ESTIMATING THE HEALTH IMPACT OF PM_{10} POLLUTION ON THANH XUAN DISTRICT BY SURVEY RESULT OF NGUYEN TRAI ROAD

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TÓM TẮT

ĐÁNH GIÁ TÁC ĐỘNG CỦA Ô NHIỄM BỤI PM_{10} Ở QUẬN THANH XUÂN TỚI SỨC KHỎE THÔNG QUA KẾT QUẢ KHẢO SÁT TẠI ĐƯỜNG NGUYỄN TRÃI

Việc đánh giá ảnh hưởng sức khỏe do ô nhiễm môi trường không khí đến các bệnh hô hấp được thực hiện dựa trên các kết quả quan trắc chất lượng không khí (bụi PM_{10}, $PM_{2.5}$, CO) do giao thông gây ra, dựa trên kết quả điều tra dịch tễ học và số liệu kinh tế xã hội vùng nghiên cứu. Phương pháp này cho thấy sự liên hệ giữa chất lượng môi trường không khí cho các loại chất ô nhiễm khác nhau đến nguy cơ bệnh tật, tử vong khác nhau. Nguyên tắc là sự thay đổi mức độ ô nhiễm môi trường không khí đối với một chất ô nhiễm nhất định, có ý nghĩa thống kê đối với các căn bệnh hay sự tử vong trong cộng đồng.
Từ đồ thị phụ thuộc liều lượng và đáp ứng, hệ số b_i được tính toán cho các ảnh hưởng cao, thấp và trung bình lên sự thay đổi nồng độ PM_{10} (dA) được xác định thực tế, có thể tính được tỉ lệ tử vong sớm, số ngày nghỉ việc, nằm viện do bệnh hô hấp gây ra cho mỗi người dân và cho cộng đồng dân cư trong khu vực. Các kết quả nghiên cứu là con số biết nói có ý nghĩ cảnh báo cụ thể nhất cho việc giảm thiếu ô nhiễm môi trường, bảo vệ sức khỏe cộng đồng.
Bài báo này trình bầy kết quả áp dụng phương pháp xác định giá thiệt hại do ô nhiễm PM_{10} trên đường Nguyễn Trãi, quận Thanh xuân, tới 06 nhóm dân cư dễ bị tổn thương ở Việt Nam và đưa ra những cảnh báo về những tổn thất do ô nhiễm bụi PM_{10} tới cộng đồng.
Keywords: *Cell pollution, PM_{10}, health risks, morbidity, vulnerability.*

1. INTRODUCTION

In Vietnam, there have been a number of studies on the health impact of environmental pollution, especially the surrounding air environment on public health, but very few [5,6.7.8]. Respiratory diseases are caused by many factors such as viruses, weather or air pollution, dust etc. This paper assesses the impact of air pollution on public health on a road in Hanoi, from which it is possible to make predictions about major co-umbilical effects across the city.

To estimating the health impacts of air pollution, the Dose-Response relationships are functions mostly based on data from the US, Canada, and United Kingdom. The princip is that changes in morbidity (sickness) and mortality (death) in population. The coefficients are estimated that are multiplied by changes in mabient pollution concentrations and the population exposed as relationship of the approach of Bart Ostro to Jakarta, Indonesia [1,2,3].

1.1. The methodology of estimating the health impact of pollution due to PM10[1,2,3]

For the assumptions basis for evaluating the[1,2,3] health effects as to value losses due to environmental pollution, four factors have been identified as: 1.The relationship between dose - Response; 2. Community vulnerable populations; 3-Variation related to air quality and 4- economic value for the ultimate goal: health. The estimated health impact can be estimated by the following relationship[1,2,3,4]

$$dH_i = b_i * POP_i * dA$$

Where: dH_i = Change in population risk of health effect i;

b_i = Slope from the dose – response curve for health impact i

POP_i = Population at risk of health effect i

dA = Change in ambient air pollutant under consideration

1.2. Factor b_i - Slope from the dose – response curve for health impact[1,2,3, 4]

Dose-response fuctions that relate health impacts to ambient levels of air pollution are taken from the published empidemiologic literature.

