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Community's Informal Adaptation and Disease Risk Arrest

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Abstract

Formal educated people are considered more aware of good and bad human health as comparedto informal education. Current study represents the unique findings favor of informal education in mitigatingthe human health effects due to water pollution. Village Motian in Pakistan is prone to the industrial wastewater contamination in the drinking water of community. Due to presence of bacterial coli (Escherichia coli), community is facingDiarrheal and Intestinal infection diseases. Theoretically health production function is used to find the association of contaminants and diseases. Forthe estimation of impact of this association, probit model is used. Two categories of households based on the primary data were surveyed. One who obtained formal school education and the other who participated in pollution awareness through informal channels. Results of the study proved that formal school education did not show any significant impact in mitigating the disease risk whereas informal ways of education showed the effective impacton the reduction and mitigation of the diseases. It is also recommended to the provincial government as part of policy to include pollution awareness in the formal education right from the primary education tier.

Keywords: Drinking Water Contamination, Industrial Waste, Informal Awareness, Disease risk.

Introduction:

Common man is aware only to common diseases, consequences, and their remedies. There is large numbers of diseases and their causes which are not known to the public. It requires some special knowledge and awareness. In the western and developed nations education offers opportunities to learn more about environmental health impacts and risks. In these countries, awareness is given to the people either in school curriculum or by imparting to individuals through social pollution awareness programs. People are trained in the educational institutions about important lifestyle choices to prevent or mitigate the diseases Therefore adults with higher levels of education tend to have lower exposure to pollution. Individuals with more education have greater socioeconomic

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resources for a healthy lifestyle and a greater relative ability to live and work in healthy living(Kanny et al. 2013).

It is believed that the formal educated community is less likely to have risky attitude towards apprehended diseases and are likely to adopt proactive healthy behavior such as conscious in diet and exercise(Atreya, Sitaula, and Bajracharya 2013). Safe drinking water and important sanitation are severe problems in developing countries. Pakistan is one of those countries which is passing through the phase of transition. Industrialization has boosted the economic growth in terms of higher gross national product and gross domestic product in Pakistan. It also causes the losses to well-being and welfare in terms of environmental degradation. Education has an impact on the health behavior of the community (Kant and Graubard 2007). It is also equally true that education in the developed countries is equipped with the general know how about the healthy lifestyle for example the awareness about the environmental impacts and their remedies, like pollution.

Scarce and clean water is at one place but awareness about water pollution is another which makes the people more vulnerable todiseases. Even highly educated people do not have specific knowledge of water pollution, its causes, consequences to avoid water pollution(Akar et al. 2009). One study was carried out in 2009-10, that adults, who were not graduated formally, were smokers as compared to the graduated students who were not smokers (Cutler and Lleras-Muney 2010). Globally, the riskiest water quality issue is often associated with pathogen loading. Diarrheal illness causes much mortality worldwide, particularly in children under the age of 5. Walker et. al.,(2013) studied that the greatest rise in exposure to pollutants are predicted to occur in low- and lower middle-income states, principally because of higher population and economic growth and the lack of wastewater managementsystems.

Although environmental degradation has left its lethal effects in almost every aspect of life in Pakistan, but the most severe and immediate effects of environmental degradation are health impacts. These diseases are mostly bacterialDiarrhea. Diarrheal diseases are a major threat to human health and still represent a leading cause of morbidity and mortality in Pakistan. Communities living around the industrial areas are open pray to environmental and human health problems due to industrial pollution, stemming from poor planning, environmental unawareness and inadequate pollution control facilities. Incidence and case-fatality ratios are much higher in developing countries (Anwar and Sun 2011). *E. coli*and *Shigella* are among two of the four main causative agents of moderate to severe diarrhea among children in these areas(Ensink et al. 2004). This study investigates and concludes that the above-mentioned facts in favor of formal education to reduce the risks of illness due to bacterial. *Coli (Escherichia Coli)* contamination is justified only in the developed countries. As for as the case of developing nations is concerned, the role of school

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education does not impact positively on the reduction of diseases. In support of this argument, we observed four justifications.

