PRELIMINARY RESULT OF ABSENTEEISM RELATED COST DUE TO AIR POLLUTION AMONG PRIVATE COMPANIES IN ULAANBAATAR, MONGOLIA

Mandukhai Ganbat[1,a*], Narantsetseg Amarsanaa[2,b], Nasantogtokh Erdenebileg[3,c], Chuluunbileg Batbold[3,c]

[1]Lux center, 1001, Zaigal Research Institute

[2]Mandakh University

[3] Lux center, 1001, Zaigal Research Institute

[3] Lux center, 1001, Zaigal Research Institute

[a]mandukhai@zaigal-institute.com [b]narantsetseg@mandakh.mn [c]nasantogtokh@zaigal-institute.com [c]chuluunbileg@zaigal-institute.com

Abstract

Air pollution is a grave problem that impacts billions of people across the globe. According to the World Health Bulletin, the most polluted air in Mongolia is found in Ulaanbaatar, where 46% of the country's population resides. For companies in Ulaanbaatar, the medical effects of pollution may lead to higher absenteeism. The absenteeism rate is the number of absences per number of employee-workdays in a specified period, expressed as a percentage. High rates of absenteeism are costly, because fundamentally, absenteeism is a bottom-line killer for a company's finances. The costs might include loss of salary, loss of productivity, loss of cash in the economy, the opportunity costs of missed days of work, and the costs in worker productivity associated with poor health.

Analyses will be conducted using these data to provide a comprehensive picture of absenteeism, its associations with pollution, and its causes and costs. We employed times-series cross-sectional study to assess cost.

Mean of individual cost estimation for children during high air pollution level is 95750MNT (35.000-500.000). Diagnosis related cost for employees without children is equal to 162 322 MNT and for employees with children – 159 890 MNT, which is statistically insignificant.

Key words: sick, employee, workday, salary, particle matter

BACKGROUND

Air pollution is a grave problem that impacts billions of people across the globe. For example, it is the primary cause of death in India, killing over 1.6 million people a year[1]. In Mongolia, pollution may cause over 4,000 deaths annually, an incidence of 132 deaths per 100,000 people compared to the global average of 92 deaths per 100,000 people per year (WHO)[2]. According to the World Health Bulletin, the most polluted air in Mongolia is found in Ulaanbaatar, where 46% of the country's population resides[3]. The air pollution is defined as the high concentration of particulate matter measured in microgram (millionth of a gram) per cubic meter of air.

For companies in Ulaanbaatar, the medical effects of pollution may lead to higher absenteeism. Not only will employees themselves suffer the consequences of constantly breathing highly polluted air, but many employees must take time from work to care for sick children and other family members. This adversely affects the finances and productivity of both the employer and the employee. Since illness does not occur on a particular schedule, these absences are unpredictable and may be very disruptive. The employee is not available to carry out his or her tasks and the employee may lose income and incur additional expenses to care of the child. Moreover, employees may not be as productive if they are working while ill.

The absenteeism rate is the number of absences per number of employee-workdays in a specified period, expressed as a percentage. The period can be anything — a year, a month or a quarter. The resulting number will tell the percentage of days that staff members unexpectedly miss per period measured. Absences in this context include any unplanned absence from workday, as when an employee calls in sick or has child-care problems. It does not include the absences that are authorized and planned for, such as personal leave and vacation time.

High rates of absenteeism are costly, because fundamentally, absenteeism is a bottom-line killer for a company's finances. According to a report by the workforce performance solutions company Circadian, absenteeism in the shift-work sector costs businesses approximately $2,600 per shift worker per year. For a workforce of 50 workers on an hourly wage, these losses could reach $133,000 annually on direct absenteeism costs[4].

To date, the costs of absenteeism have not been carefully and thoroughly analyzed for companies operating in Ulaanbaatar. We hypothesize, however, that pollution and its health effects create a substantial loss of productivity that hurts both businesses and employees, this may reduce the productivity of Mongolia as a whole, as UB is the primary commercial center of the entire nation. Therefore, the impact of air pollution on corporate and employee finances, as well as employee health, may create significant societal costs as well. These costs might include loss of salary, loss of productivity, loss of cash in the economy, the opportunity costs of missed days of work, and the costs in worker productivity associated with poor health.

