Health Burden Relating To Exposure To Ambient Air Pollution In Vietnam: Sciences Evidence For Policy

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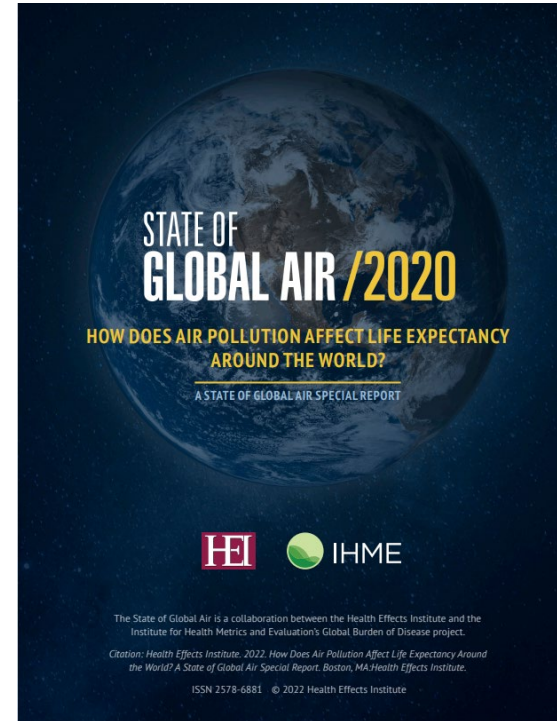
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Health burden of air pollution

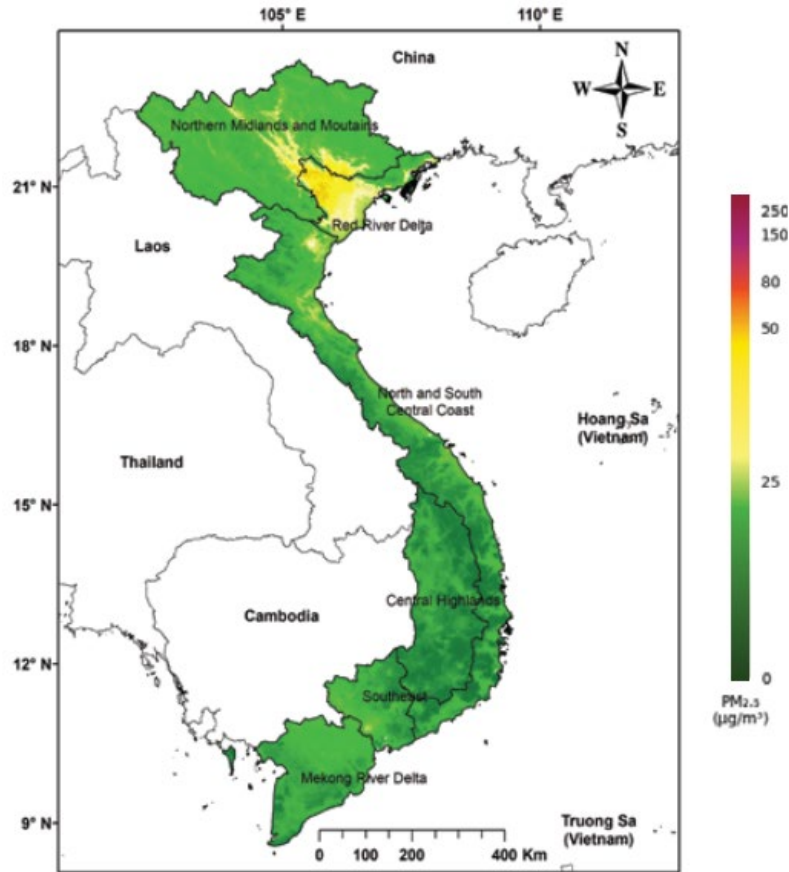Globally, approximately 100% and 92% of people living in areas with $PM_{2.5}$ and O_3 exceed WHO recommendations ($5\mu g/m^3$ and $60\mu g/m^3$, respectively). (HEI, 2022)

About 1.8 years of human life was reduced due to air pollution worldwide, including $PM_{2.5}$ and O_3 (HEI, 2022).

