

Inhalation Exposure of Traffic Police Officers to Traffic-Related Air Pollutants in Thanh Xuan, Hanoi

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Abstract: Traffic-related air pollutants have been under intensive scrutiny. Exposure to Total suspended particles (TSP) and NO₂ from automobile exhaust can be a serious occupational problem for traffic police. This present study was conducted to estimate the inhalation exposure of traffic police to the two air pollutants (TSP and NO₂) in Nguyen Trai - Khat Duy Tien intersection during daily rush hours (7 am. to 9 am.) According to our results, mean personal exposure to TSP was $96 \pm 71 \mu\text{g}/\text{m}^3$, with peaks of about $506 \mu\text{g}/\text{m}^3$. Mean concentration of NO₂ in the breathing zone was $109 \pm 141 \mu\text{g}/\text{m}^3$. The potential of the two pollutants in posing adverse health effects was discussed. Total inhalation exposure of a traffic police officer to TSP and NO₂ was about 1.04 mg/day and 1.2 mg/day, respectively.

Keywords: Inhalation exposure, traffic-related air pollutants, traffic police officers, Hanoi.

1. Introduction

Along with the rapid development of the society, there are raising concerns about air quality and health effects in the urban areas especially when some studies suggested that long-term exposure to fine particulate matters (PM) and nitrogen dioxide in the air was associated with life shortening [1]. The PM is a complex mixture of extremely small solid and liquid particles that get into the air. Anthropogenic airborne PM and nitrogen dioxide derives from a wide range of sources, in which vehicle emission has been considered as

the major one [2-10]. These pollution sources are particularly typical for big cities in Asian countries. Urbanization is happening quickly leading to the increasing demand in travelling, thus to the rapid increase of the transport means, especially personal vehicles. To end of 2015, Hanoi with 5.8 million vehicles (including 376,417 cars and 5.4 million motorbikes), not to mention a large number of vehicles from other provinces going in and out the city during the day [4, 5]. In Vietnam, traffic-related PM pollution is still an urgent and unimproved issue. According to the Nation State of Environmental Report, 68.12% of the collected Total suspended particles (TSP) concentration data exceeds the Vietnam Standards and approximately 25% exceeds the standard by more than twice [4, 5].

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Few studies on both children and adult have addressed that long-term exposure to particle matter put adverse effects on health. The patients have to suffer more respiratory symptoms, allergies and reduced lung function [11]. The impacts of air pollution on personal health vary relatively depend on the nature, habits and activities. Obviously, the more people stay on the streets, the more they are exposed to the traffic-related pollutants. In fact, traffic police officers (TPOs) are among the groups of people suffered severely due to the location of their work which along the busy road, the exposure level and ensuing health risks for TPOs are believed to be significantly higher than those of the general population [12]. These workers are professionally exposed to vehicle exhausts while controlling traffic by airborne polycyclic aromatic hydrocarbons (PAHs) [12-14], PM [15], CO [15], benzene [15-17], and so on. However, the remain question is to what extent do they have to be exposed, especially in the context of a highly polluted working environment as on the street of Hanoi city, and how severe do the pollutants travel into their inhalation system. The objective of this study is to have an insight into the inhalation exposure of TPOs in Hanoi to PM and NO₂ at a traffic hotspot in Hanoi. The air pollutants were determine at point-of-contact level and calculate the potential personal exposure of traffic policeman.

2. Methodology

2.1. Sampling design

The sampling site was set up at Nguyen Trai - Khat Duy Tien intersection, by the side of the traffic police patrolling station (Fig. 1). This intersection was considered as the most important traffic junction which is the gateway to the city center. At the same time, this is the intersection of four different road types including an underground road, on ground road, elevated monorail, and elevated highway. Hence, the vehicle density in this crossroad is

always higher than others. Sibata LD-3B Digital Dust Indicator was used for collecting the data of the total suspended particles (TSP).



Fig.1. The sampling area, Nguyen Trai - Khat Duy Tien intersection.

Meanwhile, the data of NO₂ was gathered by using GrayWolf DirectSense TOX. The equipment was light and small enough for the traffic police to carry in the backpack. To measure exposure level, the equipment were set up to collect the data in 1-minute interval and at the human breathing zone height. This study was conducted in rush hour from 7:00 am to 9:00 am at the traffic police patrolling station on non-rainy 7 days (Monday to Sunday), from 6 - 24 September 2017.