Firstly, the above conclusion is based on assumption that if curriculum of the formal education is tailored in such a way that the student may obtain the enough knowledge about the general pollution, its consequences and to avoid its fatal impacts on the human health. Secondly, the success of school education against pollution and its health impacts is relevant to choose behavior of individual; for example, it is likely for the person to smoke or drink by his choice irrespective of his focus on health. But it fails in the situation where choice is not involved, instead when it is imposed on the community such as the residence of the community in the vicinity where industrial water contamination exists without any intervention(Estabrooks, Lee, and Gyurcsik 2003). Third reason for the positive implication of school education is in the developed countries and not in the developing countries. Fourth reason is that the general formal literacy rate of Pakistan is 62% which is the 8th out of 9 countries in the region("Economic Survey of Pakistan" 2018).

Current study pertains to Pakistan. This Study was carried out in the communities living in the premises of industrial estate where affluent of all the industrial waste is contaminating the drinking water of the community. We found unique evidence of formal and informal education on the community's health. People who are educated formally obtained proper school education but did not have any general knowledge of water pollution. These communities are more vulnerable to the diseases as compared to the people who have general water pollution awareness throughinformal modes. Community compromised with the circumstances of imposed water pollution. They obtained general know how about water contamination; its health impacts and some effective measures by individual actions to reduce exposure and health risks. For example, participation in any non-governmental organizational program, pollution awareness program, perception about causes and diseases, fear of cost of illness, knowledge of water testing techniques etc.

Based on these information and educations obtained informally, people adopt some precautionary measures to avoid the lethal effects of contamination. Few measures are boiling of water, installation of domestic water purifier or filtration plant, chlorination and purchase of market bottle. Ill People who intake contaminated drinking water incur heavy cost of illness. Consequently they compromise to live with the imposed industrial water pollution(Sajid 2006). People of selected village, Motian, are reported to have the water contamination in their drinking water from the main Hattar Industrial Estate's wastewater channel named Jhar. This water contamination is the vital reason for the prevalence and incidence of water born. Because of these diseases, affected communities incur heavy cost of illness and thereby, directly and indirectly their

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utility effects. Current study pertains to those informal factors adopted by the community to reduce the health impacts, cost of illness and welfare gain(Maria 2003)through informalawareness whereas the people having only the formal school education are found to be the pray of diseases.

Study Aims

Objectives of the study are to estimate and analyze the impact of informal education on mitigation of disease risks, physical relationship between water contamination and illness.The focus of the study is the comparison of the impact of formal and informal education on disease risk minimization.

Materials and Methods

Sample Design and Technique

Composition of sampling technique is multi staged and divided in two parts; first water quality analysis to find out the E. coli (Escherichia coli) in the contaminated drinking water and its association with the diseases and secondly household survey to assess the impact of formal and informal education on human health damage. Water and household samples were digitized on geographical information system (GIS)using Arc- GIS software. Targeted area is the affected community of Village **Motian** adjacent to the Hattar Industrial Estate (Pakistan). Hattar Industrial Estate (HIE) is situated 40kilometers from the capital of the country, Islamabad, Pakistan. In HIE there are around 200operational units, and mainly composed of food and beverage, textile, crockery, paper printing, chemical, fertilizers, stainless steel, cement, publishing, chemical, rubber, carpets, battery and leather products. Representative sampling of village, **Motian** of district Haripur was taken for the study purpose. Motian is located at the downstream of industrial wastewater channel *Jhar* (Local name) and is vulnerable to industrial water contamination.

Table 1. Profile of the villages

Village Name	Area (Km2)	Total Population	No of Households	Household sampled	Union Council/Ward	Digital Arial Coordinates
Motian (Target)	0.0811	1781	258	150	Dingi	33° 54' 01.83" N 72° 47' 52.33"E

Table.1 shows the profile of the entire village. Geography of Motian is situated on the left side of the industrial waste water channel but 60 meter above the industrial waste water bed which has been proved scientifically in our study that the dug well's depth and wastewater channel bed have the same level (Fig-1).

