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Health Effects of People Living Close to a Petrochemical Industrial Estate in Thailand

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Objective: *An acute health effect of people living near the petrochemical industrial estate in Thailand was assessed using a panel study design.*
Material and Method: *The populations in communities near the petrochemical industrial estates were recruited. The daily air pollutant concentrations, daily percentage of respiratory and other health symptoms reported were collected for 63 days. The effect of air pollutants to reported symptoms of people were estimated by adjusted odds ratios and 95% confidence interval using binary logistic regression.*
Results: *The significant associations were found with the adjusted odds ratios of 38.01 for wheezing, 18.63 for shortness of breath, 4.30 for eye irritation and 3.58 for dizziness for total volatile organic compounds (Total VOCs). The adjusted odds ratio for carbon monoxide (CO_2) was 7.71 for cough, 4.55 for eye irritation and 3.53 for weakness and the adjusted odds ratio for ozone (O_3) was 1.02 for nose congestion, sore throat and 1.05 for phlegm.*
Conclusion: *The results showed that the people living near petrochemical industrial estate had acute adverse health effects, shortness of breath, eye irritation, dizziness, cough, nose congestion, sore throat, phlegm and weakness from exposure to industrial air pollutants.*

Keywords: *Industrial air pollutants, Health effects, Petrochemical industrial estate*

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Map Ta Phut Industrial Estate is located in the municipality of Map Ta Phut, Mueng, Rayong. The question was asked whether industries and communities can live together[1]. The industrial estate has fifty-eight production industries, including gas separation facilities, an oil refinery, petrochemical, chemical, and steel production, fertilizer industries, and power plants[2]. In 1997, 120 students at a school located in the northeastern area of Map Ta Phut Industrial Estate complained of nuisance odors. Some students developed dizziness, sinusitis, sore throat and fatigue[3]. In 1999, the Thailand Environment Institute (TEI) surveyed and collected data from the industries located within Map Ta Phut Industrial Estate and found that volatile organic compounds (VOCs), primarily released from fuel combustion, incinerators, industries and storage tanks pervaded the surrounding atmosphere[4]. The Pollution Control Department (PCD), Ministry of Natural Resources and Environment, reported 34 VOCs monitoring of the ambient air from September 2006 to June 2010 and found that levels of 1, 3-butadiene, 1, 2-dichloroethane and benzene at the Map Ta Phut primary care unit were higher than the Thai annual standard[5]. The health effects of petrochemical industry were mainly concentrated on respiratory symptoms in young children[6,7]. Molhave et al (1986) studied sixty-two healthy volunteers exposed to a mixture of twenty-two VOCs at three concentration levels of 0, 5 and 25 mg/m^3 for 2.75 hours[8]. The increased irritation of eyes, nose, and throat had a significant correlation with exposure to both concentrations of 5 and 25 mg/m^3. Yang et al (1997) looked at the residents of a petrochemical polluted town in Taiwan and reported that the complaints of eye and throat irritation, nausea were markedly higher in those areas of the town which experienced increased VOC levels[9]. The effects of the

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ambient air pollution on general population caused complaints; people do not need to consult with medical doctors. The effects of ambient air pollution to people's health are not properly investigated particularly in developing countries[10].

This research aimed to study the effects of petrochemical air pollutants around Map Ta Phut Industrial Estate including PM_{10} (Particulate matter), CO (Carbon monoxide), total VOCs (Volatile Organic Compounds), O_3 (Ozone), NO_2 (Nitrogen dioxide) and SO_2 (Sulfur dioxide) upon the local population living near the estate. The study identified adverse health effects, primarily respiratory symptoms, and other health symptoms suffered by the population living in this area.

Material and Method

A panel study of the population living close to the petrochemical industries was conducted to evaluate daily respiratory symptoms and other health symptoms in relation to the daily concentrations of petrochemical air pollutants for a 63-day study period. The present study was reviewed and approved by the Ethics Committee on Human Rights Related to Human Experimentation, Mahidol University, No. MUPH 2009-079.

