Major Health Problems of Expressway Workers in Thailand: An 8-Year Cohort Study

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Background and Objective: *Workers in the transportation sector may be expose to environmental hazards resulting in adverse health outcomes. The present study aimed to assess environmental-hazard-related morbidity among transportation workers over an eight-year period.*

Material and Method: *Data were extracted from the registry database of a cohort of workers in the Expressway Authority of Thailand between 2004 and 2011. Annual trends and changes in health status were described. Factors associated with major health problems were also evaluated.*

Results: *The cohort consisted of 2,000 to 2,700 workers. The trend of abnormal lung function, abnormal hearing, high blood pressure, high cholesterol, and asthma significantly increased over the period.Very few workers had high serum lead levels.*

Conclusion: *The present study revealed several major occupation-related health problems among transportation workers. In addition to an annual health assessment, other control measures should be instituted to protect workers from occupation-related exposures.*

Keywords: *Expressway workers, Transportation, Health impact, Occupation-related, Prospective cohort*

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Occupations in the transportation sector are reportedly linked to a multitude of adverse health outcomes, including clinical, psychophysiological, and other morbidities[1]. Several studies have examined diseases, sickness, impairment, and even mortality, among professionals working on the highways, as road constructors, highway patrol, traffic control, or those with driving careers[1-8]. Exposure to gasoline/diesel fumes, small particles, and dust were reported as potentially associated with headache, nausea, respiratory tract problems, stroke, and cardiovascular disease. Postural fatigue in the working environment, as well as exposure to noise or vibration, could lead to musculoskeletal disorders, injuries, fatigue, insomnia, and headaches. The types of work that dictate a sedentary lifestyle and unhealthy diet have shown significant associations with being overweight and a tendency to obesity, high cholesterol, hypertension, stroke, and diabetes.

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Epidemiological studies on the health-impact assessment of public transportation have mostly been based on secondary data and cross-sectional or short-term follow-up. However, results based on cross-sectional or short-term follow-up may not reflect the health impact of occupational exposures, which usually requires long-term exposure. A longitudinal cohort study of workers would provide strong evidence of occupational-related health problems and diseases. Monitoring health conditions of a cohort of workers in particular organizations would help assess occupation-related health problems, which is important for planning prevention and control in an organization.

The Expressway Authority of Thailand (EXAT) cohort of workers who underwent annual health examinations was established, in collaboration with the Faculty of Tropical Medicine, Mahidol University, in 1994. EXAT is responsible for the construction, maintenance, and management of expressways and public land transportation infrastructure, and other expressway-related activities. With the development of new expressways and highways across the country, the numbers of motor vehicles, as well as the transport energy consumption, have been increasing rapidly. That means that air,

noise, and other environmental pollutions are also increasing continually.

The main aim of the present study was to assess health problems among workers in the transportation sector over an eight-year period (2004-2011). In addition, the health problems of different at-risk groups were investigated with time-varying exposure variables.

Material and Method

Participants

The cohort, established in 1994, consisted of EXAT workers who had been working in five operational units, which included maintenance, toll collection, traffic control, special construction, and strategic planning. Due to the inconsistency of data collected before 2004, only those workers who attended and registered at the hospital for the annual checkup program between 2004 and 2011 were involved in this study. New workers could be enrolled during the course of the eight-year follow-up period, while a few retired or died.

Health assessment

The main purpose of the worker cohort was to monitor their health status, for help plan health promotion activities and prevent occupation-related illness/disability. The on-going annual health checkup program includes a general physical examination, vision examination, color-blindness examination, hearing test (audiogram), pulmonary function test, and chest X-ray. Basic laboratory tests, including hematological examinations, urinalysis, and stool examinations, were performed for all workers. In particular, serum lead levels are routinely monitored. Workers aged >35 years also receive health-status checks for diabetes, lipid profiles, renal and liver function, and serum uric acid.

