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Measuring the Health Benefits from Reducing Air Pollution in Kathmandu Valley

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Contents

Abstract

The study estimates the health benefits to individuals from a reduction in current air pollution levels to a safe level in the Kathmandu metropolitan and Lalitpur sub-metropolitan areas of Kathmandu valley, Nepal. A dose response function and a medical expenditures function are estimated for the purpose of measuring the monetary benefits of reducing pollution. Data for this study were collected over four seasons from 120 households (641 individuals) and three different locations. Household data were matched with air pollution data to estimate welfare benefits. The findings suggest that the annual welfare gain to a representative individual in the city from a reduction in air pollution from the current average level to a safe minimum level is NRS 266 per year (USD 3.70). Extrapolating to the total population of the two cities of Kathmandu and Lalitpur, a reduction in air pollution would result in monetary benefits of NRS 315 million (USD 4.37 million) per year. If the Government of Nepal implements its energy Master Plan and pollution is reduced to meet safety standards, discounted benefits over the next twenty years would be as high as NRS 6,085 million (USD 80.53 million).

Key Words: Air Pollution, Human Health, Dose Response Function, Panel Data, Health Diary

Measuring the Health Benefits from Reducing Air Pollution in Kathmandu Valley

1. Introduction

The evidence on the adverse impacts of air pollution on the environment in general and on human health in particular is not controversial. Research has established that high concentrations of lower atmospheric pollution - ozone, lead, and particulate matter - contribute to human morbidity and mortality. Humans can inhale particulate matter with an aerodynamic size less than 10 microgram (called PM_{10}) into the thoracic, which then moves to the lower regions of the respiratory tract, carrying the potential to induce harm. Prolonged exposure to air pollution may lead to irritation, headache, fatigue, asthma, high blood pressure, heart disease and even cancer (Brunekreef et al., 1995; Pope et al., 1995; Pope, 2007). Such health problems clearly have economic costs arising from expenses incurred in treating the disease and loss of productivity (Bates, 1990; Ostro, 1994; Banerjee 2001).

Rapid urbanization in the Kathmandu valley has resulted in a significant deterioration in air quality. Although vehicular emissions, poor infrastructure, re-suspension of street dust and litter, black smoke plumes from brick kilns, and refuse burning are among the many sources contributing to increased air pollution in the Kathmandu valley (Shrestha, 2001), vehicular emissions have now become the main source of pollution. An inventory of emission sources by the Ministry of Population and Environment (MoPE) indicates that exhaust fumes increased more than four times between 1993 and 2001 (MOEST, 2005). According to a more recent inventory, vehicular emissions are responsible for 38% of the total PM_{10} emitted in the Kathmandu valley, compared to 18% from the agricultural sector and 11% from the brick kilns (Gautam, 2006). The increase in vehicular emissions is mainly due to the increase in the number of automobiles, as well as poor transport management and vehicle maintenance. The number of vehicle registered in Bagamati Zone[1] is ever increasing. While the number registered in this Zone in 2000/01 was less than 27 thousand, it had reached close to 50 thousand by 2009/10, with the total number now at 250 thousand , which amounts to 56% of all vehicles registered in the country during the 2006-2010 period (DoTM, 2010). Indeed, the number of vehicles registered has been growing at a rate of 15% per year, which is approximately three times the population growth rate. This growth rate is the highest in the case of private vehicles such as motorcycles and small cars (ICIMOD, 2007).

In addition to vehicular emissions, poor infrastructure and the seasonal operation of the brick kilns in the Kathmandu valley further worsen the air quality. Brick kilns operating during the winter contribute to an increase in air pollution levels during this season. Since the complex topography of Kathmandu results in limited air pollution dispersion, air pollution control has become a problem of immense proportions in the Valley.

In view of the high levels of air pollution in the valley, the government of Nepal has already implemented some policies to arrest deteriorating air quality, which are primarily aimed at controlling emissions from vehicles and brick kilns. Among the initiatives taken by MOEST (Ministry of Environment Science and Technology) are the enactment of the Industrial and Environmental Act, the vehicle emissions exhaust test, a ban on diesel-operated three-wheelers (tempos), the introduction of electric and gas-powered vehicles, the import of EURO-1 standard vehicles, and the ban on new registrations of brick kilns. The Government is also preparing a master energy plan which aims at reducing air pollution to safe levels through resort to options such as LPG, CNG, or electricity in the transportation sector (GON, 1997).

Given this background, the objective of the paper is to arrive at an estimate of the health benefits from reducing air pollution in the Kathmandu valley. This estimate would provide useful information to stakeholders interested in air pollution regulation initiatives. Benefits estimation will enable policy makers to assess the economic viability, within

[1] Most of the vehicles registered in Bagmati Zone operates in Kathmandu Valley

a cost-benefit framework, of the different air pollution programs currently under consideration. It would also provide the basis for long-term alternative energy initiatives in the Valley.

The paper is organized as follows. Section 2 offers a review of related literature while section 3 describes the study area and section 4 provides a brief description of the data collection methods. Section 5 describes the economic and empirical methods used for data analysis and section 6 outlines the results and discussion. Section 7 offers conclusions and recommendations.

2. Review of Literature

While epidemiological studies have tried to establish a relationship between air pollution and incidence of illness using what is known as dose response and damage functions, economists have estimated the health costs of air pollution using different valuation techniques (Grossman, 1972; Alberini et al., 1997; Ostro, 1994; Krupnick, 2000; Murty, 2002). The techniques that are used to value costs include the health production function approach, the benefit transfer approach and the contingent valuation approach.

Several studies have attempted an estimation of the health benefits from a reduction in air pollution to safe level in the Kathmandu valley. A World Bank study by Shah and Nagpal (1997), which estimated the health impacts of PM_{10} in Kathmandu in 1990, found that the cost of the health impacts was approximately NRs 210 million. The study, however, used a dose-response relationship based on research in the US, combining it with the estimated frequency distribution of PM_{10} exposure in Kathmandu Valley in 1990. Further, CEN/ENPHO (2003) estimated that the avoided cost of hospital treatment through a reduction in PM_{10} levels in Kathmandu to international standards was approximately NRs 30 million. However, this study did not cover the costs of the entire spectrum of health impacts from air pollution in Kathmandu. It did not capture, for instance, the cost of emergency room visits, restricted activity days, respiratory symptom days, treatment at home, and excess mortality.

Murty et al. (2003) estimate the annual morbidity and mortality benefits to a representative household from reducing PM_{10} concentrations to the safe standard of 100 $\mu gms/m^3$ to be NRs 1,905. Likewise, a report of the Ministry of Environmental Science and Technology (2005) revealed that the annual mortality rate due to the current levels of PM_{10} in Kathmandu was approximately 900 per 1,000,000 inhabitants in 2003. This study also found that if the concentrations of PM_{10} in Kathmandu valley could be reduced to levels below 50 $\mu g/m^3$, 1,600 deaths could be avoided annually.

Existing studies on valuing the health costs due to air pollution in the Kathmandu valley have various limitations because of methodological issues and data problems. The present study differs from the previous studies in several respects. Firstly, it is based on a longitudinal survey and captures the seasonal variation in air pollutants and the effect of such variation on human health. Secondly, while most other studies have used time series secondary data and the benefit transfer approach to value human health costs, this study uses the household health production function approach.