1. RESEARCH METHODOLOGY

Representatives of employers and selected employees will be surveyed using quantitative and qualitative instruments to characterize the specific issues that they face during the highly polluted months. Secondary data will also be used, where available, to provide more specific measures of the losses incurred and that the factors that trigger absenteeism. Analyses will be conducted using these data to provide a comprehensive picture of absenteeism, its associations

with pollution, and its causes and costs. We employed times-series cross-sectional study to assess direct and indirect cost.

1.1 Company selection

We defined target private sector employers. This includes creating an inclusion and exclusion criteria. These criteria will likely encompass business type, employee numbers, availability of employee attendance records, format of records, quality and completeness of records and willingness to share records. Therefore, we selected 4 companies for analyzing preliminary result based on above mentioned criteria.

1.2 Quantitative data

Description of variables that come from quantitative questionnaire. Absenteeism related questions, air pollution related common symptoms and diseases questions, cost to employees' questions and demographic and behavioral questions will be asked through the survey.

Absenteeism data for the previous 5 years will be calculated in hourly, daily and monthly increments. For example, calculating the number of hours missed will allow data on employees reporting to work late to be incorporated into unexcused absenteeism data. This is the equation we will employ in the study.

$$Absenteeism(\%) = \frac{Number\ of\ hours\ taken\ off\ for\ absence}{Total\ hours\ scheduled\ by\ the\ work\ force\ over\ the\ period}\ x\ 100$$

Air quality data will be obtained from the Historical Daily Ambient Air Quality Data, released by the National Agency for Meterology and Environmental Monitoring. The UB air quality department has 11 monitoring stations, and accordingly we will able to obtain pollution data for both the site of employment and the location of domicile. Additionally, weather stations records including temperature, precipitation, humidity and wind speed will be obtained to account for weather conditions.

1.3 Qualitative data

We use 2 types of qualitative tools, focus group interview and individual interview, to uncovering costs that are not readily apparent to researchers such as personal costs from lost income or due to medical costs. Additionally, focus groups will help determine why company employees experience absenteeism. A focus group guide will be developed using three types of questions including probing, follow-up and exit questions. Focus group participants will be grouped to create homogeneity based on company employees' gender, age and hierarchy in the group to help participants feel more comfortable expressing their opinions. The inclusion criteria of the focus group will be at least one sick absence during the past winter based on self-reported experience, and at least one child with under five in the household.

Face-to-face interviews will be conducted with key employer personnel to determine costs that are important to the employer and company's coping technique to prevent from air pollution. These will include two representatives from each company, including the director of human resource and accounting department.

2. COST ANALYSIS

We calculated the company direct cost including annual salary, social insurance contribution, bonus payments, contracted overtime and short-term disability cover.

Company costs will be examined by lost productivity and company human resources policies to respond to absent workers. In the case of manufacturing and production, these will be analyzed by records of goods and services produced. Other costs include sick pay, additional hiring and overtime.

Cost of air pollution for company: (DC1+DC2+DC3+DC4+DC5)

DC1- Bonus payment for employee DC2- contracted overtime DC3- travel allowance DC4- meal allowance DC5- private health care insurance

Individual cost to employees will be collected through questionnaires. Variables in the questionnaire to assess cost of the individual and his/her family members such as medical treatment, medicine, doctor's visit and laboratory tests and transportation. We will calculate hourly wage and multiply it by the number of hours or days that employee missed because of air pollution related sickness. For instance, if company employee hourly wage is 5000 MNT, and he/she missed work for three days (8 hours per day), and calculation will be: 5000MNT x (8 hrs*3 days) = 120000 MNT (total lost wages). For the employer they may have records of what is paid vs what is under contract. This data can be used to measure lost wages. If employees don't want to share their salary information, a crude measure will take annual turnover of the company divided by the number of employees then multiplied by the number of hours of absent employees.

2.1 Data analysis

After we have cleared the HR data, we have more than two groups, so we can estimate the difference in groups using the ANOVA test. Then evaluate the correlation and regression analysis and time series.

Correlations between high air pollution and absenteeism will be determined by analyzing absenteeism and air quality levels as officially recorded in a sample of air quality monitoring stations across Ulaanbaatar. We will correlate all air pollution indicators with cost. Two variables will be checked with normality assumption. If two continuous variables are normally distributed, we will use the Pearson correlation test. If two variables are not normally distributed, we will employ the Spearman correlation test.