Factor bi – slope of the Dose - Response curve of the health impacts of specific pollutant i is calculated and determined from epidemiological studies. Impact level was determined by Bart Ostro with 3 level for each type of harm of concentrations of suspended matter causing health: estimates above, middle and bottom, corresponding limits that may change each type of harm. The harm caused by the concentration of suspended matter (PM10 dust) includes:

- ***Percentage change in mortality [1,2,3,4]***

Premature mortality is a major problem associated with high levels of particulate matter. Percentage change in mortality is estimated with three levels

+ Upper percentage change in mortality:
0.130 x dA (change in PM_{10})
+ Central percentage change in mortality:
0.096 x dA (change in PM_{10})
+ Lower percentage change in mortality:
0.062 x dA (change in PM_{10})

- ***Premature change in mortality (PCM)[1,2,3,4]***

$PCM= M\% * dA * 1/100 * MR * POP_i$

Where : M% - percentage change in mortality (given above); MR: Crude Mortality rate (Statistics available), POPi: the population exposed.

+ Upper estimate of change in mortality:
$9.10 * 10^{-}6$ * change in PM_{10}
+ Central estimate of change in mortality:
$6.72 * 10^{-}6$ * change in PM_{10}
+ Lower estimate of change in mortality:
$4.47 * 10^{-}6$ * change in PM_{10}

- ***Morbidity[1,2,3]***

Respiratory Hospital Admissions- RHA[1,2,3,4]

Based on Canadian and US studies, there is a statistically significant relationship between the incidence of hospital admissions due to respiratory diseases (RHA) and ambient TSP levels.

+ Upper change in RHA per 100,000:
1.56 * change in PM_{10}
+ Central change in RHA per 100,000:
1.20 * change in PM_{10}
+ Lower change in RHA per 100,000:
0.657 * change in PM_{10}

Emergency Room Visit – ERV[1.2.3,4]

The US study also showed that the relationship between the number of emergency Room Visit and change the concentration of dust in the air.

+ Upper change in ERV per 100,000:
34.25 * annual change in PM_{10}
+ Central change in ERV per 100,000:
23.54 * annual change in PM_{10}
Lower change in ERV per 100,000:
12.83 * annual change in PM_{10}

***Restricted Activity Days- RAD*)[1,2,3,4]**

Restricted activity days (RAD) include days spent in bed, days missed from work, and other days when normal activities are restricted due to illness, even if medical attention is not required. Studies from the US suggest a statistically significant relationship between particulates of various sizes and RAD:

+ Upper change in RAD per person per year: 0.0903 * change in PM_{10}

+ Central change in RAD per person per year: 0.0575 * change in PM_{10}

+ Lower change in RAD per person per year: 0.0404 * change in PM_{10}

These systems have been applied to 34.7% of the population under the age of 18 in Jakarta..

2. RESEARCHING METHOD[3,4]

There are three steps for the researching work

Step 1. Determine the level of air pollution; comparing the difference between air quality standards of WHO with current air quality, (value dA µg/m3).

Step 2: Define the Relationship between Dose - Response to demonstrate the association of health to the level of ambient air pollution obtained from the references of epidemiology. This step includes the calculation of partial derivatives (slope bi) of the Dose – Response curve. Bi is obtained from epidemiological data given by WHO according to the available documents.

Step 3. The population of the community related to exposure (POPI) that are affected air pollution, especially children and people with asthma.

2.1. Selection of the most vulnerable and most at risk population[2,4]

The study was caried out on the risk impact from air pollution originating from traffic operations to public health, particularly respiratory diseases. Key research are vulnerable people, namely the objects are most at risk, such as people living and working on both sides of the road as sellers, motorbiker, students, traffic police... on Nguyen Trai Street (191 people).

Table 1 shows percentage of main occupation of the surveyed group.

Table 1. Percentage of occupation numbers of respondents

Worker	Owner shop	Employ-ee in shop	Traff.Police	Car keeper	Student	Driver
38.7	10.5	9.7	4.8	5.6	23.4	7.3

2.2. Equipment to PM_{10} determination[3,4]

***** *PM_{10} measurement equipment:*

For PM_{10} we used the pDR-100AN model manufactured by Thermo Inc., USA.

This passive monitor measures mass concentrations of dust, smoke, mists and fumes, ranging in size from 0.1 – 10 µm. The instrument estimates mass concentrations ranging from 0.001 to 400 mg/m^3.

The instrument has an accuracy of ± 5%.

The concentration measurement range is 0.001 to 400 mg/m^3.