Morbidities and health status were assessed by physicians at the hospital. In the present study, the morbidities directly examined by the physicians during the annual checkup visit included impaired lung function, hearing impairment, and lead level. In addition, from the interview at annual checkup, certain morbidities diagnosed by any physician(s) during the previous year were self-reported by the registered workers. Some of these morbidities were not confirmed at the current annual checkup visit.

Statistical analysis

Data in the annual registry database for the period between 2004 and 2011 were extracted. The annual trends and changes in health status as well as diseases/sickness were assessed descriptively using the existing reported data. Factors associated with main morbidities, including health problems and selected diseases, were evaluated using a generalized estimation equation model with time-varying covariates. Due to the nature of the registry, where health check-up procedures are voluntary, some data were missing and incomplete across variables. Thus, analysis was only based on complete and clean data for each variable.

Ethical consideration

Data analysis was based on extracted secondary data with unlinked identification. The use of the data was authorized by the Program Director and the EXAT Director, with ethical review and approval by the Ethics Committee of the Faculty of Tropical Medicine, Mahidol University.

Results

Demographics and exposures

Besides the physical, clinical, and laboratory examinations, general health and exposure status were assessed by the health personnel at the hospital. As shown in Table 1, the number of workers who attended the checkup program varied over the eight years, ranging from 2,000 to 2,700. About two-thirds of the workers were male, and half of them aged between 31 and 40 years. About 50% were of normal weight, while 40% were overweight. Interestingly, about one-third never consumed alcohol, while there was a shift of 40 to 50% from "frequently drink alcohol" to "occasionally" since 2009. In terms of smoking, the statistics were consistent; about 60% were non-smokers and 20% were current smokers. The workers were classified by the location where most of their work time was spent. Over the eight-year follow-up period, about 40% had been working in offices or traffic-control centers, 35 to 40% worked in toll booths, 20% on expressways, and 4% did field work (including equipment repair and landscaping).

Major health problems

An increase in self-reported cases with at least one health problems was observed, from 35% in 2004 to 53% in 2011. The trend of workers with two or more reported health problems also increased during the eight-year period. As shown in Fig. 1, the most frequently reported health problems were high cholesterol, asthma, and high blood pressure. Other diseases with the proportion <5% were also reported.

Table 1. Characteristics of the registered annual check-up personnel during 2004 to 2011

	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)
Sex								
N*	2,075	2,370	2,375	2,393	2,499	2,750	2,702	2,731
Male	68.1	68.2	68.2	68.1	69.0	65.1	63.8	65.7
Female	32.0	31.8	31.8	31.9	31.1	34.9	36.2	34.4
Age								
N*	2,075	2,370	2,375	2,393	2,499	2,750	2,702	2,731
<30	30.4	24.1	18.8	13.1	10.4	20.6	24.0	23.4
31-40	48.7	53.6	55.9	59.7	60.1	50.6	46.5	44.6
41-50	18.8	20.0	22.4	23.5	25.2	23.7	23.6	25.3
>50	2.0	2.3	2.9	3.7	4.3	5.1	6.0	6.8
BMI								
N*	2,073	2,368	2,375	2,392	2,499	2,750	2,699	2,731
Normal	51.6	50.6	49.3	49.0	46.5	48.5	47.0	45.3
Underweight	15.6	12.0	10.2	9.7	8.8	12.2	10.0	9.6
Overweight	32.8	37.5	40.5	41.3	44.7	39.4	43.1	45.1
Alcohol consumption								
N*	2,069	2,360	2,349	2,392	2,470	2,720	2,665	2,713
Never	35.7	34.9	35.8	37.0	35.0	32.2	30.4	30.4
Used to, but quit	18.9	19.1	20.6	20.1	20.9	11.5	11.6	10.5
Frequently	45.4	46.0	43.7	42.9	44.1	7.1	6.6	6.8
Occasionally	0.1	0.0	0.0	0.0	0.0	49.2	51.3	52.3
Smoking								
N*	2,069	2,360	2,352	2,392	2,470	2,718	2,662	2,712
Never	59.6	57.9	58.3	59.7	59.1	61.9	62.2	60.8
Quit	15.3	17.5	18.3	17.6	18.6	16.9	18.0	17.4
Current smoker	25.1	24.6	23.3	22.7	22.3	21.3	19.8	21.8