Linear Regression Model

$$Absentijkt = a + b1Pkt + b2Xijkt + b3Zjkt + b4Vkt + \varepsilon ijkt$$

Absentijkt: absence of employee i, in company j, local area k and year t;
Pkt: pollution level in area k and year t
Xijkt: time-varying individual characteristics (age, gender, education level, etc.)
Zjkt: time-varying company characteristics (number of employees, sector, etc.)
Vkt: time-varying local area characteristics (for example, weather variables)
εijkt: error term

Poisson regression model

We will suppose that the Poisson incidence μ is determined by a set of k regression variables (the X's). The expression relating these quantities is:

$$\mu = texp(\beta 1X1 + \beta 2X2 + ……..+\beta \kappa Xk)$$

$$Absencet = \alpha + \beta 1Pm2.5 + \beta 2PM2.5t\text{-}1+\beta 3\text{weekly sum of } PM2.5 + \varepsilon t$$

In the event that absence data is over dispersed (variance significantly greater than mean), or if there are excess zeros in the data, we will consider alternatives to the Poisson model, such as negative binomial or zero inflated models.

Spatial modeling

Our investigation hypothesizes an exposure-response relationship that is inherently spatial. Specifically, we suspect that pollution levels are spatially heterogeneous, a possibility that can be supported with data from the 11 pollution monitoring stations distributed in the UB environs. Thus, it is natural to hypothesize that work absenteeism is related to (1) workplace location and/or (2) employee residential location, which will create spatially heterogeneous exposure to pollutants among the work force.

Geographic observations violate assumptions of independence in statistical models. Observations that are closer to one another geographically will tend to be related or non-independent, not only with respect to measured study variables but also unmeasured effects. Thus, without a modeling structure that accounts for this phenomenon of "spatial autocorrelation," models that incorporate spatial data may exhibit spatially clustered residuals or model error.

We will employ two strategies to account for spatial error. For models in which the observation is the individual employee, with her/his residential location encoded as a longitude/latitude coordinate pair, we will use an isotropic smooth function that will model spatially local variation in our outcome variable (count of absences or probability of absence). This can be accomplished using a generalized additive model, which employs nonparametric splines or Gaussian process smoothing ("kriging") to smooth the effect of coordinate space.2, 3

A second strategy will be for models that use 2-dimensional areas (i.e. neighborhoods) as a unit of observation. This is a convenient modeling strategy in that it allows us to (2) sample environmental variables within the boundaries of our neighborhoods and (2) incorporate census variables in some cases. To incorporate neighborhoods in a regression model requires an adjacency definition, which is a matrix defining how our areas neighbor one another in space. A regression model can then use a conditional autoregressive structure such as the Besag-York-Mollie autocorrelation function to simultaneously model both spatially correlated and uncorrelated random errors.4

Temporal modeling

Time can be modeled as both a continuous variable, from the initial to the final date in our study period, as well as a cyclic or seasonal variable with weeks, months, and seasons repeating annually. Using smoothing splines, statistical models can incorporate both of these conceptualizations as separate model parameters(5). This will allow us to evaluate linear trends in absenteeism while controlling for seasonality. Additionally, we will be able to evaluate the impact of seasonally variable exposures such as temperature and pollution, while controlling for seasonality.

Analysis control variables:

Control variables: Previous research has shown age to increase the risk for absences for both men and women, although there might be no clear pattern. Sickness absence seems to be higher for women than men. Although there are no clear differences between full- or part-time workers in sickness absences, working hours affect the duration that one is exposed to a stressful working situation. Therefore, we will control for weather, age, gender, education level and employment factor, and time (day of week, month, and year) of absenteeism.

3. RESULTS

Total of 807 private companies' employees between the age of 19 and 64 participated in the survey. 54.6% /440/ of respondents was male, 45.4% /367/ was female and average age is 31.5±7.6. 90% of employees have 1-4 children. /table 1/

Table 1. Demographic information of employees of private companies

	Company_1		Company_2		Company_3		Company_4	
	Count	**N %**	**Count**	**N %**	**Count**	**N %**	**Count**	**N %**
Gender								
Male	145	57.1	60	57.4	142	78.5	93	34.2
Female	114	42.9	43	42.6	39	21.5	164	65.8
Total	259	100.0	103	100.0	181	100.0	257	100.0
Education								
Univeristy	132	52.8	101	100.0	137	82.0	235	91.4
Secondary	90	36.0	-	-	15	9.0	12	4.7
Technical	20	8.0	-	-	14	8.4	9	3.5
College	8	3.2	-	-	-	-	1	0.4
Primary	-	0.0	-	-	1	0.6	-	-
Do you have a child?								
No	25	9.7	4	3.9	43	23.8	9	3.4
Yes	234	90.3	99	96.1	138	76.2	255	96.6
Total	259	100.0	103	100.0	181	100.0	264	100.0
Work time								
≤8	86	34.7	56	56.0	151	86.3	150	63.3
≥9	162	65.3	44	44.0	24	13.7	87	36.7

Survey from employees of private companies showed that average work time is 9.5 ± 3.5. Distance from home to work is between 5.2 and 9.4 km on average.