2.2. Calculating potential inhalation exposure

Fig. 2 shows the schematic of dose and exposure [18]. The general equation for potential dose for intake processes, e.g., inhalation (see Fig. 2 for illustration of various exposures and doses) is simply the integration of the chemical intake rate. The potential inhalation exposure was calculated by Eq. (1) as describe in [18]:

$$D_{pot} = \int_{t_1}^{t_2} C_{(t)} * IR_{(t)} dt \quad (1)$$

Where:

D_{pot}: The potential dose

C_(t): The concentration of the chemical in the medium

IR_(t): The ingestion or inhalation rate

The concentration of the chemical in the medium $C_{(t)}$ are the values monitored from the sampling presented above. The inhalation rate in this study is referenced from Đức (2006).

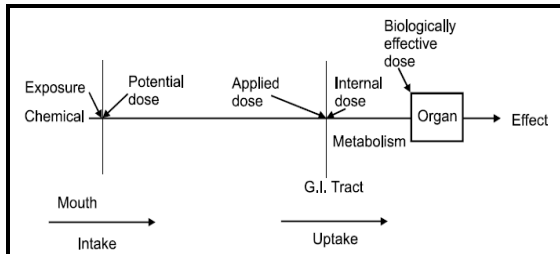


Fig. 2. Schematic of dose and exposure.

3. Results and discussion

3.1. Level of traffic air pollutants at point-of-contact

Levels of the air pollutants related to traffic activities in rush hour in urban street Nguyen Trai in Hanoi is presented in Fig. 3. As for TSP, the average exposure concentration and standard deviation for all week is $96 \pm 71 \mu\text{g}/\text{m}^3$, well situated within the proposed QCVN 05:2013/BTNMT 1h-standard. In comparison to the results reported in the same dry season 2015 in $350 - 400 \mu\text{g}/\text{m}^3$ [4], it shows a significant decrease of TSP concentration at this point after the inauguration of the Nguyen Trai tunnel in 2016. However, when viewed in absolute terms, the difference was marginal. Average of aerosol concentration in the

weekdays is witnessed to be remarkably higher than in the weekends ($127 \pm 65 \mu\text{g}/\text{m}^3$ and $28 \pm 40 \mu\text{g}/\text{m}^3$ respectively) in which 6.7% exceeds the standard. The explanation drive to this phenomenon could be easily attributed to the decline in traffic density due to the official days-off of government institutions, schools and colleges [20]. Meanwhile, the average concentration of NO_2 is noticeably high of $109 \pm 141 \mu\text{g}/\text{m}^3$ with 28% of the data exceeds the standard. The results point out the fact that the TPOs exposure level were 3 - 4 times higher through inhalation than that of a typical urban resident. This large amount of NO_2 may have been caused by the considerably increasing number of vehicle and poor maintenance of these vehicles as well as the type of fuel [2]. On the other hand, there is a substantial difference between the recorded data in working-days and weekend which are $93 \pm 138 \mu\text{g}/\text{m}^3$ and $144 \pm 143 \mu\text{g}/\text{m}^3$ respectively. It is important to note that besides the traffic flow, meteorological parameters in term of temperature, relative humidity, wind speed, precipitation, tend to have the potential to influence the NO_2 concentration. Moreover, both relative humidity and wind speed have negative correlation with NO_2 concentration [21, 22]. Therefore, higher average humidity and wind speed in weekdays (81.4% and 5km/h) than weekends (66% and 3km/h) is the root cause to this phenomenon.