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Figure 1: Geographical Map, showing the location of Industrial Wastewater Channel

Figure 1 shows that village Motian is situated on the left side of the industrial wastewater channel. For sampling of water and households, the population living around the wastewater channel was distributed in three variant distances i.e. total area Motian is 0.0811square kilometer (Table.1) around the wastewater channel. Hence the household living at100 meter, 200 meters and 300 meters on the left side of the channel have been selected for sampling. Sampling points both for Water and households marked on GPS-60, Garmin Device to obtain the coordinates (Table.1) which further were transformed into Google earth to map the area. Based on GPS coordinates we digitized the sampling area. Variant distances reflect the degree of closeness of household's residential location and their source of drinking water. Water sampling was carried out in two phases, one from the source of water contamination i.e. main industrial wastewater channel and the 2nd drinking water sampling from household. (Table.2).

Table.2. Household sampling for Village, Motian

Village	Total No. of Households	Confidence level	Water sample	Sample size	% of Population
Motian	258	95%	45	150	58

Water Sampling from Household's residence:

The second phase of investigation was the collection of data from households. Primary data of 150 households from Motian covering their demographic, socioeconomic, cultural, diseases, education, pollution awareness, risk perception, exposure to the pollution and water

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contamination was collected during the period of2017-18. Data was collected through a well-structured and purpose-built questionnaire. On 95% confidence interval, a household sample of 150 out of 258 households was selected for survey and drinking water quality. Geographically Motian is situated on the GPS coordinates33° 54' 01.83" Nand 72° 47' 52.33"E (see Table 1). Sampling points from wastewater channel, household along with their drinking water sources were marked on Garmin GPS 60.

Model

Quantification of our objective to investigate the impact of informal education requires two models: theoretical Economic model of Utility function and the Health Production Function model using environmental quality as an input. The utility function of the household affected by the environmental quality is interpreted differently from the traditional utility function. As in relation to environmental quality, utility is studied in terms of Health production function. The health production function model was first developed by(Grossman 1972)and later improved by (Cropper 1981; Gerking and Stanley 1986; Harrington and Portney 1987). Freeman(1993)proposed a model in which environmental quality C, and mitigating activity M, avertiv activity A, stock of health capital K, and stock of social capital S, like education level of a household are inputs of the health production function H. Household's utility function U is given. The health production function relates exogenous variables (including environmental variables) like water contamination and choice variables such as Avertive expenditure, and treatment cost(Thornton 2002). Health at any time is measured by the number of sick days whereas other determinants of health status are the level of exposure or dose of some environmental contaminants(Fayissa and Gutema 2005). Dose is represented by scalar variable which depends on concentration of pollution and the amount of avertiv activity undertaken to avoid or reduce exposure to pollution (Grandjean and Landrigan 2006).

Utility Model:

$$U = U(Y, H, C, L) \quad (1)$$

Where Y is a private good other thanH which is health status and C is Environmental Quality(contamination) and L is leisure.

Health Production Function Model:

$$H = H(C, M, A, K, S) \quad (2)$$

Where H represents number of sick days, environmental quality, mitigating activity M, Avertive activity A, stock of health capital K, and stock of social capital S, like education level are the inputs. Pollution affects individual utility indirectly through the health production function.

The household's budget constraint is given as:

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$$I = I^* + w(T - L - A_t - H) = Y + P_m M + P_a A \quad (3)$$

Given the level C, K, S, income I, and prices w (wage rate), P_m (Price of medical activities), and P_a(price of Avertive activities), the individual maximizes (I) with respect to Y, M, A and L given the budget constraint.

Solution to this problem yields the demand function for mitigating activities and averting activities by the household in the following equation.

$$\max G = U(Y, H, C, L, I) + \lambda\,[I^* + w(T - L - A_t - H) - Y - P_m M - P_a A] \quad (4)$$

Variables Obtained from questionnaire:

Income of the households is monthly income. Mitigating cost is the expenditure incurred by the household to mitigate the illness. Household's exposure to the contaminated water was measured on five exposures: drinking, cooking, bathing, ablution(cleanness) and washing. Each exposure was assigned 1 weight.Sickness is a binary variable which interprets 1 if the disease exists otherwise 0.E. coli were measured in counts. Pollution awareness (Polawar) of the household was measured on five information: presence of Radio, TV,internet,Participation of any government or NGO program of awareness of pollution. If any household has 3 or more than three information was marked 1 otherwise 0.Perception of risk(Pr) was determined on specific knowledge of E. coli (Escherichia coli) contamination, water borne diseases, metals associated diseases, water quality test and presence of metal associated disease in family. Like pollution awareness the household responded more than 3 positively was marked 1 otherwise 0.Family size is the number of members in the family of household.Education of the household was measured on four levels: 1-Primary(1-5),2-Middle(6-8),3-Matric(9-10) and 4- above matric.