3. Study Area

The Kathmandu valley, which consists of the three administrative districts of Kathmandu, Lalitpur and Bhaktapur, is the fastest growing major urban area in the country. Its bowl-like topography, surrounded by 500m-1,000m high hills, and low wind speeds create poor dispersion conditions, predisposing Kathmandu to serious air pollution problems. The complex topography of Kathmandu often dictates the flow of the lower atmosphere, thus limiting air pollution dispersion (MOEST, 2005).

The data on PM_{10} recorded at various monitoring stations in the Kathmandu valley shows that the pollution level in the Valley is very high, especially during the dry season. Among the various parameters monitored, particulate matter generally exceeds the national ambient air quality standards (NAAQS) in the core city area. In order to monitor the air pollution variations in the Kathmandu valley, MOEST has set up six monitoring stations at different locations. These locations include areas by the roadside such as Patan and Putalisadak, residential areas such as Thamel, areas coming under the 'urban background[2] ' category such as TU, Kirtipur and Bhaktapur and areas coming under the 'valley background' category such as Matkshyagaun. Figure 3 shows the study area and monitoring stations. The data reveals that PM_{10} at roadside stations and residential areas often exceeds the national ambient air quality level of 120 g/m^3. The 'urban background' stations have sporadically exceeded the safe-level although the 'valley background' stations often remain within the safe level of pollution.

The spatial dispersion of air pollution in the Kathmandu valley reveals that it varies significantly across seasons and locations. Hence, while the concentration of air pollutants in the dry season generally reaches an unhealthy range (up to 349 g/m^3), it decreases significantly during the rainy season. It also varies significantly across different locations of the Kathmandu valley.

4. Data and Household Survey Design

This study relies mainly on primary data collected from household surveys. The socio-economic characteristics of households and individual characteristics of family members were collected from a cross-section household survey. In addition, we collected four rounds of health information on individuals through health diaries administered at the household level to account for seasonal variation. We also use secondary data that are mostly related to air pollutant parameters and climatic conditions. Among the secondary information, we collected the air pollution measurement of PM_{10} from MOEST which maintains a daily record of PM_{10} across various monitoring stations (MOEST 2005, 2006). We collected data on other climatic variables like temperature, rainfall and humidity from the Department of Meteorology.

The questionnaire designed for collecting primary data had two parts: a part on household general information and a health diary. We therefore collected the data in two phases. In the first phase, we collected general household information on the socio-economic and individual profiles of the household members (see Appendix B). We conducted the survey during September, 2008, using a pre-tested questionnaire. This questionnaire, which consisted of various blocks, sought information on accommodation, income and expenditure, household health information, and indoor air-quality information. While the section on household members sought information on various socio-economic and demographic characteristics such as age, sex, education level, marital status, occupation, and smoking habits, the household health information section collected information on current health stock and symptoms of chronic illness. The income and expenditure section collected data on the household's monthly income and expenditure pattern along with information on durable consumption goods like TV, refrigerator, bicycle, etc. The accommodation and indoor air pollution sections captured the type of accommodation using information on house type, construction materials used, etc., along with information on indoor air pollution level. To capture the degree of exposure to indoor air pollution levels, we collected information on the household practices of cooking (for example, whether cooking was done using gas, firewood or kerosene), availability of air conditioner, and the use of insecticides and pesticides.

From the 120 households interviewed, we collected information on a total of 641 individuals regarding their socio-economic profiles and individual health characteristics. The average size of the surveyed households was 5.42. Out of the 641 individual members, almost 51% were female. The age of the members ranged from 1 to 87 with an average age of 34 years. We give the descriptive statistics of household members and their health information in Table 1.

The second questionnaire used was the health diary (see Appendix C), which sought to capture information on air pollution variation and its effect on human health. Given the seasonal variation in air pollution levels, we collected diary data for 12 weeks. We collected information for 3 weeks in a row in each season during four different seasons, viz., post-monsoon period, winter, summer and monsoon season. Three trained enumerators collected the data with a recall period of one week from three different areas through a pre-tested health diary. They collected the data during September-October 2008, January-February 2009, April-May 2009 and July-August 2009. We provide the descriptive statistics of the data collected through the health diary in Table 1.

[2] See MOEST (2005) report for details of monitoring stations.

Following Gupta (2006), this study used a two-stage stratification for selecting households. The main reason for adopting a two-stage stratification was to capture the residents' exposure to air pollution and their ability to avert such exposure.

For the first stage stratification, we identified the location of the air pollution monitoring stations. We selected three monitoring stations, viz., Thamel, Putalisadak and Patan, for this study. We selected a total of 40 households around each monitoring station. We give details on the distribution of the households in the sample in Table 2. The rationale for the location of monitoring stations in these areas is that PM_{10} has often exceeded the national ambient air quality level in these areas while also displaying considerable variation. Moreover, these areas also fall within the core city area of Kathmandu valley with a dense population. After locating the monitoring stations, we drew a radius of 500m from the monitoring station using GIS technology. This enabled us to select households falling within the 500m radius for the health diary and household information. We also divided the area falling within the 500m radius into 4 sub-areas. Having coded the roads in the different blocks, we randomly selected a road from each block. Every third household situated on the selected road constituted the sampling frame for each block.

In the second stage, we stratified the households based on a wealth indicator, which determined whether the household had a four-wheeler or two-wheeler vehicle. Hence, having selected a road from each block, we asked every third household located along both sides of the road whether they possessed any vehicles. We then selected the households randomly according to proportional stratified sampling. Since the continuous exposure of an individual to air pollution causes illness, we considered for the interview only those individuals who had been residing at the selected locality for at least five years.

5. Methodology

5.1 Theoretical Framework

Following Freeman (1993), Dasgupta (2001), Murty et al. (2003), Gupta (2006) and Chowdhury et al. (2010), we use a simplified version of the general health production function in this study:

$$H = H(Q, M, A; Z) \quad (1)$$

where, H indicates the health status taken as the days of illness of an individual that are positively related to the level of air pollution (Q); M refers to mitigating activities including an individual's expenses related to travel to a clinic to consult a doctor, medicines, laboratory tests, hospitalization, etc; A is averting activities that include the number of days that an individual stays indoors to avoid exposure, extra miles traveled per day to avoid polluted areas in the city, use of a mask while traveling, etc; and Z is a vector of individual characteristics such as the individual's baseline health (or health stock).

The utility function of an individual is defined as

$$U = U(X, L, H, Q) \quad (2)$$

where X is consumption of other commodities, L is leisure, H is health status, and Q is air quality.

The individual's budget constraint is expressed as

$$Y = Y^* + w^*(T\text{-}L\text{-}H) = X + P_a A + P_m M \quad (3)$$

where w is the wage rate, P_a and Pm are the price of averting and mitigating activities respectively and the price of aggregate consumption (X) normalized to one, Y^* is the non-wage income while $w^*(T\text{-}L\text{-}H)$ is the income earned from work such that the sum of these two components gives the total income of an individual.

The individual maximizes the utility function with respect to X, L, A and M subject to the budget constraint. The first order conditions for maximization yield the following demand functions for averting and mitigating activities.

$$A = A(w, P_a, P_m, H, Q, Y, Z) \quad (4)$$

$$M = M(w, P_a, P_m, H, Q, Y, Z) \quad (5)$$

Given the equations (1) to (5), we could derive the individual's marginal willingness to pay (WTP) function for a change in pollution as the sum of the individual's marginal lost earnings, marginal medical expenditure, marginal cost of averting activities, and the monetary value of disutility caused by illness. We express this function as

$$WTP = w\frac{dH}{dQ} + P_m\frac{dM}{dQ} + P_a\frac{dA}{dQ} - \frac{U_H}{\lambda}\frac{dH}{dQ} \quad (6)$$

As the monetary benefits from a reduction in discomfort are quantitatively difficult to measure, the monetary benefits from a reduction in air pollution are generally captured by the first three expressions of (6), that is,

$$WTP = w\frac{dH}{dQ} + P_m\frac{dM}{dQ} + P_a\frac{dA}{dQ} \quad (7)$$

Considering that the cost of averting activities is hard to measure accurately, the general practice is to consider the lower bound of estimates, called the cost of illness (COI) as

$$COI = w\frac{dH}{dQ} + P_m\frac{dM}{dQ} \quad (8)$$

This measure of benefits (that is, the cost of illness saved due to a reduction in air pollution) is estimated as the sum of lost earnings due to workdays lost and medical cost to the concerned individual.