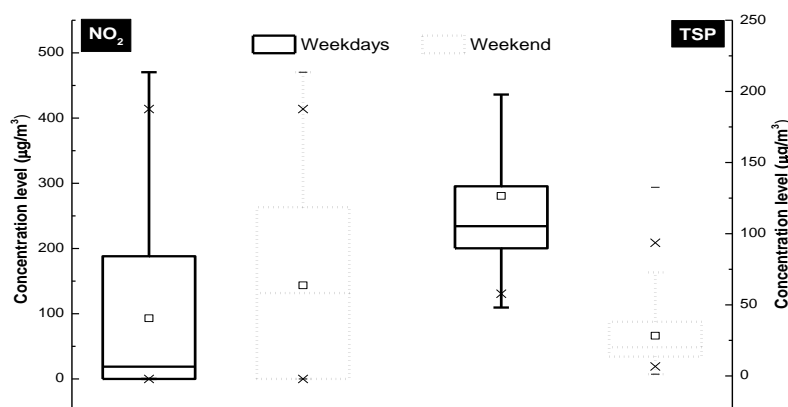


Fig. 3. Levels for the TSP, NO_2 concentration. The box limits are the 25th and 75th percentiles, and the solid line in the box is the median. The whiskers are the 10th and 90th percentiles.

Asterisk (✱) outliers: cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box. Asterisk (■) extreme value: cases with values more than 3 box lengths from the upper or lower edge of the box.

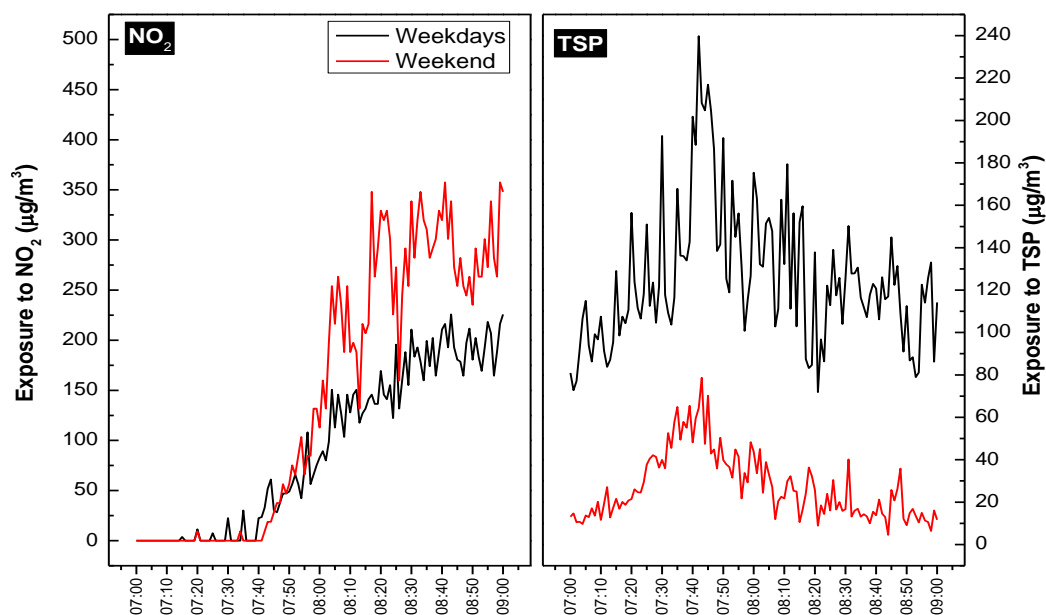


Fig. 4. Variation of traffic air pollutants, TSP (right) and NO₂ (left) in Nguyen Trai, Hanoi.

Fig. 4 indicates the stark contrast between weekdays and weekend. The circulation of the traffic light as well as the quality of means of transport were considered to clarify the dramatic fluctuation trend of these two lines. Both lines start to shoot up sharply from 7:20 reaching a pick at 7:40 am, then followed by a downturn to previous level at 8:10 am. The trend of these lines is quite reasonable due to the fact that the period of time from 7:30 am is when citizens leave their houses for work and study. In general, the line of NO₂ concentration was witnessed to undergo an upward trend. Regard to the weekdays line, the line stayed at the same level from 7:00 to 7:25 am, grew moderately in the next 15 minutes then surged suddenly from 7:40 to 8:10 am when has the

highest traffic density of a day and finally remained at high level of NO₂ concentration.

3.2. Potential inhalation exposure of traffic policeman at Nguyen Trai - Khat Duy Tien intersection

In this study, the traffic policeman who direct the traffic have to work 8 hours per day, one day off per week. As mentioned before, the study used an assumption basing on literature where average respiratory rate of normal human is 15 breath in a minute, each breath containing 500 mL of air [19, 23]. Thus, the traffic-related air pollutants at point-of-contact level and potential inhalation exposure of TPOs are listed in Table 1. Average values of the total TSP and NO₂ intakes by the TPOs were 1.04 mg/day and 1.2 mg/day, respectively.