Study area

The studied area comprised the Soi Ruam Pattana and Wat So Phon communities, Map Ta Phut, Muang, Rayong. They are located approximately two kilometers to the northeast of Map Ta Phut Industrial Estate (Fig. 1). The two communities were close to the industrial estate. The wind direction blows from the north into the area from October to December and the wind direction comes from the south to the area in February-April. In June to September, the wind from the southwest will flow into the area in community[11]. The people in the community are exposed to volatile chemicals from the wind direction from the south and the southwest from February to April and June to September, respectively. The effects of land breeze and sea breeze also affect the wind direction at Map Ta Phut. Some small mountains situated along the shores in the gulf of Thailand prevent the land breeze to blow the VOC emission from the Map Ta Phut industrial estate into the sea.

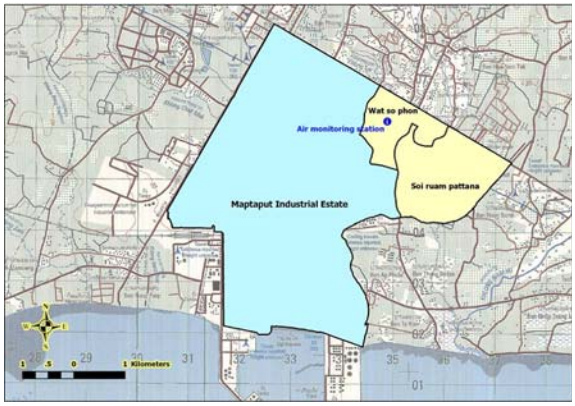

Fig. 1 The studied area showing Soi Ruam Pattana and Wat So Phon communities, the ambient air monitoring station at Map Ta Phut health center, and Map Ta Phut Industrial Estate.

An air monitoring station of the Pollution Control Department (PCD), Ministry of Natural Resources and Environment, is located at Map Ta Phut primary care unit in the Wat So Phon community. They are densely populated areas having residences close to industrial areas.

Study population and sample group

The population in Soi Ruam Pattana and Wat So Phon communities is approximately 3,600. Most residents worked and had business with the industries in the estate. The inclusion of subjects was carried out with the help of community leaders. A purposive sampling was used to recruit subjects using a screening questionnaire to identify subjects conforming to the following criteria: (1) males and females working and living in the community, (2) age range from 18 to 60 years old, (3) do not work in the industries, (4) are not currently suffering from asthma, tuberculosis, or chronic bronchitis and (5) are pleased to participate in the present study for 63 days with written informed consent. Approximately 150 subjects were screened and, finally, 111 subjects conformed to the present study criteria and voluntarily participated in the present study.

Air pollutants monitoring

The air pollutants were identified as, PM_{10}, NO_2, O_3, CO, VOCs and SO_2. Meteorological conditions were monitored daily for the 63-day study period at the air monitoring station of the PCD at Map Ta Phut primary care unit. Monitoring began on the 20th December 2009 and concluded on the 20th February 2010. The air pollutants were collected on a daily basis at the primary care unit in the community area throughout the present study period.

Symptoms

The subjects were interviewed by the researcher and trained staff daily, using a slightly modified questionnaire (ATS-DLD-78-Adult Questionnaire)[12] consisting of general characteristics, and a daily symptom diary during the 63-day study period. The trained staff were high school students living in the community and they were familiar with those subjects. Each trained staff was responsible for collecting information for 15-20 subjects throughout the present study period. They had to explain the different health symptoms in the diary to each subject during the first few days of the interview, and tried to confirm with the subjects when they reported any symptoms. The daily symptom diary consisted of twelve symptoms which could be categorized into respiratory symptoms (i.e. nose congestion, sore throat, cough, phlegm, wheeze and chest tightness) and other health symptoms (i.e. headache, shortness of breath, fever, eye irritation, dizziness and weakness). The interviewers asked about symptoms on the previous day. The percentage of daily reported symptoms was calculated[13]. If the interviewers did not meet with the subjects on the day of the interview, they would ask the subjects on the next day and report to the daily symptom diary.

Data analysis

The arithmetic and geometric means, median, range and interquartile range (IQR) were used for descriptive statistics. The arithmetic, geometric mean and median (50% percentile) were presented due to the skewed data. The adjusted odds ratios and 95% confidence interval were calculated using binary logistic regression. The assumption of the analysis was that all these pollutants namely, total VOCs, NO_2, O_3, CO and PM_{10} had effects on the health symptoms of people in the communities. To avoid multi-collinearity, all air pollutants could not be put into one model because NO_2 and O_3 were theoretically correlated between them[14,15]. Therefore, the effects of NO_2 and O_3 need to be analyzed separately into two models.