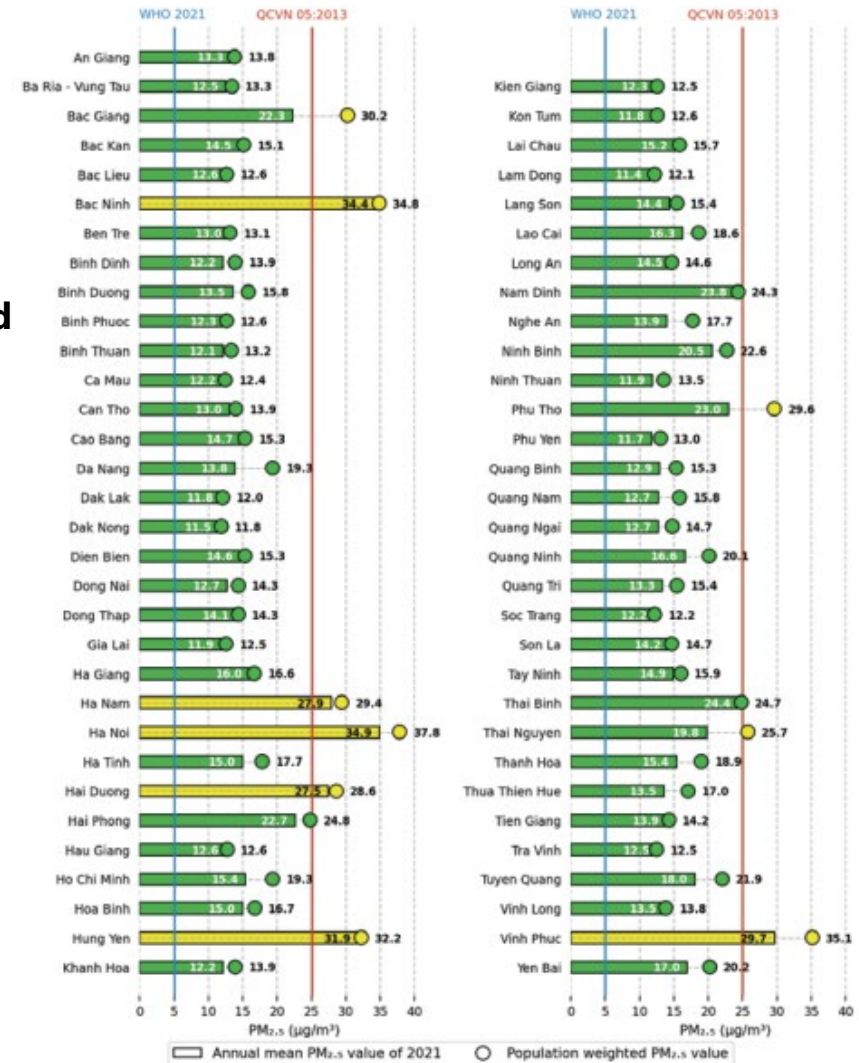➔ **This is an urgent call for clean air action plan from the Vietnamese government**

Air pollution in Vietnam

Annual mean of PM$_{2.5}$ concentration in 2021

In 2021, there were 6 provinces/cities exceeded the QCVN 05:2013 (25µg/m³).

No province or city met the WHO air quality guidelines (5µg/m³).

Mean of PM$_{2.5}$ concentration and population-weighted PM$_{2.5}$ concentration by province in 2021

Vietnamese air quality standard and WHO guidelines

		QCVN 05:2013 (µg/m³)	WHO air quality guidelines (2005) (µg/m³)	WHO air quality guidelines (2021) (µg/m³)
$PM_{2.5}$	Annual average	25	10	5
	24-hour average	50	25	15
PM_{10}	Annual average	50	20	15
	24-hour average	150	50	45
O_3	8-hour average	120	100	100
NO_2	Annual average	40	40	10
	24-hour average	–	–	25
SO_2	24-hour average	–	20	40
CO	24-hour average	–	–	4

Vietnamese policies for air quality management

- In 2013, National Technical Regulation on Ambient Air quality was born (denoted as **QCVN 05:2013**).