5.2 Econometric Specification of the Model

As discussed above, researchers generally estimate the health production function and the two demand functions for mitigating and averting expenditure. Since capturing the averting activities to outdoor air pollution is not easy, this study only estimates the health production function and the demand function for mitigating activities. Depending on the nature of the data, we can estimate reduced form equations of the health production function and the demand function for mitigating activities using the Logit, Probit, Tobit or Poisson regression models.

As in the case of two recent studies based in South Asia (Gupta, 2006; Chowdhury and Imran, 2010), we too estimate a reduced form household health production function initially using the Poisson regression model. Similarly, we estimate the demand for mitigating activities using a Tobit regression equation. We specify the Poisson regression model to estimate the household health production function as:

$$H_{it} = E(H_{it}) + u_{it} = \lambda_{it} + u_{it}$$

$$1n\, \lambda_{it} = \beta_1\, 1n\, X_{it} + u_{it}$$

where λ_{it} is the mean value of the number of sick days, β_1 is the vector of regression coefficients, and X_{it} is the vector of independent variables. The Tobit model for estimating the demand function for mitigating activities is specified as:

$$M^*_{it} = X_{it}\beta_2 + u_{it}$$

where M^*_{it} is a latent variable with

$$M^*_{it} = M_{it} \quad \text{if } M_{it} > o$$

$$M^*_{it} = 0 \quad \text{if } M_{it} \leq 0$$

where β_2 is the vector of regression coefficient and X_{it} is the vector of independent variable.

For empirical purposes, we estimate two reduced form equations of the household health production function and the demand for mitigating activities. The estimated equations are as follows:

$$H = \alpha 1 + a2\ PM_{10} + \alpha 3\ DTEMP + \alpha 4\ Rain + \alpha 5\ Age + \alpha 6\ Age2 + \alpha 7\ Sex + \alpha 8\ Education + \alpha 9\ Smoking + \alpha 10\ HR_{inside} + \alpha 11\ Exercise + \alpha 12\ Chor + \alpha 13\ HH_{type} + \alpha 14\ Kerosene + \mu \quad (9)$$

$$M = \beta 1 + \beta 2\ PM_{10} + \beta 3\ DTEMP + \beta 4\ Rain + \beta 5\ Age + \beta 6\ Age2 + \beta 7\ Sex + \beta 8\ Education + \beta 9\ Smoking + \beta 10\ HR_{inside} + \beta 11 Exercise + \beta 12\ Chor + \beta 13\ HH_{type} + \beta 14\ Kerosene + \acute{\omega} \quad (10)$$

where μ and $\acute{\omega}$ are the stochastic error terms.

The dependent variables of the regression equations are the number of sick days (*H*) and the expenditure on mitigating activities (*M*). The independent variables include the climatic variables, the air pollutants and the individual characteristics affecting health. The description of the variables used in equation (9) and (10) are as follows:

PM_{10}: This is the weekly average PM_{10} ($\mu g/m^3$) recorded at the corresponding monitoring station

Difference in Temperature (DTEMP): This represents the variation in temperature, which is defined as the average weekly difference between the daily maximum and minimum temperatures. Studies show that a relatively high variation in temperature increases the likelihood of illness such as cough, flu and fever (McGeehin and Mirabelli, 2001).

Rain: This is defined as the average weekly rainfall recorded in the valley. Heavy rains wash the pollutants from the air and therefore reduce air-pollution-related symptoms.

Age: This is the age of the individual members of the sampled household. Aging increases the chances of falling ill as the health-stock deteriorates.

Age2: This is the square of the age of the individual in order to capture any non-linearity relation between age and illness.

Sex: This refers to the gender of the individual and is equal to 1 if the individual is male and 0 otherwise. We assume that males and females experience different levels of air pollution exposure as women generally stay inside the home, which also includes cooking at open hearths, while men work outside of home. The sign of the coefficient of this variable will depend on who works in a relatively safer place with less exposure to air pollution.

Education: This is a dummy variable referring 1 as literate and 0 as illiterate individuals. It is expected that a literate individual would be more aware of the health consequences of air pollution and will try to reduce exposure to it.

Smoking: This is a dummy variable which equals 1 if an individual admits to the habit of smoking and 0 otherwise. We assume that smoking further exacerbates the probability of falling ill due to air pollution.

Number Of Hours Stayed At Home (HR_inside): This is defined as the number of hours that an individual spends at home. The coefficient can be positive or negative depending on whether an individual works or spends time in areas with safer air pollution levels. Since there was no information available for outside home air pollution levels when an individual might be expected to be outside the home, we make no prior assumptions about the sign of the coefficient.

Exercise: This is a dummy variable that takes 1 if an individual exercises daily. An individual who exercises is expected to have better health-stock, which would decrease his/her vulnerability to air pollution. However, this again depends on where the individual exercises: indoors or outdoors.

Choronic Disease: This is a dummy variable that captures the presence of chronic illness. It takes the value 1 if a particular individual has a chronic illness and 0 otherwise. If a member has suffered from any disease[3] including those related to air pollution for more than 5 years, the individual is assumed to have a chronic disease.

House Type: This is used as a dummy variable which equals 1 when it is a cement-bonded house and 0 otherwise. The house type is a proxy for wealth and the ability to take avertive actions.

[3] The diseases include Runny Nose/Cold, Sinusitis, Headache (migraine), Flu/Fever, Allergy, Cough, Asthma, Bronchitis, Heart Disease, Tuberculosis, Diabetes, and High Blood Pressure, which are proven epidemically to be caused by air pollution.

Kerosene: This variable captures indoor air pollution levels. It is a dummy variable taking the value 1 if a particular household uses kerosene for cooking frequently. If a household reported the use of kerosene for cooking more than 15 times a month, the variable takes the value 1.

6. Result and Discussion

6.1 Regression Result

The results of the regression analysis are reported in Tables 4 and 5. We estimated OLS and Tobit equations for the demand for mitigating activities (Table 4) while in addition to the Poisson, Logistic and Negative Binomial Regressions are estimated for the dose response function (Table 5). We used the Tobit results in Table 4 and the Poisson results in Table 5 to compute the annual health benefits to a representative individual and the entire city from a reduction in air pollution to the safe level.

The OLS estimates show that the air pollutant parameter is significant in determining the mitigating costs of illness due to air-pollution-related diseases. The coefficient of PM_{10} suggests that an average reduction of 100 $\mu g/m^3$ of PM_{10} could result in a health cost saving of NRs 39. However, given the fact that several individuals do not report any air pollution related illness and therefore there are no mitigating costs for several individuals, the OLS results actually underestimate[4] the mitigating costs for these censored cases. In order to correct for this problem, we use a Tobit estimation. The results from the Tobit estimation in Table 4 show that the air pollution parameter (PM_{10}) is significant in affecting the demand for mitigating expenditures. This implies that an average reduction of 100 $\mu g/m^3$ in PM_{10} results in a reduction in mitigating costs by NRs 320. Climatic variables like differences in temperature and rain are not statistically significant with regard to mitigating costs although they have the expected sign. We also found that most individual characteristics are not statistically significant except chronic disease which was found to be statistically significant at less than one percent. We found the coefficients for household type and use of kerosene to be significant with regard to mitigating costs.