Two models of analysis were used to quantify the effects of the multiple air pollutants, total VOCs, CO, NO_2, O_3 and PM_{10} for 63-d study period. The first model estimated the effects of total VOCs, CO, and O_3 by controlling for gender, age, working duration (h) and PM_{10}. The second model calculated the effect of multiple pollutants using total VOCs, CO and NO_2 by adjusting for gender, age, working duration (h) and PM_{10}.

Results

Characteristics of subjects

One hundred eleven subjects participated in this study; most of them had age ranging from 30 to 39 years old. Most of them (46.8%) had a primary school level or lower, 10.8% had secondary school levels and 10.8% had high school levels of education (Table 1). Most subjects worked as merchants (40.5%) and general employees (27%). No subjects worked in the industries; they worked for 8-12 hours in the communities. Approximately 16% admitted to smoking cigarettes. The subjects were asked about annual physical check-up, fifty-one percent had an annual

Table 1. Characteristics of subjects

General characteristics of subjects (n = 111)	Number	%
Sex		
Male	37	33.3
Female	74	66.7
Age		
18-19	1	0.9
20-29	16	14.4
30-39	39	35.1
40-49	30	27.0
50-60	25	22.5
Education		
Uneducated	6	5.4
Primary school	46	41.4
Secondary school	12	10.8
High school	12	10.8
High and vocational schools	17	15.3
Bachelor's degree	16	14.4
Master degree	2	1.8
Occupation		
Merchant	45	40.5
Housewife	8	7.2
General employee	30	27
Student	5	4.5
Hairdresser	5	4.5
Self employed	11	9.9
Others	7	6.4
Working duration		
≤8 hrs	39	35.1
8.1-12.0 hrs	49	44.1
≥12.1	23	20.7
Smoking		
Yes	18	16.2
No	91	82.0
Ex-smoker	2	1.8
Total	111	100.0

physical check-up and 10% of subjects reported that they had diseases, such as high blood pressure, cancer, high cholesterol and diabetes.

Air pollutants monitoring

The daily 1-hr air pollutants monitored were PM_{10}, SO_2, NO_2, O_3, VOCs and CO during the 63-d study period (Table 2). The arithmetic, geometric means and median (50% percentile) were presented due to the skewed data. The geometric means were used for comparisons with other studies. Most PM_{10} levels were below the Thai standard (120 $\mu g/m^3$)[16] except for the PM_{10} level being 140 $\mu g/m^3$ on the 24th of December, 2010 due to the construction sites in the area. The total VOCs in the communities were monitored because the VOCs may be the cause of health symptoms in people in the communities nearby the petrochemical industries[4]. The 1-hr ambient air quality standard was not available for total VOCs. The CO, O_3, NO_2 and SO_2 levels were all below the national standard[16,17]. The temperature in the communities ranged from 21.4 to 32.7°C with an average temperature of 27.7°C. The relative humidity ranged from 33 to 87% with an average of 68.8%.

Daily symptom frequencies reported

The average daily percentages of subjects reporting symptoms are shown in Table 3. The median (50 percentile) was presented because the data were not normally distributed. The most often reported symptoms were coughing, headache, phlegm, nose congestion, sore throat, and weakness. The least often reported symptoms were chest tightness, wheezing and shortness of breath.

Quantification of effects of air pollutants

The present study investigated twelve respiratory and health symptoms most likely caused by industrial air pollutants, PM_{10}, NO_2, O_3, CO and VOCs. Binary logistic regression was used to quantify the effects of multiple industrial air pollutants. The adjusted odds ratios and 95% confidence interval was

Table 2. Descriptive statistics for 1-hr average air pollutant concentrations at Map Ta Phut health center, Mueng, Rayong