The monitor has an internal data logger which can store more than 13,391 data points. The monitor is very portable as it weighs only 0.5kg. This instrument's performance has been widely studied under different operating conditions (Wu, Delfino, Floro et al. 2005, Chakrabarti, Fine, Delfino, et al. 2004, Muraleedharan and Radojevic 2000)

** Measurement equipment of teperature (T), relative hurmidity (RH) and global position system (GPS).*

The performance of the particulate matter monitors is highly dependent on temperature (T) and relative humidity (RH) conditions. The $PM_{2.5}$ monitor (model pDR-1500) has internal sensors for T and RH. However, for the model pDR-1000AN we needed to use external climate sensors. We used the model U12-013 HOBO sensors made by Onset, USA.

The range of measurements are - Temperature: -20° to 70°C (-4° to 158°F) and RH: 5% to 95% RH. This product can store up to 43,000 measurements of 12-bit resolution readings. The sensors have an accuracy of Temperature: ± 0.35°C from 0° to 50°C (± 0.63°F from 32° to 122°F); RH: ±2.5% from 10% to 90% RH (typical), to a maximum of ±3.5%.

The resolution is Temperature: 0.03°C at 25°C (0.05°F at 77°F), RH: 0.03% RH. The sensor weighs 46g.

3. RESULTS AND DISCUSSION

Personal PM_{10}, $PM_{2.5}$ and CO concentrations were measured for 24h during each sampling session. Daily fixed location measurements were collected for the duration of the sudy period. Due to the relatively low PM5 and CO content, the research team did not include it in this report [2,4].

3.1. Particulate dust PM10, and cacbon dioxid CO monitoring results on Nguyen Trai, Thanh Xuan[4]

This article uses the test results of the average dust concentration monitoring of PM_{10}, $PM_{2.5}$ and CO at locations on Nguyen Trai Street, Thanh Xuan District (Survey results from WB project by the authors themselves[4]- unpublished report, 2015).

Table 2. PM_{10}, CO dust concentrations on surveyed road

Đường	4/2014		5/2014		6/2015	
	CO (ppm)	*PM_{10} (mg/m^3)*	*CO (ppm)*	*PM_{10} (mg/m^3)*	*CO (ppm)*	*PM_{10} (mg/m^3)*
	(n= 15)	(n=13)	(n=15)	(n= 13)	(n=15)	(n=15)
Nguyễn Trãi	7.934 ± 0.543	0.076 ± 0.003	9.453 ± 0.725	0.093 ± 0.003	9.135 ± 0.624	0.106 ± 0.003

(Source: WB Project: Consulting services for exposure and health effects for Hanoi (Package 01b/HP3The East-West Center (EWC), USA [Sub – Consultant: Institute ofnvironment Science and Public Health (IESH)]

3.2. Identify population change potentially affected by PM_{10} pollution and disease risk in Thanh Xuan District[5.]

The research team has selected Nguyen Trai Street as a typical polluted area caused by traffic. Figures are measured from the World Bank project (2014-2015) implemented by the authors group. The population of Thanh Xuan district POP used according to the district's statistical yearbook is (For example: 262,600 people)[5]- According to estimates of the project team based on the number of houses and agencies along the two sides of Nguyen Trai Street, the number of people living and working on this road is about 14,600 - PM_{10}'s dA of Nguyen Trai street is: 0.216 µg/m^3

The change in the number of people likely to cause premature loss due to PM_{10} dust pollution is:

Premature change in mortality (PCM) on Nguyen Trai road [4]

Table 3. Concentrations of particulate PM10 on Nguyen Trai road

4/2014	5/2014	6/2014
PM10 µg/m^3	*PM10* µg/m^3	*PM10* µg/m^3
(n=13)	(n= 13)	(n=15)
0.236 ± 0.003	0.193 ± 0.003	0.219 ±0.003

+ Change in number of deaths (High):
9.1x10-6 * 216 * 14600 = 29 people
+ Change in number of deaths (Midle):
6.72x10-6 * 216 * 14600 = 21 people
+ Change in number of deaths (Low):
4.47x10-6 * 216 * 14600 = 14 people

On average, 21 people die prematurely due to PM_{10} pollution, meaning that the number of deaths will decrease by an average of 21 people if the PM_{10} level in the air falls below the Vietnamese standard.