- In 2016, government issued **Decision No 985a/QĐ-TTg**: "National Action Plan on air quality management by 2020 including a vision for 2025"
    - Focusing on emissions control and ambient air quality monitoring

- In 2021, many legal documents was born:
    - **Directive No 03/CT-TTg** on enhancing air quality management.
    - **Decision No 1973/QĐ-TTg** "National Action Plan on air quality management during 2021-2025". This document enhanced the previous goal and focus on research to provide information via early warning system.
    - **The Official Dispatch No 3051/BTNMT-TCMT** on the technical guidelines of building air management plan at provincial level ➔ Emphasized the important of Health Impact Assessment of air pollution and recommended using AirQ+
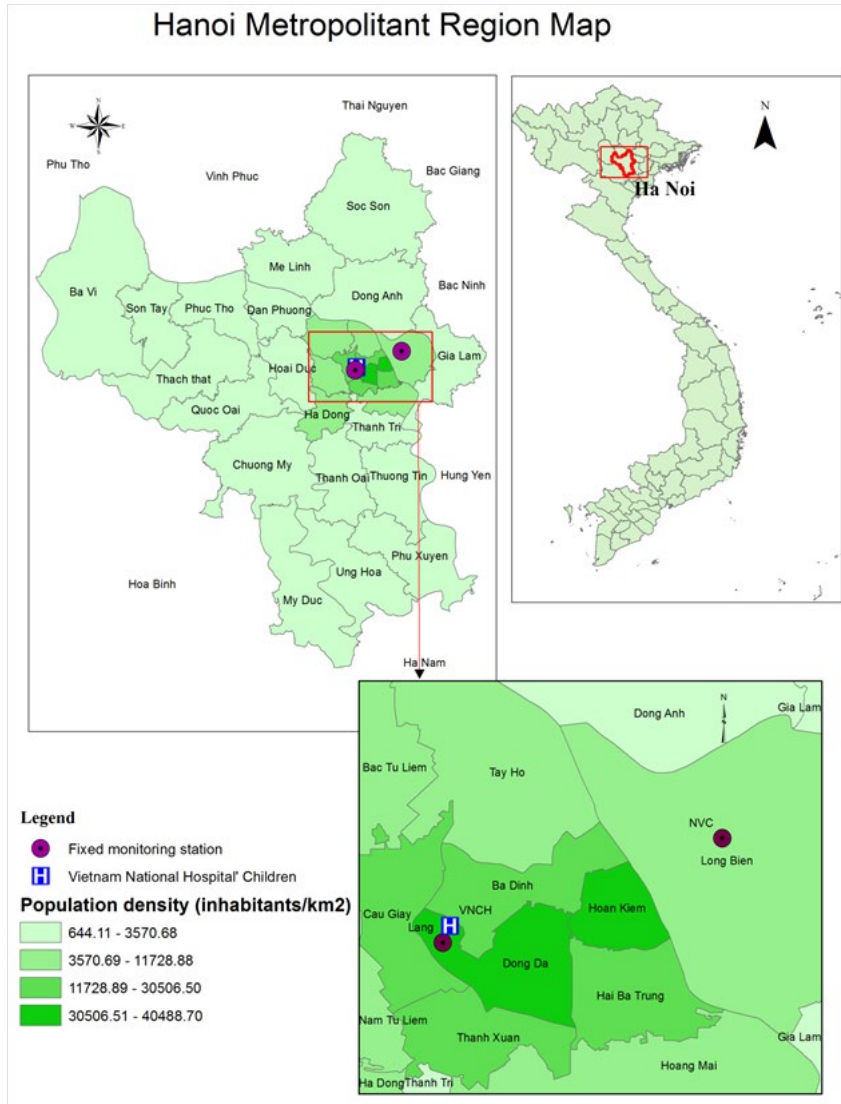
Health effects of air pollution –
The primary evidence

RESEARCH REPORT

HEALTH EFFECTS INSTITUTE

Number 169
June 2012

Effects of Short-Term Exposure to Air Pollution on Hospital Admissions of Young Children for Acute Lower Respiratory Infections in Ho Chi Minh City, Vietnam

HEI Collaborative Working Group on Air Pollution, Poverty, and Health in Ho Chi Minh City (Le Truong Giang, Long Ngo, Sumi Mehta, et al.)