Air pollutants	Day	Mean**		Median	Range	IQR	1-hr standard*[14-15]
		AM	GM				
PM_{10} ($\mu g/m^3$)	63	62.05	59.46	55.33	37.75-140.29	48.29-74.92	120 $\mu g/m^3$ (24-hr)
CO (ppm)	63	0.51	0.46	0.49	0.12-1.14	0.34-0.68	30 ppm
Total VOCs (ppm)	63	2.30	2.29	2.27	1.97-2.98	2.12-2.45	-
O_3 (ppb)	63	27.11	25.79	26.43	11.70-49.96	20.78-32.13	100 ppb
NO_2 (ppb)	63	14.53	13.35	13.35	5.30-30.30	9.39-19.35	170 ppb
SO_2 (ppb)	63	5.99	5.03	5.55	1.17-15.04	2.82-8.57	300 ppb

* Thai ambient air standard
** AM = arithmetic mean; GM = geometric mean

Table 3. The percentage (%) of the daily reported symptoms of subjects (111)

Symptoms	Mean	Median	SD	Range	IQR
Headache	3.77	3.60	3.16	0-11.70	0.90-5.40
Nose congestion	2.76	2.70	1.77	0-6.30	0.90-3.60
Sore throat	2.70	2.70	1.96	0-7.20	0.90-3.60
Cough	4.08	3.60	2.66	0-15.30	1.80-5.50
Phlegm	2.78	2.00	2.47	0-12.60	0.90-4.50
Wheeze	0.62	0.00	0.93	0-4.50	0-0.90
Chest tightness	0.46	0.00	0.68	0-2.70	0-0.90
Shortness of breath	0.63	0.00	1.00	0-3.60	0-0.90
Eye irritation	1.83	0.90	2.29	0-11.70	0-2.70
Dizziness	2.42	1.80	2.48	0-9.00	0-4.50
Weakness	2.66	1.80	2.71	0-13.50	0.90-3.60

estimated for multiple air pollutants, O_3, CO and total VOCs based on a series of daily reported symptoms (Model 1) by controlling for gender, age, working duration (h) and PM_{10} (Table 4). When the level of CO is increased 1 ppm, the adjusted odds ratios increase 3.53 for headache, 7.71 for cough, 4.55 for eye irritation and 3.53 for weakness. In addition, when the level of total VOCs is increased by 1 ppm, the adjusted odds ratios for developing symptoms increase 38.01 for wheezing, 18.63 for shortness of breath, 4.30 for eye irritation and 3.58 for dizziness. Furthermore, with an increase of 1 ppb O_3, the adjusted odds ratio for reported nose congestion, sore throat, phlegm and shortness of breath increases by 1.02, 102, 1.05 and 1.02, respectively. The second model presented the effects of multiple industrial air pollutants, NO_2, CO and total VOCs based on a series of daily reported symptoms by controlling for gender, age, working duration (h) and PM_{10} (Table 5). The adjusted odds ratios of reported symptoms increase to 4.01 for headache, 6.23 for coughing, 7.97 for phlegm and 4.91 for eye irritation with an increase of 1 ppm CO. When total hydrocarbons are increased by 1 ppm, the adjusted odds ratios increase 15.92 for eye irritation. In addition, the adjusted odds ratio

Table 4. The adjusted odds ratio with 95% confidence interval (CI) was estimated for multiple air pollutants, PM_{10}, CO , total VOCs and O_3 on a series of daily reported symptoms (Model 1). The results are controlled for gender, age, working duration (hr) and PM_{10}

Symptoms	CO OR (95%CI)	Total VOCs OR (95%CI)	O_3 OR (95%CI)
Headache	3.53 (1.39-8.96)*	2.29 (0.81-6.42)	1.010 (0.20-1.03)
Nose congestion	2.61 (0.88-7.77)	1.66 (0.47-5.85)	1.020 (1.00-1.04)*
Sore throat	2.15 (0.72-6.41)	2.47 (0.71-8.63)	1.020 (1.00-1.04)*
Cough	7.71 (2.57-23.14)*	0.83 (0.23-2.98)	1.000 (0.98-1.02)
Phlegm	1.11 (0.11-11.02)	4.66 (0.36-60.39)	1.050 (1.00-1.09)*
Wheeze	6.73 (0.57-79.45)	38.01 (2.65-546.12)*	1.030 (0.99-1.07)
Chest tightness	2.69 (0.32-22.70)	2.38 (0.24-24.16)	1.025 (0.99-1.07)
Shortness of breath	3.40 (0.91-12.68)	18.63 (4.45-78.00)*	1.020 (1.00-1.05)*
Eye irritation	4.55 (1.41-14.65)*	4.30 (1.14-16.26)*	1.000 (0.98-1.02)
Dizziness	2.52 (0.83-7.63)	3.58 (1.04-12.35)*	1.010 (0.99-1.03)
Weakness	3.53 (1.39-8.96)*	2.29 (0.81-6.42)	1.010 (0.20-1.03)

