners take very few steps to improve the quality of health of the workers. As workers are available in Bangladesh, the factory owners always employ young workers whose ages are in the range of 16-30 years.

We have conducted the survey as like Navrud (2001), Tolley et al. (1986) and Tolley et al. (1994). In the survey we have observed that no worker has any idea about WTP, as they have not heard this type of word before and even factory authorities did not tell them about WTP. When we have explained the importance of WTP then 10% workers supported WTP, 50% lightly understood and the rest did not understood WTP. At the survey we have not mentioned illness due to air pollution. We have asked them about their health and how much they spend for health, and how much they are conscious to develop health. Also we have asked them how many days they face the seven light symptoms and one major symptom asthma (which are discussed below) for last 12 months that is, for last 1 year. Good news is that we have found none with the habit of smoking, as the practice of smoking to female is detestable and odd in Bangladesh.

We have divided the sample into two sub-samples *A* and *B*. Sub-sample *A*, is asked about their WTP to avoid one additional day of symptoms for the next 12 months in the light of experience obtained in the last 12 months. Sub-sample *B*, is asked about their WTP to avoid 14 additional days of symptoms for the next 12 months. As most of the female workers are illiterate, we face various difficulties and they feel boring to answer the questions. We have tried to convince them that WTP will be beneficial for their services. If the workers or their children feel respiratory related diseases then costs of medicines and fees of doctors will be in free to avoid of these symptoms. Some workers have answered properly but most of the workers have mixed the 7 symptoms with each other and some workers have not responded, and have denied answering any question. Some have feared to lose the job if they answer the questions. Some workers have supported zero WTP to avoid symptoms days. Our procedure of asking about WTP is the same as that of Navrud (2001). So far we have asked respondents about their WTP to avoid additional days with one symptom. This exercise is followed by a question about their WTP to avoid days where they would experience a combination of three symptoms (coughing, sinus trouble and throat irritation).

We have questioned them the following 7 light symptoms according to rank and an 8th question which is of major symptom asthma. We have asked them following eight questions about WTP to avoid 1 and 14 additional days due to respiratory illness (Navrud 2001):

i). *additional day of coughing*
You will cough 6-7 times per hour, and each cough will last up to 1 minutes. You will feel the cough in your chest, but it is not severe enough to make you problem in the work place. The coughing will not abrupt your normal activities.

ii). *additional day of sinus congestion*
You will have congestion and pain in the sinuses and forehead all day. You will be bothered by a feeling of stuffiness in your head, accompanied by sinus drainage in your throat. You will have to blow your nose every 15-20 minutes. You will have to breathe through your mouth most of the time.

iii). *additional day of congested throat*
On this day you will have congestion in your throat and upper respiratory tract. You will make repeated efforts to clear your throat. The throat clearing is annoying to you and those around you. Your throat will be scratchy. Your voice will be hoarse, and you will have some difficulties in speaking.

iv). *additional day of itching and smarting of eyes*
Watering and smarting of your eyes will force you to interrupt what you are doing every 30 minutes or so. You rub your eyes and close them. Stinging will bring tears - bad enough to cause you to use a handkerchief or a tissue paper around your eyes.

v). *additional day of headache*
You will have two painful and splitting headaches during the day. Each period of headache will last three hours.

vi). *additional day of breathing trouble*
You will feel stuffiness in your chest all day. You have difficulties in inhaling properly and loose your breath at even small efforts like climbing the stairs between two stories or taking a short walk.

vii). *additional day of acute bronchitis*
You will feel soar and congested in your breast behind the breast bone all day. You will have a cough, which is dry and hurts, and later you will cough up mucus. You will have a light fever.

viii). *additional day of a major asthma attack*
You get one attack per day of acute difficulty of breathing (dyspnea) together with wheezing due to congested respiratory tracts. Often one will bend forward to get more air.
We have provided forms with list of seven light symptoms to fill the form by themselves and we have filled the forms what they have answered on behalf of those who are illiterate.