* N varies with the available data in the annual registry
BMI = body mass index

Based on lung function examinations, there were fluctuating levels of abnormal lung capacity through the years, ranging from 1% to 28% (Table 2). In self-reported asthma diagnosis, however, there was a consistent level of about 20% over the eight-year period. In addition, increasing problems with hearing were observed during examinations at the annual visits; the proportion of workers who had problems with one ear increased from 12% to 18%, and with two ears from 22% to 29% in 2004 and 2011, respectively. The majority of hearing problems were classified by the checkup physician as being noise-induced hearing loss. Levels of high blood pressure in 2004 to 2011 were similar between self-reported cases and the results of blood pressure examinations during the checkup visit. Levels of self-reported hypertension increased from 5% to 16%, while high blood pressure measured during the annual checkup increased from 8% to 19%. Self-reported cases of high cholesterol also revealed an increasing trend over the eight-year follow-up period, from 11% to 30%.

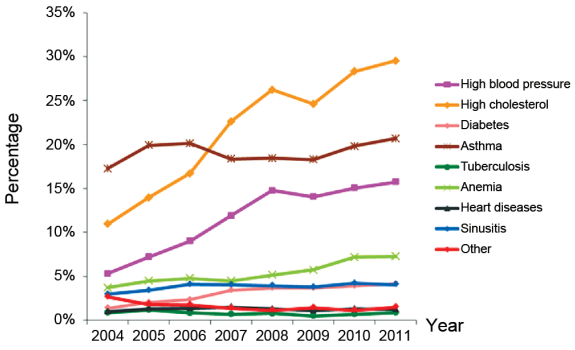

Fig. 1 Trends of physician-diagnosed morbidities reported by registered personnel.

When classifying major health problems by risk group (Fig. 2), abnormal lung function tended to be higher in later years across all groups; from 2004 to 2011, 8% to 25% among office staff, 12% to 27% for tollbooth staff, 4% to 32% for field workers, and

Table 2. Percentages of diagnosed morbidities and major health problems among EXAT personnel during 2004 to 2011

	Year							
	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)
Morbidity								
N*	2,074	2,369	2,374	2,393	2,499	2,746	2,692	2,727
1 disease	25.3	28.0	28.9	29.0	29.9	27.4	28.4	29.8
2 diseases	7.5	8.8	10.2	13.0	13.6	13.9	15.7	15.3
3 diseases	1.9	3.2	3.9	4.4	6.1	6.0	7.2	8.2
Lung function test								
N*	1,951	2,258	2,286	2,296	2,389	2,588	2,550	2,541
Obstructive	7.2	0.9	0.9	1.4	0.8	0.7	1.2	0.8
Restrictive	2.4	0.0	8.4	4.0	15.7	13.6	7.0	26.7
Mixed	0.4	0.0	0.1	0.2	0.3	0.2	0.2	0.2
Diagnosed asthma (self-reported)								
N*	2,075	2,370	2,375	2,393	2,499	2,750	2,702	2,731
Yes	17.3	19.9	20.1	18.4	18.5	18.3	19.8	20.7
Hearing problem								
N*	2,025	2,273	2,330	2,361	2,383	2,655	2,609	2,635
1 ear	11.6	12.5	13.3	16.8	17.4	18.6	16.8	17.8
2 ears	21.8	21.6	24.8	22.8	24.6	20.9	19.8	29.3
Right ear hearing:								
Hearing impaired	1.4	2.2	1.6	2.6	2.3	0.5	0.9	0.2
Sensorineural	0.0	0.0	0.0	2.2	2.4	3.2	2.7	6.7
Noise-induced	13.6	15.2	16.4	16.8	20.9	21.2	20.7	20.9
High pitched	11.8	10.1	12.2	9.1	8.4	7.3	7.0	7.3
Left ear hearing:								
Hearing impaired	1.3	1.7	1.7	2.2	2.0	0.6	1.1	0.1
Sensorineural	0.0	0.0	0.0	1.7	1.5	3.1	2.4	8.2
Noise-induced	13.3	15.9	17.6	16.4	19.6	17.7	15.7	24.7
High pitched	13.8	10.4	13.3	11.2	9.5	7.0	5.7	8.4
Diagnosed hypertension (self-reported)								
N*	2,075	2,370	2,375	2,393	2,499	2,750	2,702	2,731
Yes	5.3	7.2	9.0	11.9	14.8	14.1	15.1	15.8
Diagnosed hypertension (examination)								
N*	2,075	2,368	2,374	2,392	2,499	2,750	2,700	2,727
Yes	8.3	9.4	11.6	15.4	14.5	17.0	16.2	19.2
Diagnosed high cholesterol (self-reported)								
N*	2,075	2,370	2,375	2,393	2,499	2,750	2,702	2,731
Yes	10.9	14.0	16.7	22.6	26.2	24.6	28.3	29.5
Cholesterol level (aged >35 or as per request only)								
N*	892	1,083	1,246	1,424	1,618	1,697	1,693	1,826
Mean (SD)	219 (40)	216 (40)	211 (39)	215 (40)	207 (38)	220 (42)	216 (39)	217 (40)
(min-max)	(91-458)	(106-383)	(97-378)	(98-529)	(80-432)	(110-545)	(94-367)	(90-464)