* significant at $p<0.05$

Table 5. The adjusted odds ratio with 95% confidence interval (CI) was estimated for multiple air pollutants, PM_{10}, CO, total VOCs and NO_2 on a series of daily reported symptoms (Model 2). The results are controlled for gender, age, working duration (hr) and PM_{10}

Symptoms	CO OR (95%CI)	Total VOCs OR (95%CI)	NO_2 OR (95%CI)
Headache	4.01 (1.47-10.94)*	1.98 (0.54-7.29)	1.00 (0.93-1.06)
Nose congestion	2.34 (0.71-7.70)	0.53 (0.11-2.63)	1.05 (0.97-1.13)
Sore throat	1.86 (0.56-6.20)	0.59 (0.12-2.94)	1.07 (0.99-1.15)
Cough	6.23 (2.27-17.07)*	0.43 (0.11-1.731)	1.06 (0.99-1.12)
Phlegm	7.97 (2.50-25.48)*	0.81 (0.17-3.90)	1.00 (0.93-1.08)
Wheeze	0.64 (0.05-9.22)	0.22 (0.01-7.65)	1.16 (0.98-1.37)
Chest tightness	4.98 (0.33-75.17)	5.54 (0.17-176.81)	1.10 (0.93-1.29)
Shortness of breath	4.12 (0.04-41.30)	1.89 (0.98-1.03)	0.98 (0.84-1.14)
Eye irritation	4.91 (1.19-20.28)*	15.92 (2.69-94.14)*	0.98 (0.90-1.07)
Dizziness	3.09 (0.87-10.98)	1.74 (0.33-9.27)	1.06 (0.98-1.15)
Weakness	1.38 (0.40-7.74)	0.65 (0.13-3.28)	1.11 (1.03-1.20)*

* significant at $p<0.05$

increases 1.11 for weakness with an increase of 1 ppb NO_2.

Discussion

Map Ta Phut Industrial Estate was established in 1988 following the government policy to be the biggest petrochemical complex in Thailand[18]. Currently, Map Ta Phut produces substantial amounts of petrochemicals, chemical products, steel and oil refineries. As the rapid development and expansion of Map Ta Phut went on, the impact upon people's health also increased, including problems with air quality, water, quality of life, etc. Finally, the government declared Map Ta Phut and the nearby areas as pollutant control areas in May 2009. An action plan for pollutant reduction and mitigation has been underway[18]. This current study collected data from the 20 December 2009 to 10 February 2010 in the winter season. The wind blew from the south to the area; the wind blew pass through the industrial estate to the community. The community people would expose to VOCs and other pollutants from the industrial estate. The temperature in the community areas ranged from 21.4 to 32.7°C with an average temperature of 27.7°C. The relative humidity ranged from 33 to 87% with an average of 68.8%.

Most subjects (56.9%) had low education levels from being completely uneducated up to primary and secondary schools. Merchants made up 40.5%; they operated small shops, were self-employed and sold a number of different things consumed by the local people and industrial estate workers. With regard to general employees, they worked as laborers depending upon the needs of employers in the community. If they had higher education, they could get work in the industries. During the period of the present study, the Map Ta Phut Industrial Estate and the area nearby had already become a pollution control area. Most industries have many corporate, social responsibility programs in order to share resources, support health promotion and the general welfare of the people in the communities. This research may encounter selection bias because some subjects are reluctant to participate in the research because of long duration of data collection. Some who are serious with the VOC emissions from the industries refuse to be part of the present study. In the present study design at the beginning, the study intended to recruit only non-smokers without chronic diseases, who worked and lived in the community, but could not get enough subjects to participate. Finally, smoker-subjects (16.2%) were recruited in the present study.