The dose response estimations, as previously noted, are presented in Table 5. The results of the Poisson Regression reported in Table 5 do not show any statistical evidence of a relationship between illness days and PM_{10}. As expected, the sign of the coefficient is positive indicating that the probability of illness increases with the increase in PM_{10}. The climatic variables -temperature and rain - were not found to be significant with regard to illness days. Among the individual characteristics affecting a person's health, we found age square to be negative and statistically significant at 10%. As with the other estimated equations, we found chronic disease and kerosene dummies to be significant with the expected sign. However, given the over-dispersion of data, the econometrics literature suggests that it is better to use a Negative Binomial regression instead of a Poisson regression. However, the Negative Binomial regression also suggests no statistically significant relation between number of illness days and PM_{10} (Table 5).

As an alternative, we examined the relationship between days of illness and its determinants using a logistic regression (see Table 5). The results showed the coefficient of the air pollution parameter (PM_{10}) to be both positive and significant at the 5% level. This indicates that PM_{10} is one of the major factors contributing to air-pollution-related diseases in the Kathmandu valley. Among the individual characteristics, we found age and age squared and history of chronic diseases to be statistically significant in the logistic estimation of the household health production function. The coefficient for age is negative while age squared is positive suggesting that the probability of falling ill decreases for an increase in age up to a certain age but increases thereafter. The results also show that the probability of an individual with a history of chronic disease falling ill is higher (significant at less than one percent) than that for one without such a history. Other individual characteristics such as education, smoking habit and exercise were not statistically significant although the sign of the coefficient is as expected.

In order to capture the exposure of an individual to a particular air pollution level, we used the number of hours an individual spends inside the home as one of the explanatory variables. Though we did not find this to be statistically

4 Amemiya (1984) and Green (1997; 2003) argued that the Tobit models address the significant censoring (i.e., large numbers of zeros). These are typically found in reported cases of illness data while the OLS estimation leads to biased and inconsistent estimates.

significant, the sign indicates that an individual is exposed to relatively safer air pollution levels outside the home than within. We found the type of house and the use of kerosene for cooking to be significant with the probability of illness increasing if the household did not own a cement-boned house structure. Similarly, the use of kerosene for cooking also increased the probability of an individual falling ill.

6.2 Health Benefits from Reduced Air Pollution

This study provides lower bound estimates of health benefits from reducing air pollution since it does not include avertive expenditures. The total benefits to an individual include the benefits from avoiding restricted activity days (days suffering with illness) and saving from mitigating costs. Given the low proportion of reported illness by individuals, most of the health benefits accrue through the decrease in expenses to individuals on mitigating activities due to improved air quality.

To calculate the monetary benefits from reduced mitigating costs, we need to compute the marginal effect from the Tobit regression, which is given by the coefficient of PM_{10} multiplied by the probability of the mitigating expenses taking positive values (Gupta, 2006).

The average PM_{10} level during the study period was 254.75 $\mu g/m^3$. Therefore, the average change required to reduce pollution to the safe level of 120 $\mu g/m^3$ is 134.17 $\mu g/m^3$. Since the marginal effect of PM_{10} in the Tobit equation is given by the coefficient of PM_{10} multiplied by the probability of mitigating expenditure, the annual gain from improved air quality to an individual in Kathmandu valley is given in the expression below (See Gupta, 2006; Chowdhury and Imran, 2010).

Saving from reduced Mitigating Costs per year = $\beta * \Pr(MC>0) * \Delta PM_{10} * 365/7$

Thus, we estimate that the annual welfare gain to a representative individual in the sample is NRs 161 (USD 2.25) per annum due to a reduction in air pollution from the current average air pollution level of 254.75 $\mu g/m^3$ to the national ambient air quality standard of 120 $\mu g/m^3$.

As discussed in the sampling design, we assume the individual in the sample to represent an individual from the Kathmandu metropolitan and Lalitpur sub-metropolitan areas. Therefore, we extrapolate the expenditure for the entire city using the average expenditure of an individual in the sample. Although this estimation is for an individual assumed to reside within 500m of the monitoring station, we extrapolate the health benefits on the assumption that any individual in the city is exposed to the same level of PM_{10}. Taking into consideration the projected population[5] of the Kathmandu metropolitan and Lalitpur sub-metropolitan areas for 2009 from the census report (CBS, 2003), we calculate the annual gain to be NRs 256.60 million (or USD 3.56 million).[6]

Likewise, the number of restricted days due to air pollution is computed from the Poisson regression.

Restricted days per annum = $\propto * e^{\Sigma \alpha X} * \Delta PM_{10} * \frac{365}{7}$; where, $\propto$ is the coefficient of PM_{10} and $e^{\Sigma \propto X}$ is the predicted values of the Poisson regression.

The Poisson regression estimates shows that the marginal saving of 0.0000559 days per week from a unit reduction in PM_{10}. With the required reduction of 134 $\mu g/m^3$ in PM_{10} to keep pollution at a safe level, a representative individual could save 0.39 days per annum. A sick employee who goes to work may still earn the same wage rate as a healthy person. But productivity would go down due to illness, and this should reduce profits to employers. This reduced productivity should be accounted for while calculating the cost of illness. From the sample data we know that the average wage rate is NRs 273.35 per day. Thus, the estimated benefit by avoiding restricted days to an employed person is NRs 105 per year. Nearly 37% of the individuals in our sample were employed individuals. Thus, extrapolating to the entire city with same employment ratio gives an annual saving of NRs 58.5 million (USD 0.81 million) for the entire city.

5 Since a Census was conducted on 2001, only the projected population of the two cities is available. We have assumed a population 1,500,000 in two cities, who are residing in these cities for more than 5 years.

6 We use an exchange rate of 1 USD = 72 NRs.

Total benefits from air pollution reduction is computed as the sum of benefit from avoided restricted activity days and saved mitigating costs to a representative individual. This amounts to NRs 266.44 (USD 3.70) per annum. The sum of benefits to the entire city is calculated to be NRs 315 million (USD 4.37 million)

The estimates of health benefits from reduced air pollution in Kathmandu compare well with available estimates from other cities in the sub-continent. Other studies have estimated avoided restricted days from air pollution reductions to safe levels to be 0.43 days in Taiwan (Alberini et al., 1997), 0.41 days in Kolkota and 0.66 days in Delhi (Murty et al. 2003), 0.62 days in Kanpur, India (Gupta, 2006) and 0.53 days in Dhaka (Chowdhury and Imran, 2010). Our estimates are are 0.39 days per annum in Kathmandu. Likewise, the monetary gain of USD 3.70 in terms of saved costs to a representative individual is also comparable to other studies: USD 3.66[7] in Kanpur (Gupta, 2006) and USD 4.00 in Dhaka (Chowdhury and Imran, 2010).

6.3 Discounted Health Benefits

The Government of Nepal is in the process of preparing a long term energy Master Plan, which seeks to control air pollution in the Valley. If the plan is implemented, it will result in a reduction of air pollution over the next decades. We use our current estimates of benefits from reduced pollution to calculate the discounted benefit flow that could occur during the next 20 years. Some caveats apply. Mitigating expenditure could increase over time because of an increase in income and medical prices. Since medical expenditure is generally income inelastic, we do not expect a substantial increase in expenditure due to an increase in income. One major component that would increase the cost of illness for entire city over the next twenty years is the population growth rate.