* N varies with the available data in the annual registry
EXAT = expressway authority of Thailand

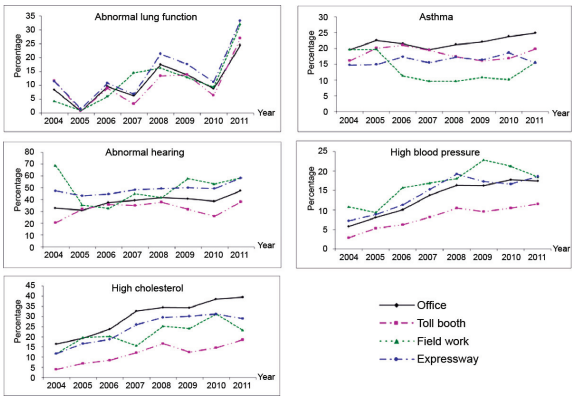

Fig. 2 Trends of major health problems by risk group.

11% to 33% for expressway personnel. In contrast, levels of diagnosed asthma from previous years increased slightly and were relatively consistent across risk groups; from 2004 to 2011, 20% to 25% for office staff, 16% to 20% for tollbooth staff, 16% to 20% for field workers, and 15% to 16% among expressway workers. Similarly, levels of abnormal hearing increased over the eight-year follow-up period and were again relatively consistent across the groups; from 2004 to 2011, 33% to 48% for office staff, 20% to 38% for toll booth staff, 35% to 58% for field workers (levels were exceptionally high in 2004, at 69%), and 47% to 58% among expressway workers. As expected, blood pressure and cholesterol levels tended to be higher in later years across the groups. From 2004 to 2008, high blood-pressure cases were recorded as follows: 6% to 17% among office staff, 3% to 12% for toll booth staff, 11% to 18% for field workers, and 7% to 19% among expressway workers. Over the eight-year period, high cholesterol was recorded at 17% to 40% among office staff, 4% to 19% for tollbooth staff, 12% to 23% for field workers, and 12% to 29% for expressway workers. Only three cases had serum lead levels above the standard cutoff of 40 µg/d: one office worker and one expressway worker (2010), and one office staff member (2011); among these three workers, no clinically significant lead poisoning was found.