Table 2. Individual sick visit by frequency

Variable	Diagnosis related visits	Medicine related visits	Hospitalization	Transportation and food
Mean(SD)	3.46 ± 1.8	5.52 ± 2.1	1.64 ± 0.8	7.72 ± 1.4
Max	20 times	30 times	10 times	60 times
Min	1 time	1 time	1 time	1 time

During winter, when the air pollution level is high, children get diagnosis 3.46 ± 1.8 times, get hospitalized 1.64 ± 0.8 times and buy medicine 5.52 ± 2.1 times. In addition, children get diagnosis 1-20 times and get treated 1-30 times during winter. When children get sick, their parents are fully responsible for transportation, meal and medical costs.

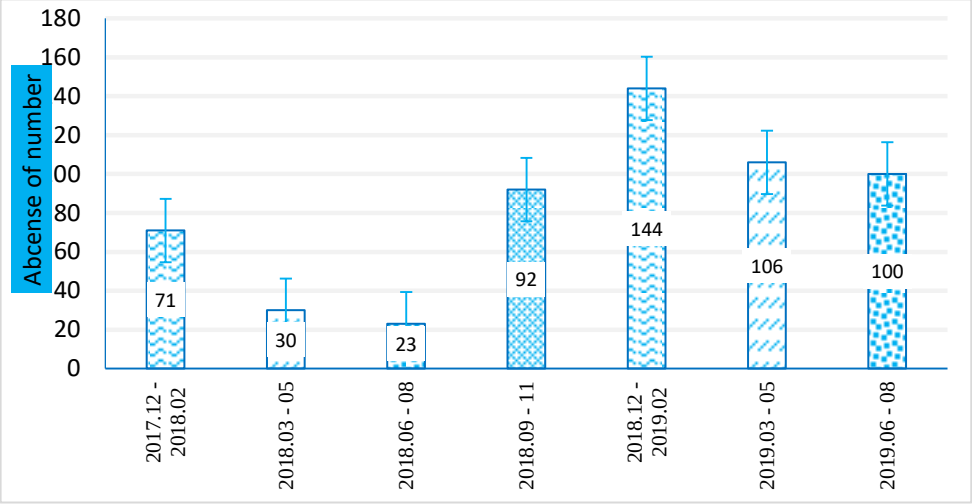
Table 3. Individual cost estimation for children during high air pollution level

Variables	Median /MNT/	Interquartile range		Min /MNT/	Max /MNT/
		25th	75th		
Diagnosis related costs	91 500	40000	150000	5 000	5 000 000
Medicine related costs	100 000	40000	200000	3 000	1 500 000
Hospitalization related costs	200 000	100000	400000	10 000	5 000 000
Transportation and food related costs	70 000	30000	150000	1 000	1 000 000
Total costs	95 750	35000	500 000	19 000	12 500 000

Sickness related costs of employees with children and without children are statistically significant. Diagnosis related cost for employees without children is equal to 162 322 MNT and for employees with children – 159 890 MNT, which is statistically insignificant. Medicine cost

for employees without children is 91 181 MNT and for employees with children – 154 503 MNT.

Figure 1. Absenteeism /days/



During from December to February, absence of number is highest through the 4 companies whereas it is the lowest in June, July and August.

Qualitative data results:

Diagnosis cost: there is no cost when visiting a family health center. Medical examinations cost 20 000 - 40 000 MNT and analysis cost 15 000 – 30 000 MNT in private hospitals.

Treatment cost: hospitalization costs 80 000 – 120 000 MNT per day in private hospitals. Medicine costs 30 000 MNT minimum, 150 000 MNT maximum. People mostly spend 40 000 – 50 000 MNT for medication. Most of the respondents do not precisely calculate money spent on meals and transportation and this cost is approximately 200 000 – 500 000 MNT.

CONCLUSION

In the winter, the disease related to air pollution is higher prevalence and the absence rate has high level in 4 companies. Company cost may have trend to increase as absence rate increasing. So there has necessary to involve many companies to explore deeply.

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