Table 1. Potential inhalation exposure of TSP and NO₂

Values	TSP (<i>n</i> = 120)		NO ₂ (<i>n</i> = 120)	
	Conc. (*)	PIE	Conc. (*)	PIE
Average	96	1.04	109	1.2
Range	1 - 506	0.014 - 1.82	0 - 470	0 - 1.7

Note:

(*) Concentration at point-of-contact.

PIE: Potential inhalation exposure (mg/day).

4. Conclusion

The exposure levels of traffic police in Nguyen Trai - Khat Duy Tien intersection to TSP and NO₂ in were found to be $96 \pm 71 \mu\text{g}/\text{m}^3$ and $109 \pm 141 \mu\text{g}/\text{m}^3$ respectively. The data is recorded to exceed the Vietnam Standard for ambient air quality. Total inhalation exposure of a TPOs to TSP and NO₂ are about 1.04 mg/day and 1.2 mg/day, respectively. The results help to evaluate one of the very typical professional risks that TPOs have to face in the big city of Vietnam related to air pollution from traffic activity. The study would be helpful in warning the policy makers to improve the working environment for TPOs or issue more appropriate compensation for the risk.

References

- [1] Stephen T Holgate Bert Brunekreef, Air pollution and health, *The Lancet* 360 (2002) 1234.
- [2] Xianglu Han, Luke P Naeher, A review of traffic-related air pollution exposure assessment studies in the developing world, *Environment international* 32 (2006) 106.
- [3] Esther Rijnders, NA Janssen, PH Van Vliet, Bert Brunekreef, Personal and outdoor nitrogen dioxide concentrations in relation to degree of urbanization and traffic density, *Environmental health perspectives* 109 (2001) 411.
- [4] MONRE, Báo cáo hiện trạng môi trường quốc gia giai đoạn 2010 - 2015, Bộ Tài nguyên và Môi trường, Hà Nội, 2015.
- [5] MONRE, Báo cáo hiện trạng môi trường quốc gia năm 2013: Môi trường Không khí, Bộ Tài nguyên và Môi trường, Hà Nội, 2013.
- [6] Vương Đức Hải, Nguyễn Tri Quang Hưng, Lê Việt Mỹ, Hoàng Anh Lê, Đánh giá tình trạng Sol khí sinh học tại một số điểm trên địa bàn thành phố Hồ Chí Minh, *Tạp chí Khoa học Đại học Quốc gia Hà Nội (Các Khoa học Trái đất và Môi trường)* 32 (2016) 132
- [7] Nguyễn Tri Quang Hưng, Nguyễn Tùng Lâm, Hoàng Anh Lê, Lê Bá Phước, Vương Đức Hải, Đánh giá ô nhiễm không khí (PM₁₀ và BTEX) tại thành phố Hồ Chí Minh năm 2014, *Tạp chí Đại học Quốc gia Hà Nội (Khoa học Tự nhiên và Công nghệ)* 31 (2015) 172.
- [8] Hoang Anh Le, Hoang Xuan Co, Dinh Manh Cuong. Climatic Effects of Aerosol and the Importance of Monitoring Aerosol. Assessment of Short - Lived Climate Pollutants Levels in Vietnam, 30 June 2016; Hanoi2016.
- [9] Hoàng Anh Lê, Ninh Thị Hương, Nguyễn Hồng Phúc, Ảnh hưởng của lưu lượng phương tiện giao thông và tốc độ gió đến hàm lượng bụi PM₁₀, PM_{2.5} tại đường Trường Chinh, thành phố Hà Nội, *Tạp chí Khoa học Đại học Quốc gia Hà Nội (Khoa học Tự nhiên và Công nghệ)* 31 (2015) 186.
- [10] Hoàng Anh Lê, Đặng Thị Xuân, Phơi nhiễm black carbon khi sử dụng xe máy và xe buýt làm phương tiện giao thông trên đường Trường Chinh, thành phố Hà Nội, *Tạp chí Khoa học Đại học Quốc gia Hà Nội (Khoa học Tự nhiên và Công nghệ)* 31 (2015) 179.
- [11] RR Cacciola, M Sarva, R Polosa, Adverse respiratory effects and allergic susceptibility in relation to particulate air pollution: flirting with disaster, *Allergy* 57 (2002) 281.
- [12] YN Liu, S Tao, H Dou, TW Zhang, XL Zhang, R Dawson, Exposure of traffic police to polycyclic aromatic hydrocarbons in Beijing, China, *Chemosphere* 66 (2007) 1922.
- [13] Andrea Perico, Marvela Gottardi, Vieri Boddi, Paolo Bavazzano, Eudes Lanciotti, Assessment of exposure to polycyclic aromatic hydrocarbons in police in Florence, Italy, through personal air sampling and biological monitoring of the urinary metabolite 1-hydroxypyrene, *Archives of Environmental Health: An International Journal* 56 (2001) 506.
- [14] WT Zhang, Han Dou, YN Liu, XL Zhang, Shu Tao, Exposure of traffic police in Haidian district to PAHs, *Huan jing ke xue= Huanjing kexue* 27 (2006) 224.
- [15] Andrea Cattaneo, Matteo Taronna, Dario Consonni, Silvana Angius, Paolo Costamagna, Domenico Maria Cavallo, Personal exposure of traffic police officers to particulate matter, carbon monoxide, and benzene in the city of Milan, Italy, *Journal of occupational and environmental hygiene* 7 (2010) 342.
- [16] R Crebelli, F Tomei, A Zijno, S Ghittori, M Imbriani, D Gamberale, A Martini, A Carere, Exposure to benzene in urban workers: environmental and biological monitoring of traffic police in Rome, *Occupational and environmental medicine* 58 (2001) 165.
- [17] Viroj Wiwanitkit, Jamsai Suwansaksri, Suphan Soogarun, Cancer risk for Thai traffic police