Multivariate analysis was adjusted for gender and other time-varying factors (age, risk behavior, personal protective equipment), and suggested significant changes over time and differences across each of the risk groups (Table 3). Abnormal lung function was higher among expressway personnel than office workers (OR = 1.31; 95% CI 1.12-1.53), and the increasing proportions were much higher in 2011 than the baseline proportion in 2004 (OR = 3.23; 95% CI 2.76-3.77). Asthma was not different among the risk groups, but levels increased significantly in later years compared with the baseline year (in 2011, OR = 1.26; 95% CI 1.14-1.40). Regarding abnormal hearing, tollbooth workers (OR = 1.13; 95% CI 1.03-1.24),

Table 3. Multivariate analysis of risk groups and trend over time of major health problems

	Abnormal				
	Abnormal lung* OR (95% CI)	Asthma* OR (95% CI)	Abnormal hearing+ OR (95% CI)	Hypertension# OR (95% CI)	High cholesterol# OR (95% CI)
Workplace					
Office	1	1	1	1	1
Toll booth	1.13 (0.98-1.30)	1.01 (0.93-1.11)	1.13 (1.03-1.24)	1.01 (0.88-1.17)	0.83 (0.73-0.93)
Field work	0.99 (0.75-1.30)	0.95 (0.80-1.11)	1.25 (1.06-1.48)	1.23 (0.99-1.53)	0.77 (0.62-0.96)
Expressway	1.31 (1.12-1.53)	0.96 (0.86-1.09)	1.33 (1.18-1.48)	1.06 (0.91-1.23)	0.95 (0.82-1.09)
Year					
2004	1	1	1	1	1
2005	0.08 (0.05-0.12)	1.21 (1.11-1.32)	0.96 (0.87-1.06)	1.31 (1.10-1.57)	1.24 (1.07-1.44)
2006	0.89 (0.75-1.06)	1.18 (1.08-1.29)	1.10 (1.00-1.22)	1.60 (1.34-1.91)	1.38 (1.19-1.59)
2007	0.50	1.04 (0.95-1.14)	1.12 (1.02-1.24)	1.93 (1.62-2.29)	1.86 (1.61-2.15)
2008	1.68 (1.43-1.98)	1.08 (0.99-1.19)	1.19 (1.07-1.31)	2.44 (2.06-2.90)	2.17 (1.88-2.50)
2009	1.46 (1.24-1.72)	1.08 (0.98-1.19)	1.17 (1.06-1.30)	2.43 (2.03-2.91)	2.14 (1.85-2.48)
2010	0.80 (0.66-0.95)	1.23 (1.12-1.36)	1.04 (0.94-1.16)	2.76 (2.30-3.31)	2.72 (2.35-3.14)
2011	3.23 (2.76-3.77)	1.26 (1.14-1.40)	1.55 (1.40-1.72)	2.77 (2.30-3.32)	2.60 (2.24-3.02)

Analysis was based on repeated-measures Generalized Estimation Equation model

* Adjusted for sex and time-varying age, smoking, wearing respiratory protection

+ Adjusted for sex and time-varying age, wearing ear plug

Adjusted for sex and time-varying age, smoking, alcohol consumption

field workers (OR = 1.25; 95% CI 1.06-1.48), and expressway personnel (OR = 1.33; 95% CI 1.18-1.48) were all at higher risk of hearing loss than office workers, with significantly greater levels measured through each passing year (OR = 1.55; 95% CI 1.40-1.72). High blood pressure was not significantly different among the risk groups, but office workers were more likely to have high cholesterol levels than tollbooth or field workers. Increased levels were found for these two health problems with each passing year in relation to the baseline year (in 2011, high blood pressure, OR = 2.77; 95% CI 2.31-3.32 and high cholesterol, OR = 2.60; 95% CI 2.24-3.02).