Results and Discussion

The first requirement for our empirical analysis is to determine the probability of sickness. Theoretically this probability is derived using a probit model by maximizing the following log-likelihood function.

$$L = \sum Y_i \ln \mathrm{F}(x, \beta) + (1 - Y_i) \ln\big(1 - \mathrm{F}(x, \beta)\big) \quad (5)$$

Here x is a vector of independent variables and β_s are the coefficients. Dependent Variable: Sickness (SICKNESS) isa binary variable.

The summary statistics of all the variables used for village Motian are presented in Table 3, "F" is the cumulative probability function for probit model. The dependent variable $Y_i = 1$ if E. coli (Escherichia coli) induced sickness exists and = 0 if absent for the i^{th} household.

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Using the probit model, the marginal effect due to change in the concentration of bacterial counts in the drinking water. Marginal effect for C(Coliforms) ΔF=(Coliforms=1)- (Coliforms=0), which shows the effect on changes in the probability of reducing the incidence bacteria related sickness when Coliforms contaminated water replaced to safe mode. The dependent variables sickness, E. coli (Escherichia coli) have been found above the threshold values given by WHO and EPA.

Estimation

Descriptive Statistics

Table 3 describes the summary statistics for the village of Motian. Average Sickness in Motian is 40% whereas average of E. coli (Escherichia coli) concentration in the Motian village is 61.3 which is clearly higher than the guideline value given by the WHO. Average Exposure is 3.7 out of 5 exposures. AsAvertive measures are the outcomes based on four variables: income, education, Pollution awareness and perception of risk. Most households were in the 1st and 2nd bracket of education i.e. middle and under matric. 34% of people had knowledge of general pollution, and this variable was measured as Pollution awareness. 29% of people had specific knowledge of water contamination and its associated diseases and this variable was measured as a risk perception. Although the education level of the households in the village Motian is higher but as we have already proved it with evidence that informal knowledge i.e. Perception of risk and pollution awareness play significant role in making the decision pertains to health production. Again, Location variable tells that majority of households live in Zone I and Zone II.

Table3. Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Sickness	150	0.407	0.493	0	1
Location	150	2.093	0.838	1	3
Exposure	150	3.693	1.400	0	5
Avertive measures	150	0.400	0.492	0	1
Pollution awareness	150	0.340	0.475	0	1
Risk perception	150	0.293	0.457	0	1
Education	150	1.947	0.873	0	4
Coliforms	150	61.300	106.041	0	400

With reference to the pollution effect, Motian is situated on the left bank of the industrial wastewater channel. Sources of drinking water both dug wells and drilled water bores are having the concentration of coli forms. We estimated the probability of sickness as a dependent variable whereas independent variables were concentration of coli forms; location, exposure and perception of risk, pollution awareness, and education (see Table 4).

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individual level information such as (a) education (EDU), (b) monthly income measured in Pakistan's Rs. (INCOME)(c) concentration of Coli forms count (d) Avertive measures are the binary variable if household adopts=1 otherwise 0 (AM)(e) Pr measures the perception of risk as a dummy variable (Pr) (f) Pollution awareness (POLAWAR)is also a dummy variable. (h) Location (LOCATION).

Model Estimation

Table 4.Probability of Sickness, Marginal effects and elasticities of the variables

Variables	Coefficient	dy/dx	ey/ex
Coli forms	0.0129***	0.0015***	0.032***
	(0.0049)	(0.0005)	(0.008)
Exposure	0.484**	0.0550***	2.059**
	(0.195)	(0.0210)	(0.896)
Pollution Awareness	-0.945**	-0.1074**	-0.656*
	(0.438)	(0.0481)	(0.385)
Risk Perception	-1.007**	-0.1144**	-0.785
	(0.493)	(0.0542)	(0.493)
Education	0.0879	0.0100	0.271
	(0.201)	(0.0228)	(0.619)
Avertive Measures	0.524	0.0595	0.242
	(0.437)	(0.0490)	(0.191)
Location	-0.954***	-0.1085***	-3.842***
	(0.257)	(0.0223)	(1.359)
Constant	-0.560		
	(1.130)		
Log likelihood	-30.356		
Number of obs	150		
LR chi2(7)	141.97		
Prob > chi2	0		
Pseudo R2	0.701		

*, ** and *** mean significant at 10, 5 and 1 percent. Standard errors are in parenthesis.