Number of people at risk of hospitalization for respiratory disease (RHA)[3,4]

This indicator can be understood as the number of people hospitalized for respiratory diseases, usually calculated per 100,000 population, from which the total cost for respiratory illnesses can be estimated (by calculating how much costs on average each case, then multiplying it by the total number of cases). RHA change per 100,000 inhabitants:

+ RHA in High: 1.56 * 216 µg/m^3 (change in PM_{10}) = 337 (per 100,000 population)
+ RHA in Average : 1.20 * 216 µg/m^3 (change in PM_{10}) = 259 (per 100,000 inhabitants)
+ RHA in Low : 0.657 * 216 µg/m^3 (change in PM_{10}) = 142 (per 100,000 inhabitants)

Total RHA change = RHA change per 100 000 population x (Nguyen Trai street population / 100,000)[3,4]

+High = 337 * (14600/100000) = 49 (case).
+Average = 259 * (14600/100000) = 38 (case).
+ Low = 142 * (14600/100000) = 21 (case)

Thus, it can be seen that, if the PM_{10} concentration in the air on Nguyen Trai Street is reduced by the permitted standards, on average, there will be a reduction of 38 hospital admissions for treatment of respiratory diseases in a year.

Number of emergencies (ERVs)[3,4]

In addition to hospitalization and treatment in the hospital, emergencies also bring significant costs. Operation of ambulances, first aid, doctors and nurses on duty...

It is estimated that emergencies are more than hospitalized cases, from this number can be calculated. Total costs for emergencies (by multiplying the total number of emergencies by the average cost per emergency). ERV change per 100,000 population:

+ Highest: 34.25*216 µg/m^3 (change in PM_{10}) = 7398 (per 100,000 inhabitants)

+ Mean : 23.54*216 µg/m^3 (change in PM_{10}) = 5085 (per 100,000 inhabitants)

+ Lowest: 12.83*216 µg/m^3 (change in PM_{10}) = 2771 (per 100,000 inhabitants)

Total ERV change = change in ERV per 100,000 population x (population on Nguyen Trai Street / 100,000)

+ Highest: 7398*(14600/100000) = 1080 (case)

+ Average: 5085*(14600/100000) = 742 (case)

+ Lowest: 2771* (14600/100000) = 405 (case)

Restricted Activity Days- RAD)[3,4]

Thus, people living and working on Nguyen Trai Street have an average of 742 emergencies per year due to respiratory diseases caused by air pollution. Number of days with variable activity inhibition (RAD): like hospitalization, dismissal, etc. (Restricted Activity Days-RAD)

This metric can serve as a kind of hidden, invisible cost of pollution. Cases of emergencies, hospitalization, are unable to contribute to society in those days.

The average RAD change per person per year is as follows:

+ Highest RAD / person / year :
= 0.0903 * dA = 0.0903 * 216 = 19.50 (date)

+ Average RAD / person / year:
= 0.0575 * dA = 0.0575 * 216 = 12.42 (day)

+ Lowest RAD / person / year:
= 0.0404 * dA = 0.0404 * 216 = 8.73 (day)

The paper could'n study on the Respiratory Illness in Children (LRI); According to statistics, the number of children under 18 years old in Vietnam accounts for 35.46% of the population.

Table 4. Morbidity Effects of 10 µg/m3 change in PM_{10}

No	Type of Morbidity	Central Estimate	High Estimate
1	RHA/100000	12.0	15.6
2	ERV/100000	235.4	342.5
3	RAD/ person	0.575	0.903
4	LRI/child/per asthmatic	0.0169	0.0238
5	Asthma attacks/per asthmatic*	0.326	2.73
6	Respiratory symptoms/person	1.83	2.74
7	Chronic bronchitis/100,000	61.2	91.8

Applies to the 5% of the Vietnamese population that is assumed asthmatic

The aggregate losses due to dust pollution on the Nguyen Trai road are shown in table 3, which summarizes the dose-response estimates of the morbidity outcomes of changes in PM_{10} levels of 10 µg/m3 for all of these possible health outcomes, and presents the central estimate and the high-side estimate for Thanh Xuan district.

4. CONSLUSION

The PM_{10} concentration is 0.216 µg / m3. The change in the early mortality rate (PCM) on Nguyen Trai Street can be from 14 people to 29 people.

The smallest number of respiratory disease emergencies (RHA) can be from 21 to up to 49

The average number of ERVs (restricted activities days) per 100,000 people can result in 405 to 1080 quitting, or limited activity caused by respiratory illnesses.

The average number of ERVs (restricted activities days) per 100,000 people can result in 405 to 1080 quitting, or limited activity caused by respiratory illnesses

This result of the study is just a simulation test based on real data to have a method of estmated impacting health by PM_{10} pollution. In this study just only considers one parameter PM_{10}, so that cannot be considered sufficient and accurate. So for better results, it is neccesury to survey many parameter more for next researching.

This study needs to be further improved to gradually improve a new method applied in Vietnam.

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