The present study used only one air monitoring station at Map Ta Phut primary care unit. Measuring personal exposure of petrochemical air pollutants of individual subject was not possible due to high cost and difficulty. Misclassification of exposure was the limitation of the study. The subjects in the same area were assumed to be exposed to the same concentration of multiple pollutants each day. The sources of air pollutants may come from emissions of the petrochemical industries and traffic related air pollutants. The levels of air pollutants in the communities, CO, total VOCs, O_3, SO_2, NO_2, and PM_{10} were primarily below the Thai standard. The concentration of SO_2 was low because of industries having to use coal containing less sulfur as a source of fuel in industrial processes. This gas can be changed into sulfide or sulfate at high humidity and it can also incorporate into particulate matter[19]. The CO may come from any burning or igniting of chemicals experiencing incomplete combustion. The geometric means of SO_2 (5.03 ppb), NO_2 (13.35 ppb) and PM_{10} (59.46 $\mu g/m^3$) in this current study were lower than those of SO_2 (10.60 ppb), NO_2 (17.43 ppb) and PM_{10} (93.57 $\mu g/m^3$) in the petrochemical polluted area in Taiwan[9]. When comparing between the air pollutants in the petrochemical polluted area in Rayong and the traffic polluted area in Bangkok, the average level of SO_2 was similar. The average level of CO (0.51 ppm), NO_2 (14.53 ppb) and VOCs (2.3 ppb) in the industrial, polluted area in Rayong was considerably lower than the average CO (1.43 ppm), NO_2 (52.58 ppb) and VOCs (3.54 ppm) in the traffic-polluted areas in Bangkok[13]. It can be seen that the people who live or work close to the industrial polluted area are exposed to lower air pollutants than those in the traffic-polluted area, but the chemical compositions in the traffic-polluted area may be different from the petrochemical polluted area. The toxicity of chemicals depends on types and composition of chemicals.

A daily symptom diary for each subject was used to report acute symptoms everyday for 63 days. They were asked by the trained staff about the symptoms experienced the previous day. The subjects who reported more symptoms continued to report more symptoms every day, whereas the subjects who reported fewer symptoms reported less. The average daily reported symptoms were used to compare with the daily concentrations of mixed industrial pollutants on each day for the 63 days of the study period. The daily reported symptoms of cough (4.08), phlegm (2.78) and wheezing (0.62) in this current study were quite

low when compared with reported symptoms of cough (11.2), phlegm (10.8), wheezing (6.70) in the petrochemical polluted area in Taiwan[9] or with reported symptoms of cough (7.10), phlegm (22.36) in the traffic-polluted area in Bangkok[13]. The lower reported symptoms of people in the communities may have resulted from becoming accustomed to or building up a tolerance for industrial air pollutants after having lived in this area for so many years or the lower level of air pollutants in the present study.

The pollutants having associated adverse health effects was put into the model together with other confounding factors. The confounding by population characteristics was neglible because subjects served as their own control[20]. The first model included O_3, CO and total VOCs by controlling for gender, age, working duration (h) and PM_{10}. Significant associations between petrochemical air pollutants and health effects were found, including total VOCs with wheezing, shortness of breath, eye irritation and dizziness. CO showed significant association with headache, cold, cough, eye irritation and weakness and O_3 demonstrated a relationship with nose congestion, sore throat and phlegm. Wheezing was scarcely reported by the subjects.