Discussion

Workers exposed to traffic emissions over extended periods of time, due to working on or near expressways, suffered greater health impacts than those not occupationally exposed. As reported in earlier studies, expressway workers appeared to have higher rates of respiratory symptoms than the less exposed groups[2,4,7]. The present study found that expressway workers were more likely to have impaired lung function than office or tollbooth workers. This may be due to tollbooth workers tending to use personal protective equipment (PPE) more often than expressway workers. In the present study, the odds of abnormal lung function increased over the eight-year follow-up period; about three folds higher in the eighth year compared with the baseline year. This suggests that special attention is required from the authorities to investigate the cause of this increasing trend. Other studies among workers in the transportation sector, aside from those operating near highways or busy streets, also reported specific adverse respiratory tract outcomes, ranging from acute symptoms, such as coughing and wheezing, to more chronic conditions, such as asthma and chronic obstructive pulmonary disease (COPD)[2,5,9,10]. In the present study, the odds of developing asthma, after adjusting for risk and protective factors, for workers operating in different working environments, were not significantly different. However, levels of diagnosed asthma as reported by workers in all risk groups showed a slightly increasing trend over the duration of the study period.

Increases in transport volume cause air and noise pollution. Exposure to traffic noise may cause other acute and chronic effects, such as insomnia, lack of sleep quality, and hearing loss. Several studies have supported an association between road traffic noises at higher than average levels and morbidities[11-15]. Simultaneous exposure to multiple sources of noise was reported in one study to have a combined effect on hearing impairment[11]. The study was conducted in the electronics industry; physical examinations, including hearing tests, showed the prevalence of hearing loss among workers was as high as 68%. Another study reported that police officers were 1.4 times more likely to have selective hearing loss than civil servants, and this, particularly, was 5.3 times more likely among motorcycle police officers[15]. A study in Thailand identified four different categories of occupation in Bangkok's urban areas that were at risk of traffic noise-induced hearing loss: drivers, street vendors, traffic officers, and street dwellers, with the driver group at the highest risk[14]. Like the other studies, the hearing problems in the present study, identified by hearing test during annual checkup, were relatively high across all risk groups, ranging from 38% to 58%. The odds ratios showed significantly increasing trends, up to 1.6 times, in the eight-year follow-up period. Although the organizational authority implemented engineering and administrative controls, workers still had to be encouraged to wear personal protective equipment (PPE). Personnel in both tollbooth and expressway locations require conversations with customers, so that PPE are not commonly used by these workers.

Studies of noise exposure have linked noise exposure to non-auditory physical health effects, such as changes in blood pressure and heart rate, and levels of stress[16-20]. The results were inconsistent regarding links between road-traffic noise and hypertension[21-23]. The cause of hypertension is multi-factorial, includes age, gender, and personal behaviors. In the present study, the prevalence of hypertension increased across all risk groups, from 8% up to 19% during the 8-year annual examinations. Coincidently, cholesterol levels among workers in all risk groups increased as well, from 11% to 30% over the 8 years. Both hypertension and high cholesterol outcomes may not be due to traffic-related exposure alone, and could be partially due to culture, work environment, and lifestyle. Other factors have been reported to be related to such morbidities, e.g., cigarette smoking, dietary habits, lack of physical exercise, and workplace conditions[24-27]. In addition, alternating shift work can have an impact on serum total cholesterol levels[28]. High serum total cholesterol levels were more common among shift workers than day workers, after adjustment for age and food type[29]. Almost all workers in the present study were working shifts.

One concern of traffic-related health problem is elevated blood-lead levels. However, people can be exposed to lead in their homes and the environment through inhalation, or ingestion of lead-containing dust or fumes. Even though lead in gasoline and other substances (e.g. paint, electronic fittings) declined several years ago, there is still sufficient concern to monitor lead levels among at-risk workers. In the present study, only three workers had serum lead levels above Thailand's standard cutoff (40 μg/dL). However, with a cutoff >25 μg/dL, like the level used in the Adult Blood Lead Epidemiology and Surveillance Program of the US National Institute for Occupational Safety and Health (NIOSH)[30], there were 10 cases: 1 office worker (in 2004), 1 toll booth and 1 office worker (in 2008), 2 toll booth, 2 expressway and 1 office worker (in 2010), and 1 expressway and 1 office worker (in 2011). However, in the present study, clinical lead poisoning was not observed. Considering such a small proportion of workers displayed high blood-lead levels, this is less likely to be occupation-related. However, further investigation is needed to determine the causes of high blood-lead levels among these workers.