RESULTS OF THE SURVEY
From the two sub-samples we have calculated median, mean μ, and standard deviation σ, to prepare tables of WTP. Here we have shown the results from the collected sample by calculating in Microsoft Office Excel 2003. In all the tables we have used Bangladesh currency, Taka (Tk.), (1US$ = Tk. 81 in 2011 market value). The tables-5.1 and -5.2 show the results from sub-samples *A* (1 symptom day) and *B* (14 symptom days), respectively. First we have established the table-5.1 which is WTP per person to avoid 1 additional day per year of 7 light health symptoms from sub-sample *A*.

Symptoms	WTP/person Mean, μ Tk.	WTP/person Median Tk.	Standard deviation, σ	WTP/person Min-max Tk.	WTP = 0 (In total No.)	N
1.Coughing	174	110	187	0-900	10	165
2. Sinus congestion	290	250	226	0-950	8	223
3. Throat congestion	258	200	201	0-800	11	203
4. Eye itching	226	178	172	0-700	9	185
5. Headache	287	250	223	0-900	8	221
6. Shortness of breath	267	200	227	0-925	13	215
7. Acute bronchitis	344	350	245	0-940	4	211
8. Combination of coughing, sinus congestion and throat congestion	366	352	262	0-1,000	7	271

Table 5.1: WTP per person in Bangladesh currency, Taka (Tk.), ($1 = Tk. 81) of sub-sample *A*.

Now we show the results of sub-sample *B* in the following table-5.2 which is WTP per person to avoid 14 additional days per year of 7 light health symptoms. Calculations are similar to those in the table-5.1.

Symptoms	WTP/person Mean, μ Tk.	WTP/person Median Tk.	Standard deviation, σ	WTP/person Min-max Tk.	WTP = 0 (In total No.)	N
1.Coughing	370	354	262	0- 950	7	160
2. Sinus congestion	367	350	273	0-1,020	8	176
3. Throat congestion	331	329	244	0- 925	15	178
4. Eye itching	389	360	255	0- 700	9	171
5. Headache	589	358	593	0-2,000	12	189
6. Shortness of breath	306	190	296	0-1,100	11	206
7. Acute bronchitis	256	350	257	0- 960	8	187
8.Combination of coughing, sinus congestion and throat congestion	641	614	449	0-1,500	7	142

Table 5.2: WTP per person in Bangladesh currency, Taka (Tk.), ($1 = Tk. 81) of sub-sample *B*.

We have asked a question those who stated zero WTP, why they have done so. Most of them answered that they only suffer at the lowest light symptom coughing only, in which they face no problem to work in the factories and no need to leave in the factory. Some have agreed WTP with a very low amount as their wages are very low.

Comparing tables -5.1 and -5.2 we see that WTP for acute bronchitis is higher to avoid 1 additional day per year of 7 light health symptoms for sub-samples *A* and WTP for

Symptoms	Sub-sample A Tk. per day	Sub-sample B Tk. per day	Ratio, B/A
1.Coughing	174	370÷14 = 26	0.15
2. Sinus congestion	290	25	0.10
3. Throat congestion	258	24	0.10
4. Eye itching	226	26	0.12
5. Headache	287	26	0.10
6. Shortness of breath	267	14	0.05
7. Acute bronchitis	344	25	0.07
Combination of coughing, sinus congestion and throat congestion	366	44	0.12

Table 5.3: Ratios of sub-PPsample B: sub-sample *A*, for 7 different symptoms and combination of first three symptoms ($1 = Tk. 81).

headache is higher to avoid 14 additional days per year of 7 light health symptoms from sub-sample *B*. But we have not surveyed equal number of workers in both samples. Again the workers of Bangladesh have no proper idea of WTP as it is not implemented yet in the society. We form table-5.3 by mean WTP per person to avoid 1 additional day per year of 7 light health symptoms for both sub-samples *A* and *B*. In this table we also show the ratios of sub-sample *B*: sub-sample *A*. From table-5.3 we observe that there is a declining marginal value of a symptom day as the number of additional symptom days increase from 1 to 14. The average WTP per symptom day from sub-sample *B* is 5-15% of the value of a marginal symptom day found in sample *A*. From table-5.3 we see that coughing is the symptom with the highest decline and shortness of breath is the least decline in marginal value. The decreasing marginal value is as expected from economic theory, and in general the results seem reasonable with regard to the seriousness of the different symptoms.