Taking the current level of health benefits and adjusting it for population growth rate, we calculate total discounted benefits as:

Present Value of Future Benefits (NPB) = $\sum_{t=0}^{20} \frac{B_t}{(1+r)^t}$

Where B_t is the benefit to city (adjusted for population growth) that could accrue at time period '*t*', *r* is the discount rate. Here, the discount rate used is 3%. The rationale for this choice is that the same figure is used to calculate other international health status valuations such as the Disability Adjusted Life Years (DALY) and the Quality Life Adjusted Years (QALY) (WHO, 2010).

We find the discounted benefit for the population[8] of Kathmandu and Lalitpur for the next 20 years (2010 to 2030) to be NRs 6,085.8 million (USD 84.53 million) based on the assumptions that the air pollution level will remain at the current level[9] and that economic factors would not change significantly during the given time period. These benefit numbers could be compared to any cost estimates related to the air pollution reduction Master Plan.

7. Conclusion and Recommendation

This study provides an estimate of health benefits from a reduction in air pollution from the current level to the national ambient air quality standard level in Kathmandu valley of Nepal. It finds the annual saving from reduced mitigating expenditure to a representative individual in Kathmandu valley to be NRs 266 (or USD 3.70) per annum. The savings for the two cities (Kathamndu and Lalitpur) in health costs per annum is NRs 315 million (USD 4.37 million).

In view of the Government's current initiative to implement a long term energy plan to reduce emissions from fossil fuel, promote the use of renewable energy and reduce air pollution, it is important to have an estimate of health benefits over time. This study estimates that health benefits would be in the range of NRs 6,085 million (USD 84.53 million) over the next 20 years if the plan is implemented and air pollution reduced to the safe level. This estimate assumes a business as usual scenario where there is no significant change in economic parameters.

[7] 1 USD= 45 INR.
[8] The population growth rate in the Valley is at 2% per annum.
[9] The air pollution over time has been almost stagnant despite high seasonal variation. Therefore, we assume that it will continue to remain at the same level barring untoward happenings and exceptional circumstances.

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Tables

Table 1: Summary Statistics from the Household Survey

Variable	Description of Variables	Obs	Mean	Std. Dev.	Min	Max
HH Size	Household Size	120	5.42	2.032	2	11
Sex	Sex Dummy (1 if Male)	641	0.48	0.50	0	1
Age	Age of Individual Members (in Years)	641	34.80	19.40	1	87
Education	Education Dummy, 1 Literate[10], 0 Illiterate	641	0.91	0.29	0	1
Exercise	Exercise Dummy (1 if Yes)	641	0.27	0.44	0	1
HR_inside	Number of Hours Stayed Inside Home in 24 Hours	641	21.46	2.36	10	24
Smoking	Smoking Habit of Individual, Dummy (1 if one smokes)	641	0.08	0.27	0	1
Htype	House Type Dummy (1 if cement bonded)	120	0.90	0.29	0	1
Kerosene	Kerosene Dummy if a Household Uses Kerosene Frequently (More than 15 times per month)	120	0.38	0.49	0	1
Rooms	Number of Rooms in House	120	8.98	4.99	1	40
Number of Floors	Number of Floors in House	120	2.50	0.98	1	6
Illness Dummy	Illness Dummy (1 if an individual is ill)	7704	0.09	0.28	0	1
Illness Days	Number of Days Suffered from Illness	7704	0.57	1.85	0	7
Mitigating Costs	Mitigating Costs (NRs/Week)	7704	7.83	42.55	0	750
Chronic Diseases	Chronic Disease Dummy (1 if ill for more than five years)	7704	0.07	0.25	0	1

Table 2: Distribution of Sample in the Study Area

Station	RN*	No of HH			Sample size		
		Yes**	No	Total	Yes	No	Total
Putalisadak	1	64	20	84	6	2	8
	2	112	12	124	10	1	11
	3	87	23	110	8	2	10
	4	105	12	117	10	1	11
Patan	1	67	17	84	6	2	8
	2	106	24	130	10	2	12
	3	97	15	112	9	1	10
	4	88	14	102	8	2	10
Thamel	1	60	2	62	8	1	9
	2	57	13	70	8	2	10
	3	85	6	91	12	1	13
	4	66	0	66	9	0	9
TOTAL		994	158	1152	104	17	121

* Road Number
** if HH owns a four -wheeler vehicle

[10] Literate include both formally and informally educated individuals

Table 3: Summary Statistics of Climatic and Air Pollution Variables

Variable	Description of Variable	Obs.	Mean	Std. Dev	Min	Max
Temp. Max	Average Maximum Weekly Temperature in Degrees Celsius	12	26.97	4.01	18.49	31.46
Temp Min	Average Minimum Daily Temperature in Degrees Celsius	12	13.85	6.4	2.44	21.5
DTEMP	Difference in Weekly Temperature in Degrees Celsius	12	13.13	3.29	7.53	17.13
RAIN	Average Weekly Rain in mm	12	2.3	3.42	0	12.37
PM10	Average Weekly PM10 (ug/m^3)	12	254.75	81.23	120	360

Source: Various Reports of MOEST (2009)

Table 4: Random Effect Tobit and OLS Regression Results

Dependent variable: mitigating expenses/week (value in NRs)	Tobit regression		Ols result	
Independent variables	Coefficient	Std. Err.	Coefficient	Std. Err
PM10	0.3198***	0.0996	0.0397***	0.0092
DTEMP	1.8505	2.9019	-0.0073	0.2444
Rain	-1.0489	2.5044	0.1759	0.1860
Age	-0.6617	1.1768	0.0345	0.1353
Age2	0.0111	0.0140	-0.0001	0.0017
Sex	-14.2937	12.7953	0.2502	1.4301
Education	16.3934	22.0761	1.4098	2.5363
Smoking	8.9351	21.6130	1.6049	2.6566
HR_inside	-3.5402	2.5667	0.0170	0.3005
Exercise	19.2138	14.2816	1.8916	1.3481
Chronic disease	418.8257***	20.9780	84.4224***	2.8629
House type	-39.5555**	19.8531	-2.0207	2.3997
Kerosene	21.9044*	12.5313	3.8855***	1.4414
Constant	-355.3275***	76.3164	-10.2351	8.2783
Sigma(u)	77.5208	8.4062	$R2 = 0.23$	
Sigma(e)	156.4482	5.5343		
Rho	0.1971	0.0359		
Log likelihood	-4255.1551			
Wald chi2	475.4600 (P=0.00)		1023.77 (P= 0.00)	
Number of observations	7704 (left Censored=7148)		7704	