- exposed to traffic benzene vapor, Asian Pac J Cancer Prev 6 (2005) 219.
- [18] US EPA, Guidelines for exposure assessment, Federal Register 57 (1992) 22888.
- [19] Phạm Thị Minh Đức, Sinh lý học, NXB Y học, Hanoi, 2006.
- [20] Mamdouh Ibraheim Khoder, SK Hassan, Weekday/weekend differences in ambient aerosol level and chemical characteristics of water-soluble components in the city centre, Atmospheric Environment 42 (2008) 7483.
- [21] AK Gupta, Kakoli Karar, S Ayoob, Kuruvilla John, Spatio-temporal characteristics of gaseous and particulate pollutants in an urban region of Kolkata, India, Atmospheric research 87 (2008) 103.
- [22] Sevda Ocak, F Sezer Turalioglu, Effect of meteorology on the atmospheric concentrations of traffic-related pollutants in Erzurum, Turkey, J Int Environmental Application & Science 3 (2008) 325.
- [23] Kim E Barrett, Susan M Barman, Scott Boitano, Heddwen Brooks, Ganong's Review of Medical Physiology, 25/e, (2016).

Phơi nhiễm khí thải của cảnh sát giao thông làm việc tại Thanh Xuân, Hà Nội

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Tóm tắt: Việc tiếp xúc với khí thải động cơ có thể là một vấn đề nghề nghiệp nghiêm trọng đối với các cảnh sát điều khiển hoạt động giao thông. Nghiên cứu được tiến hành quan trắc và đánh giá mức phơi nhiễm bởi TSP và NO₂ của cảnh sát giao thông trong giờ cao điểm (07h - 09h) tại nút giao Nguyễn Trãi - Khuất Duy Tiến, Thanh Xuân, Hà Nội. Nồng độ phơi nhiễm của bụi TSP là $96 \pm 71 \mu\text{g}/\text{m}^3$, và NO₂ là $109 \pm 141 \mu\text{g}/\text{m}^3$. Tương tự, liều lượng phơi nhiễm hít thở của cảnh sát giao thông tại khu vực này đối với TSP xấp xỉ 1,04 mg/ngày, và NO₂ vào khoảng 1,2 mg/ngày.

Từ khóa: Liều lượng phơi nhiễm, Khí thải giao thông, Cảnh sát giao thông, Hà Nội.