Table 4 shows the probability of sickness, Marginal effects and elasticities of the variables. It shows the crux of this study as two important parameters were focused to study: formal education and Informal education. As formal education (School education) parameter found to be insignificant, whereas informal education is the composition of pollution awareness and Risk Perception. The coefficient values and change in the probability of sickness (marginal effects)

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associated with E. coli concentration, Since E.Coli concentration in the drinking water is an evident for diarrheal and intestinal diseases. Intestinal and Diarrheal damage occurs with exposure to high levels of E. coli. The topography of the village Motian validates that the community living adjacent to the wastewater channel is prone to high risk of contamination and thereby illness. Therefore, the parameter exposure also occurs significantly. In terms of its impact on the probability of sickness the model shows that as concentration of contaminants increases the probability of sickness also increases. That is why the sickness percentage in the village of Motian is 38%. Out of 150 households 57 were found sick and the majority of people are suffering from intestinal and diarrheal diseases.

Similar results were obtained by(Haque, Murty, and Shyamsundar 2011)in Bangladesh and studied the poisonous impacts of arsenic in the drinking water of the households. Estimated model further shows that residential location of the household is negatively related with the probability of sickness in the household which is consistent to our theory and expectations which clearly shows that people living farther from the industrial wastewater channel have less chances of illness which describes higher the distance of living from the wastewater channel lower the probability of sickness. Each additional unit of farther distance will bring the probability of sickness lower to 10%. People of Motian are exposed to the contaminated water in 4 ways; drinking of water, Bathing and religious cleanness, eating and cooking. Exposure of the household and the probability of sickness are positively related which means the higher the exposure will have a higher probability of sickness. It is our investigation that people who are more exposed to contaminated water are more vulnerable to the probability of sickness. Table4 shows that one-unit reduction in the exposure will reduce the probability of sickness by 5%.

Purpose to include Perception of risk along with the awareness of pollution variable is to obtain the information about water borne diseases, their causes and impacts of health effects. Perception of risk was measured on 5 scales based on their informal education obtained by informal agencies. These five scales were 1-general pollution awareness,2-Participation of any NGO program, 3-Recieving of Pollution awareness information, 4, Knowledge of water borne diseases and regular testing of their drinking water,5-Testing of Blood and Urine Domestically. They have a lower income level and lower level of education. That is why the results show the negative relationship of risk perception with the probability of sickness which shows that higher the perception of risk will reduce the probability of sickness. Our result shows that one unit increase in the risk perception reduces the probability of sickness by 11% which is the highly influential variable. The reason was that they have more concentration of contaminants. Pollution awareness based on informal knowledge is another influential parameter which brings 10% change in the probability of sickness if it gets change by one unit. Pollution awareness also satisfies the theory that it has a negative sign which describes that higher the pollution awareness, lower the probability of sickness. The dependent variable sickness is the binary variables. E. coli

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contaminant and location are found to be highly significant at 1% level of significance whereas risk perception is significant at 5%. Exposure has come as a significant variable at 10%. Theoretically our results are consistent in signs; E. coliemerged to be positive signs which depicts that higher the concentration of water contaminants, higher the probability of sickness.

Conclusion

To avoid the lethal effects of water pollution, the community adopted a specific behavior against industrial water contamination into their drinking water and its impacts on their health. They expressed their concern by perceiving the risk of morbidity and mortality. They did not obtain any awareness pertaining to the toxic water contamination and its fatal effects on their health in the school and college but made themselves skilled and knowledge through informal adoptation. This study presents the scientific evidence of their informal adaptation against industrial water contamination and its positive outcomes whereas formal education did not show any significant impact to avoid the diseases.

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