***, ** and * indicate significance at 1%, 5% and 10% levels.

Table 5: Random Effect Poisson and Logistic Regression Results

Dependent Variable (Illness Days)	Poisson		Logistic		Negative binomial	
Independent variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
PM10	0.0003	0.0004	0.0035**	0.0014	0.0001	0.0004
DTEMP	0.0035	0.0097	-0.0224	0.0377	0.0077	0.0111
Rain	0.0001	0.0076	0.0092	0.0301	0.0015	0.0088
Age	-0.0227	0.0186	-0.0242*	0.0143	-0.0145	0.0137
Age2	0.0004*	0.0002	0.0004**	0.0002	0.0002	0.0002
Sex	-0.1184	0.1930	-0.0947	0.1564	-0.1555	0.1488
Education	0.6429*	0.3512	0.1172	0.2700	0.2723	0.2701
Smoking	-0.0027	0.3527	0.1536	0.2705	0.1833	0.2650
Hr_inside	-0.0113	0.0402	-0.0198	0.0320	-0.0204	0.0303
Exercise	-0.0224	0.0537	0.0444	0.1951	0.0026	0.0619
Chronic disease	4.1331***	0.3419	5.6909***	0.2563	7.3102***	0.2524
House type	-0.5010	0.3053	-0.4124*	0.2400	-0.3770*	0.2191
Kerosene	0.4119**	0.1966	0.2084	0.1547	0.0815	0.1465
Constant	-2.1447**	1.0777	-3.4318***	0.9388	-2.7016***	0.8021
Lnalpha	1.5118	0.0957	Lnigma2u -0.1335	0.2098	Ln_r -.1179	0.1105
Alpha	4.5349	0.4342	sigma-u 0.9354	0.0983	Ln_s -2877	0.1632
Log likelihood	-3903.52		-1239.9394			-2836.84
Wald chi2	171.01 Prob(0.00)		562.0820 Prob(0.00)		907.99 Prob(0.00)	
Number of observations	7704		7704			7704

***, ** and ** indicate significance at 1%, 5% and 10% level respectively.

Figures

Figure 1: Sources of PM_{10} in Kathmandu Valley

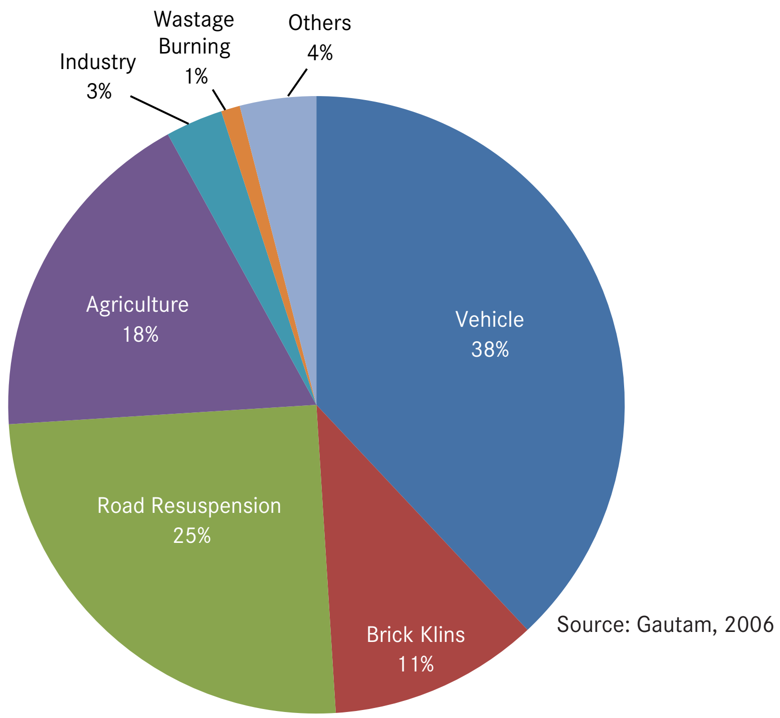
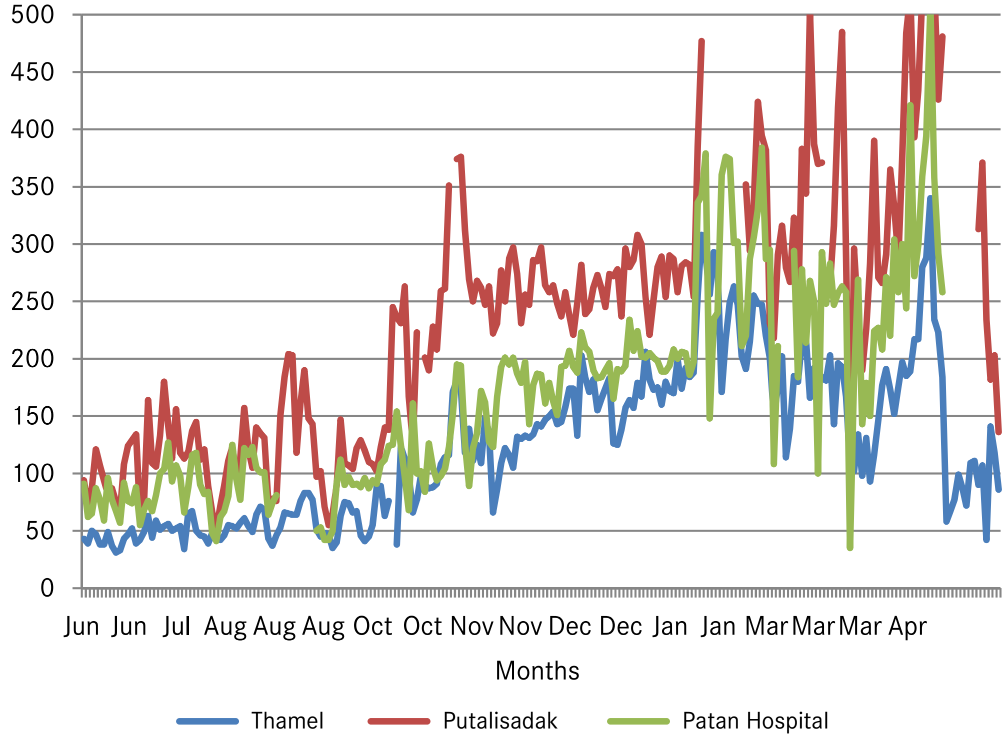