It should be noted that some occupation-related health effects have not yet been monitored in this cohort. Numerous reports have identified exposure to vehicle-related pollutants as associated with excess overall mortality, as well as with other diverse health effects, e.g., heart disease, stroke, and reproductive, psychosocial, and neurological effects[2,6,8,19]. Such morbidity risks suggest the need for further epidemiological research and interventions in the transport sector. In particular, there should be a plan for monitoring acute and long-term outcomes among workers in this cohort.

Conclusion

Based on this longitudinal cohort of workers in the transportation sector, the present study revealed several major occupation-related health problems. Expressway workers at risk of daily exposure to noise and air pollution over prolonged periods showed a tendency to have problems with lung function and hearing, when compared with office staff. Tollbooth staff and field workers were also found to have problems with hearing when compared with office staff. High serum lead levels were found in a few cases. The problems of high blood pressure and high cholesterol were found across all types of worker, and the prevalence of these major morbidities increased over the 8-year period. As a means of reducing these risks for workers, health-promotion programs should be implemented; there is strong evidence that such initiatives have been successful over the past decade[31,32]. While conducting annual health examinations has been one measure for the screening and early detection of health problems, greater efforts are required to promote and enforce self-protection measures. Engineering and administrative controls are also important to reduce occupational-related hazards.

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Potential conflicts of interest

None.

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ภาวะทางสุขภาพที่สำคัญของพนักงานการทางพิเศษแห่งประเทศไทย: การศึกษาติดตามใน 8 ปี

โชติมา จารุสภา, เกษราภรณ์ ทองภักดี, เนตรฟ้า รักมณี, ประตาป สิงหศิวานนท์, สารนาถ ล้อพูลศรี

ภูมิหลังและวัตถุประสงค์: *พนักงานที่ปฏิบัติงานในหน่วยงานเกี่ยวกับการคมนาคม อาจมีความเสี่ยงต่อการสัมผัสกับมลพิษในสิ่งแวดล้อมที่มีผลเสียต่อสุขภาพ วัตถุประสงค์ในการศึกษานี้เพื่อประเมินภาวะทางสุขภาพที่เกี่ยวข้องกับการสัมผัสกับมลพิษในพนักงานของการทางพิเศษแห่งประเทศไทย ในช่วงระยะเวลา 8 ปี*

วัสดุและวิธีการ: *ข้อมูลจากฐานข้อมูลการตรวจสุขภาพประจำปีของพนักงานการทางพิเศษแห่งประเทศไทย ระหว่างปี พ.ศ. 2547 ถึง ปี พ.ศ. 2554 นำมาใช้ในการวิเคราะห์เพื่อสรุปรูปแบบภาวะสุขภาพที่มีการเปลี่ยนแปลงเป็นรายปี และเพื่อค้นหาปัจจัยที่สัมพันธ์กับภาวะการเจ็บป่วยที่สำคัญของพนักงาน*

ผลการศึกษา: *ฐานข้อมูลประกอบด้วยข้อมูลพนักงานประมาณ 2,000-2,700 คน ภาวะทางสุขภาพ เช่น การทำงานของปอด การได้ยิน ความดันโลหิต ระดับไขมันในเลือด มีแนวโน้มผิดปกติมากขึ้นในช่วง 8 ปี ที่ศึกษา และการรายงานของโรคหอบหืดยังมีจำนวนเพิ่มขึ้นในช่วงที่ศึกษา มีพนักงานเพียง 3 ราย ที่มีระดับสารตะกั่วในเลือดสูงกว่าค่ามาตรฐาน*

สรุป: *การศึกษานี้แสดงให้เห็นถึงภาวะทางสุขภาพที่สำคัญที่เกี่ยวเนื่องกับการทำงานของพนักงานในหน่วยงานที่เกี่ยวข้องกับการคมนาคม นอกเหนือจากการตรวจสุขภาพประจำปีแล้ว ควรมีการใช้อุปกรณ์เพื่อป้องกันความเสี่ยงที่เกี่ยวเนื่องกับการทำงานด้วย*