In the second model, O_3 was replaced by NO_2; consequently, the effect of CO was slightly different from the first model. The effect of CO was significantly associated with headache, cough and eye irritation the same as in the first model, but the effect of weakness was not significant in the second model. Moreover, the effect of CO was also significantly associated with phelgm in the second model. Total VOCs were associated with only eye irritation at very high odds raito (15.92). The odds ratio of NO_2 with weakness was very low (1.11). When study the effects of several pollutants at the same time, VOCs, CO, O_3, NO_2 and PM_{10}, the errors of multi-collinearity may encounter. The NO_2 and VOCs were the precursor of O_3[14,15]. In urban air, NO_2 can photolysis to NO and atomic oxygen; the atomic oxygen reacts with oxygen to form O_3. However, fresh nitric oxide (NO) from vehicles' combustion reacts with O_3 to form NO_2 lead to ozone removal[14,15]. The main sources of air pollutants in the Map Ta Phut Industrial Estate come from petrochemical industries and traffic in the area. If unexpected situation occurr in Map Ta Phut industrial estate, such as chemicals leakage, fire and explosion of chemicals; the VOC levels will be much higher concentration than the results in the current study. The reported accute health effects will be more serious. When compared the results of the present study with other studies, the EPA did a study in six communities in different parts of the United States, and found that the VOCs were ten times higher indoors than those outdoors, including areas with petrochemical plants as air pollution sources of VOCs[21]. The current study gave similar results with the EPA study; the symptoms of VOCs-exposed subjects included eye and upper respiratory irritation, nasal congestion, headache, shortness of breath, nausea, and vomiting. When subjects are exposed to CO, symptoms may include fatigue, headache, dizziness, nausea, vomitting, cognitive impairment and tachycardia[21]. Yang et al (1997) studied the repiratory and health effects of a population living in a petrochemical-polluted area in Taiwan and found similar acute symptoms including eye irritation, nausea, throat irritation and chemical odor were reported at a significantly higher rate in the exposed area than in the control area[9].

The results of the present study showed that the petrochemical air pollutants were harmful to populations in the close proximity of the industrial estate. The health risk may be more serious in the vulnarable groups such as children, elderly, pregnant women and unborn child. This information will be useful for decision-makers to plan to reduce the emissions especially cancer causing agents from these industries. The stack emission control for cancer causing agents should help reduce the toxicity of industrial polluted area.

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Potential conflicts of interest

None.

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ผลต่อสุขภาพของประชาชนที่อาศัยอยู่ใกล้นิคมอุตสาหกรรมปิโตรเคมีในประเทศไทย

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วัตถุประสงค์: การประเมินผลต่อสุขภาพแบบเฉียบพลันของประชาชนที่อาศัยอยู่ใกล้นิคมอุตสาหกรรมปิโตรเคมี ในประเทศไทยโดยใช้การศึกษาแบบพาเนล (Panel study)

วัสดุและวิธีการ: ประชาชนที่ประกอบอาชีพและอาศัยอยู่ในชุมชนใกล้นิคมอุตสาหกรรมปิโตรเคมีได้รับการคัดเลือกเข้ามาเป็นกลุ่มตัวอย่างในการศึกษา ทำการเก็บข้อมูลความเข้มข้นของระดับมลพิษรายวัน สอบถามอาการของระบบทางเดินหายใจและอาการอื่นๆ ของกลุ่มตัวอย่างรายวันเป็นเวลา 63 วัน คำนวณอัตราความเสี่ยงของประชากร (adjusted odds ratios) ที่รายงานอาการเฉียบพลันต่อสุขภาพจากการรับสัมผัสมลพิษอากาศ ที่ความเชื่อมั่น 95 เปอร์เซ็นต์ โดยใช้สมการถดถอยพหุคูณแบบสองทาง (Binary logistic regression)

ผลการศึกษา: พบความสัมพันธ์อย่างมีนัยสำคัญทางสถิติที่อัตราความเสี่ยงของประชากรเป็น 38.01 สำหรับหายใจ มีเสียงหวีด 18.63 สำหรับหายใจขัด 4.30 สำหรับการระคายเคืองตาและ 3.58 สำหรับอาการมึนงงจากการรับสัมผัสสารอินทรีย์ระเหย อัตราความเสี่ยงของประชากรของการรับสัมผัสคาร์บอนมอนนอกไซด์เป็น 7.71 สำหรับอาการไอ 4.55 สำหรับการระคายเคืองตาและ 3.53 สำหรับความอ่อนแอและอัตราความเสี่ยงของประชากรสำหรับโอโซนเป็น 1.02 สำหรับอาการเจ็บคอและ 1.05 สำหรับการมีเสมหะ

สรุป: ผลการศึกษาแสดงว่าประชาชนที่อาศัยอยู่ใกล้นิคมอุตสาหกรรมปิโตรเคมีได้รับผลแบบเฉียบพลันต่อสุขภาพได้แก่ หายใจขัด การระคายเคืองตา อาการมึนงง อาการไอ เจ็บคอ และความอ่อนแอจากการรับสัมผัสมลพิษอากาศจากอุตสาหกรรม