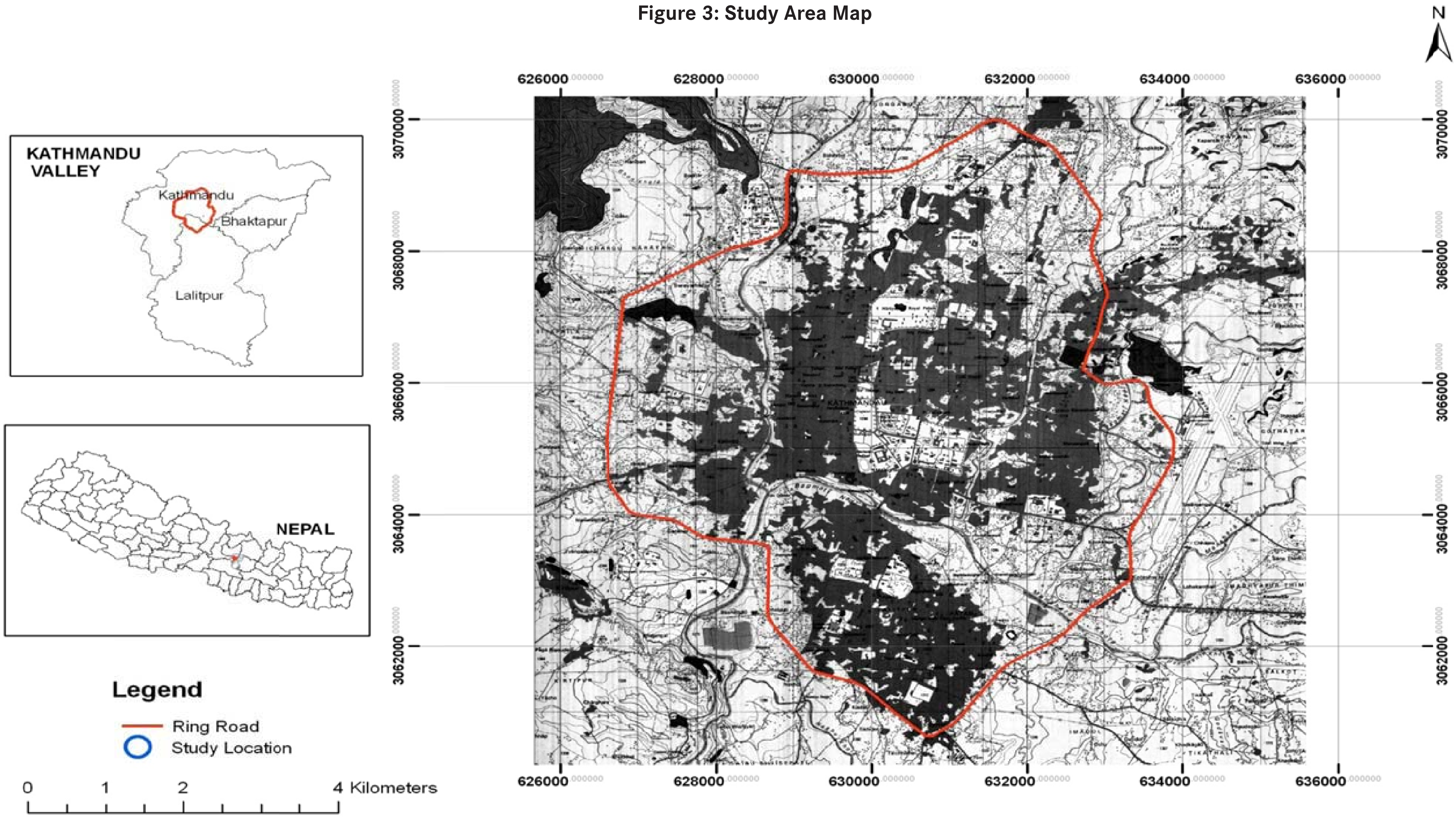
Figure 2: Average PM_{10} at Various Monitoring Stations in Kathmandu Valley (July 2007-May 2008)



Source: MOEST (Various Reports)

Appendix A: Locaton Map of Study Area

Figure 3: Study Area Map



Appendix B: Household Questionnaire

1. Survey Information:

1.1 Monitoring Station [ ][ ]

1. Thamel
2. Putalisadak
3. Patan

1.2 Household ID [ ][ ][ ]

1.3 Address [ ]

1.4 Telephone No.: [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

1.5 Interviewer's Name: [ ]

1.6 Date of Interview: [ ][ ] [ ][ ] [ ][ ]
DD MM YY

1.7 Time Started: [ ]

1.8 Time Finished: [ ]

1.9 Is this a replacement household? [ ] No → go to 3.1
[ ] Yes

1.10 If yes → This household replaces household number [ ]

1.11 Reasons for Replacement [ ]

1. Dwelling not found
2. Refusal to participate
3. Lives in Kathmandu for less than 5 yrs
4. Not at home
5. Other, specify

Interviewer's Comments [ ]

2. Accommodation Information:

2.1 What type of area do they live in?

1. Residential
2. Semi-residential
3. Commercial
4. Industrial

2.2 Is the house located on the main road or in an alley?

1. Main Road
2. Alley

2.3 How far is the house from the main road?

Write in meter (approx)

2.4 How many rooms are there in the house?

2.5 How many floors are there in the house?

2.6 Which floor do they live in?

2.7 What is the structure of the house?

1. Cemented
2. Mud & Bricks (traditional)
3. Other specify

What are the following parts of the house made of? Please use the following box to answer.

2.8 Floor

2.9 Wall

2.10 Roof

1. Cement/brick
2. Mosaic
3. Mud
4. Metal
5. Asbestos
6. Thatch
7. Other, specify

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3. Household Information:

3.1 Name of Household Head [ ]

3.2 Name of Respondent [ ] →

If respondent is household head, go to question 3.5

3.3 Why was the household head not interviewed? [ ]

1. Head of household is sick
2. Head of household is busy
3. Head of household is working as migrant labor
4. Away on emergency
5. Other ______________ ______________) specify

3.4 What is the respondent's relation to head of household? (Use code of household member information)

3.5 Is the household being interviewed for the first time? Yes [ ] No [ ]

3.6 If no → Why was (s)he not interviewed during the last visit? [ ]

1. Head of the household was not at home
2. Head of the household was busy
3. Nobody was at home
4. Head of the household was sick
5. Initially refused to participate
6. Other specify

3.7 When was the first interview attempted?

DD		MM		YY	

4. Household Member Information:

4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11
Member ID No.	Name of member	Sex	Relation to head	Age	Education	Occupation	Marital status	Exercise	Smoking	Smoke inside house?
		1. Male 2. Female	1. Head 2. Wife 3. Child 4. Parent 5. Sister/Brother 6. Daughter in law/ Son in law 7. Other in-law 8. Household staff 9. Other, specify	Write in years If less than 1 year, write 0	Record highest level completed 1. Illiterate 2. Literate without formal schooling 3. Primary school(1-5) 4. Lower Secondary (5-10) 5. SLC and IA or equivalent 6. BA and above or equivalent 7. Diploma/ Technical (like CTEVT degree) 8. Other, specify	1. Permanent Service 2. Daily Wage Basis 3. Self-owned business 4. NGO/INGO 5. Unemployed/ retired 6. Household staff 7. Other, specify	1. Married 2. Unmarried 3. Widowed 4. Separated	1. Morning walk 2. Evening walk 3. Aerobics 4. Swimming 5. Yoga 6. No exercise 7. Other, specify	1. Yes 2. No	1. Yes 2. No 3. Not applicable

5. Time Spent Outside Home:

5.1	5.2		5.3			5.4
Member ID No.	Travel		Outside Home			At Home
	5.2.1	5.2.2	5.3.1		5.3.2	
	How many hours a day do you spend traveling?	How many hours out of this do you spend in an air conditioned place?	Indoors		Outdoors	Indoors
			5.3.1.1	5.3.1.2		
			Out of the total time you spend outside your home every day, how many hours do you spend indoors?	Out of this how many hours do you spend in an air conditioned place?	Out of the total time you spend outside your home every day, how many hours do you spend outdoors (in an open place)?	Out of the total time you spend at your home every day, how many hours do you spend in air conditioned rooms?
	Write in hours	Write in hours	Write in hours	Write in hours	Write in hours	Write in hours
01						
02						

6. Household Health Information (chronic diseases):

Member ID No.	For how many years have you been suffering from this disease? (Years)																
	Name of disease																
				1. Runny nose/cold 2. Sinusitis 3. Headache (migraine) 4. Flu/fever 5. Allergy 6. Cough 7. Asthma							1. Bronchitis 2. Heart disease 3. Tuberculosis 4. Diabetes 5. High blood pressure 6. Other, specify						
	1	2	3	4	5	6	7	8	9	10	11	12 Specify					
01																	
02																	
03																	
04																	
05																	
06																	
07																	
08																	
09																	