We have questioned WTP of avoiding 1 and 14 additional coughing days one of their children whose age is below 16 years. The following table-5.4 shows the ratio of *B/A* for one of their children. We have found that their children have prevention capacity about 2% less than the adults. From tables -5.3 and -5.4 we see that the ratio *B/A* for children is 0.17 but that ratio is 0.15 for the adults. This is a survey report from the inexperience in WTP of Bangladesh garments workers, so that the result does not reflect the real health situation of the country. Finally we have asked about major symptom asthma, which is the worst of all symptoms. In Bangladesh common people and factory authorities believe that if any healthy people come with contact of asthma patient, the healthy people must attack with asthma. Hence no factory owners will agree to give job facility for an asthma patient in the factory. If anybody attacks with asthma she must lose job. Moreover labors are available if any factory wants, so that factory owners show no mercy for the asthma patients. Doctors (asthma specialists) always advise that asthma attacks are due to lungs problem and is not

Sub-sample	WTP/person Mean, μ Tk.	WTP/person Median Tk.	Standard deviation, σ	WTP/person Min-max Tk.	WTP = 0 (In total No.)	WTP/ day	WTP/day Ratio B/A	N
A	563	505	293	0-1,100	7	563	---	127
B	1293	1329	593	0-2,000	14	93	0.17	140

Table 5.4: WTP per person in Taka to avoid annual increasing in coughing days among one of their children ($1 = Tk. 81).

contaminated if anybody come contact with patients. It will be cured after a proper treatment. But doctors' advises are as like *crying in the wilderness* to the traditional society of Bangladesh. As a result all the workers avoid the question about WTP for asthma. We have requested them to give WTP report and we assured them that we will try to establish WTP for asthma in the society. But they have told us that they will think about it if any attempt is taken by the government to establish it in the society.

We have surveyed in the garments workers of CCC. Dhaka is the capital of Bangladesh and it is one of the highest air polluted towns of the world. As most of the factories of the country are in Dhaka so that WTP of Dhaka will be higher than CCC. We hope male workers responds in WTP will be higher than female workers to avoid most symptoms as male workers work in the risky and highly air polluted factories.

THE FUTURE LABOR SECTOR OF BANGLADESH

We have mentioned that Bangladesh is a densely populated and labor available country, so that government should build a healthy labor sector for the future. WTP is one of the best processes to do so. Recently Bangladesh is exporting labors in the Middle-East and some other countries of Asia and most of them are unskilled. As a result they can not send money for their families as like skilled workers. The labors who are working in the country are deprived of from their proper wages and proper health services. If all the workers are being healthy and skilled they can contribute to make a rich gross domestic product (GDP) of Bangladesh. We hope that the government should take a step to make compulsory WTP system in every labor sector of Bangladesh. Otherwise in 2050 the country will find sick and poor labor sector and the GDP of the country will not stand in a satisfactory position. Then the over population will be not boon but burden for the country. Government should provide nutritious food, proper free treatment and education to the children of the workers. This strategy will be beneficial both for labor sector and the government of Bangladesh at present and in future. In the survey we have seen that the labors have responded comparatively less WTP but the government should adjust it according to their wages and facilities in health sector. To make a healthy and skilled labor sector first the government of Bangladesh should take necessary steps.

CONCLUDING REMARKS

Perhaps this type of survey is conducted first time in the labor sector of Bangladesh. By this survey the workers have found experience about the seven common light symptoms and will be eager on WTP for the symptoms. Government of Bangladesh should take steps for valuing the health of the workers. From the survey we have observed that WTP for 14 days sample is more stable and will be beneficial both for government and the workers. At present health care programs in Bangladesh are not in a leading position. In most of the

cases health is not evaluated in a proper way so that workers will not agree on higher WTP at the starting. The government or factory owners will find a large amount of WTP from the workers and easily can provide it in the health services. After implementation of WTP the net national product of the country will be increased and obviously the GDP of the country will not decrease. Hence the country will create a healthy labor sector and a rich economy for the present and future generations.

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