7. Household Income

7.1	7.2	7.3	7.4
Consumer durable owned	Total monthly expenditure incurred in these categories (In NRs)	What is the total monthly income of your household?	Total monthly earning of household (In NRs)
Write the number of each item owned **If the item is not owned, write 0**	**Ask for the expenditure on each for the last month**	**Write total for all earning members of the household**	
1. Television 2. DVD player 3. Music system 4. Computer 5. Telephone 6. Refrigerator 7. Micro-wave Oven 1. Washing machine 2. Air conditioner 3. Geyser 4. Heater 5. Vehicle 6. Other, specify	1. Education 2. Food 3. Non-food household expenditure* 4. Utilities** 5. Travel/conveyance 6. Rent and maintenance charges*** 7. Recreation 1. ___ 2. ___ 3. ___ 4. ___ 5. ___ 6. ___ 7. ___ *Includes clothing, kitchen and toiletries, repair costs **Includes electricity, water, gas, telephones (including cell phones), internet ***If you live in your own house, how much would you have rented this house for?	**Write amount in NRs** **Did the respondent state the total monthly income?** **Yes à go to Section 8** **No à go to next question**	1. <3,999 2. 4,000 – 6,999 3. 7,000 – 9,999 4. 10,000 – 14,999 5. 15,000 – 19,999 6. 20,000 – 35,000 7. 35,000 – 50,000 8. 50,000 – 1,00, 000 9. 1,00,000 – 1,50,000 10. >1,50,000

8. Indoor Air Quality:

Please use the options in the following box to answer the next three questions:

1. Never (**0** times per month)
2. Very infrequently (**1–4** times per month)
3. Sometimes (**5–14** times per month)
4. Very frequently (**15–24** times per month)
5. Always (**25–30** times per month)

8.1 Do you use kerosene for cooking? [ ]

8.2 Do you use firewood for cooking? [ ]

8.3 Do you have AC? [ ]

8.4 Do you use insect/pest repellant coils or sprays in summer? [ ]

8.5 Do you burn incense in your home? [ ]

8.6 Do you light candles in your home? [ ]

8.7 Do you light kerosene lamps in your home? [ ]

9. Awareness Information (only for respondent):

9.1 Name of disease	9.2 Attribute to air pollution?
1. Runny nose/cold 2. Sinusitis 3. Headache (migraine) 4. Flu/fever 5. Allergy 6. Cough 7. Asthma 8. Bronchitis 9. Heart disease 10. Cancer 11. Tuberculosis	1. Yes 2. No 3. Don't know

DISEASE CODE

1	

9.3 Source of information	9.4 Major source of air pollution
1. TV and radio 2. Newspapers 3. Health workers 4. Publications and journals, Report 5. Other, specify **Please mention the most important source**	1. Transport 2. Road dust 3. Construction 4. Industry 5. Household fuel 6. Burning garbage/leaves 7. Other, specify **Please rank 3 major sources in order**

9.5 Are you aware of the prevalence of air pollution in Kathmandu? 1 = yes 2 = no ⟶ **end interview**

9.6 Use the following options to answer these questions

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree
6. Don't know
7. Not applicable

		Strongly disagree 1	2	3	4	Strongly agree 5
9.6	The magnitude of air pollution in your neighborhood is very serious.					
9.7	The magnitude of air pollution in Kathmandu is not very serious.					
9.8	Air pollution contributes significantly to your illness.					
9.9	Reduction of air pollution in Kathmandu is very important to you.					
9.10	The introduction of Safa Tempoos has significantly reduced air pollution in the city.					
9.11	You read articles in the newspaper about the status of air pollution in the city.					
9.12	Banning old vehicles (more than 20 years) will decrease air pollution.					
9.13	Air pollution has greatly increased due to the increase in the number of vehicles.					
9.14	Air pollution reduces your productivity.					
9.15	You keep the windows of vehicles closed in order to avoid air pollution.					
9.16	The Government is introducing effective policies to reduce air pollution.					

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C. Healt Diary		
1.	1.1 Household ID	
2.	1.2 Repeat Number	
3.	1.3 Date of Interview	
4.	1.4 Time Started	
5.	1.5 Time Finished	

10.1 No. of Days of Illness and No. of Workdays lost due to pollution-related illness

10.1.1	10.1.2	10.1.3																							
Member ID No.		On how many days did this happen last week? (use disease code list)																							
		10.1.3.1								10.1.3.2								10.1.3.2							
	Name of member:	You were ill with one of these diseases								You came home from work early due to the illness								You missed work due to the illness							
		0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
01																									
02																									
03																									
04																									
05																									

* Information on Working Members only (Enumerators ask for information from those working members who were sick but did not miss working day)

10.1.4 If you were sick last week but did not miss any working day, how would you rank your work performance?

Working Members ID	Days (work performance scale)						
	1	2	3	4	5	6	7
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							

Working Performance scale

1. Very poor
2. Poor
3. Satisfactory
4. Not all that normal
5. As usual

10.2 Visits to the Doctor

10.2.1	10.2.2	10.2.3	10.2.4	10.2.5	10.2.6	10.2.7
Member ID No.	Diseases code	On how many days did you visit the doctor last week?	What was the fee paid on each visit? (NRs)	What was the total transportation cost (fare) from your home to the doctor's chambers? (NRs)	How many of your family accompanied you?	What was the total time spent (travel time + waiting time)?
	See disease code list			(Please note, if you used your own transport, mention approximate cost of transport)	If yes, mention member Serial no.	(minutes)
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						

10.3 Diagnostic Tests and Medication

10.3.1	10.3.2	10.3.3				10.3.4			
		Diagnostic tests				Medication			
		10.3.3.1	10.3.3.2	10.3.3.3	10.3.3.4	10.3.4.1	10.3.4.2	10.3.4.3	10.3.4.4
Member ID No.	Disease code See disease code list	Did the doctor recommend any diagnostic tests? 1. Yes 2. No	What was the total cost of the diagnostic test(s)? (NRs)	What was the total transportation cost (fare) from your home to the diagnostic centre? (NRs) (please note that if you used your own transport, you need to mention Approximate cost of transport)	What was the total time spent (travel time + waiting time)? (minutes)	Did the doctor prescribe any medication? 1. Yes 2. No	Did you have any un prescribed medication? 1. Yes 2. No	What was the total cost of the medication?	What was the total transport ation cost (fare) from your home to the drugstore? (NRs) (please note, if you used your own transport, you need to mention approximate cost of transport)
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10									

10.4 Hospitalization (if respondent/family member has been hospitalized):

10.4.1 General Information about Hospital Stay:

10.4.1.1	10.4.1.2	10.4.1.3	10.4.1.4	10.4.1.5	10.4.1.6	10.4.1.7	10.4.1.8
Member ID No.	Disease code	Have you been hospitalized for this disease?	Type of hospital	For how many days did you stay at the hospital?	Did anyone from your family stay with you at the hospital?	For how many days did this person stay with you?	What was the total transportation cost (fare) from your home to the hospital over the entire period of hospitalization? (NRs)
	See disease code list	1. Yes 2. No	1. Private 2. Government		1. Yes (mention member serial number) 2. No		(please note, if you used Your own transport, You must mention approximate cost of transport)
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09							
10							

10.4 Hospitalization (contd.) (if respondent/family member has been hospitalized):

10.4.2 Cost of Hospitalization:

10.4.2.1	10.4.2.2	10.4.2.3		10.4.2.4
		DIAGNOSTIC TESTS		
		10.4.2.3.1	10.4.2.3.2	
Member ID No.	Ttotal hospital bill for the last stay (NRs)	What was the total cost of diagnostic test(s) done inside the Hospital? (NRs)	What was the total cost of diagnostic test(s) done outside the hospital? (NRs)	What was the total cost of medication bought during your stay at the hospital? (NRs)
		(Write 0 if no diagnostic tests were done inside the hospital)	(Write 0 if no diagnostic tests were done outside the Hospital)	
01				
02				
03				
04				
05				

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