- Published in 2012
- Increase in ambient PM_{10}, NO_2, and SO_2 in dry season (November-April) was associated with ALRI admissions for young children.

Health effects of air pollution –
Respiratory hospitalization among children in Hanoi

Hanoi Metropolitant Region Map

Legend
- Fixed monitoring station
- Vietnam National Hospital' Children

Population density (inhabitants/km2)
- 644.11 - 3570.68
- 3570.69 - 11728.88
- 11728.89 - 30506.50
- 30506.51 - 40488.70

Data source

Health data:
- Vietnam National Children's hospital
- 2007 - 2014

Monitoring station data:
- Air pollutant (NVC, LH)
- Meteorological data (BV, L, ST, HD)

Health endpoint:
- Pneumonia (J12 – J18)
- Bronchitis and asthma (J20, J21, J45)

Main findings

| An IQR increase:	PM$_{10}$	PM$_{2.5}$	PM$_1$	NO$_2$	NO$_x$
Pneumonia (0-17):	▲5.8%	▲5.3%	▲5.7%	▲6.1%	▲4.6%
Bronchitis and asthma (0-17):	–	–	▲5.8%	▲5.5%	▲5,6%

Acute effects of ambient air pollution on lower respiratory infections in Hanoi children: An eight-year time series study

Nguyen Thi Trang Nhung[a,b,c,*], Christian Schindler[a,b], Tran Minh Dien[d], Nicole Probst-Hensch[a,b], Laura Perez[a,b,1], Nino Künzli[a,b]

[a] *Swiss Tropical and Public Health Institute, Basel, Switzerland*
[b] *University of Basel, Basel, Switzerland*
[c] *Hanoi University of Public Health, Hanoi, Viet Nam*
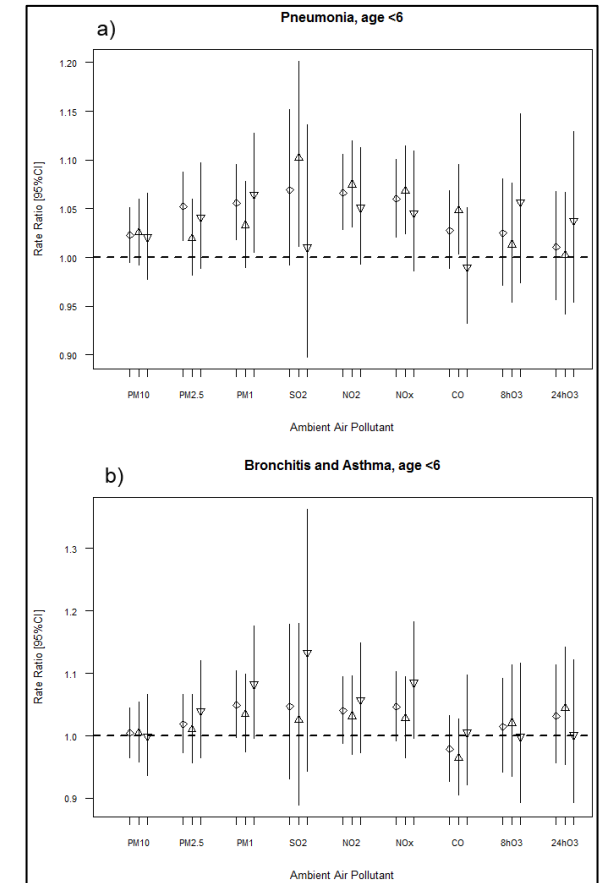[d] *Vietnam National Children's Hospital, Hanoi, Viet Nam*

Health effects of air pollution –
Respiratory hospitalization among children in Ha Noi
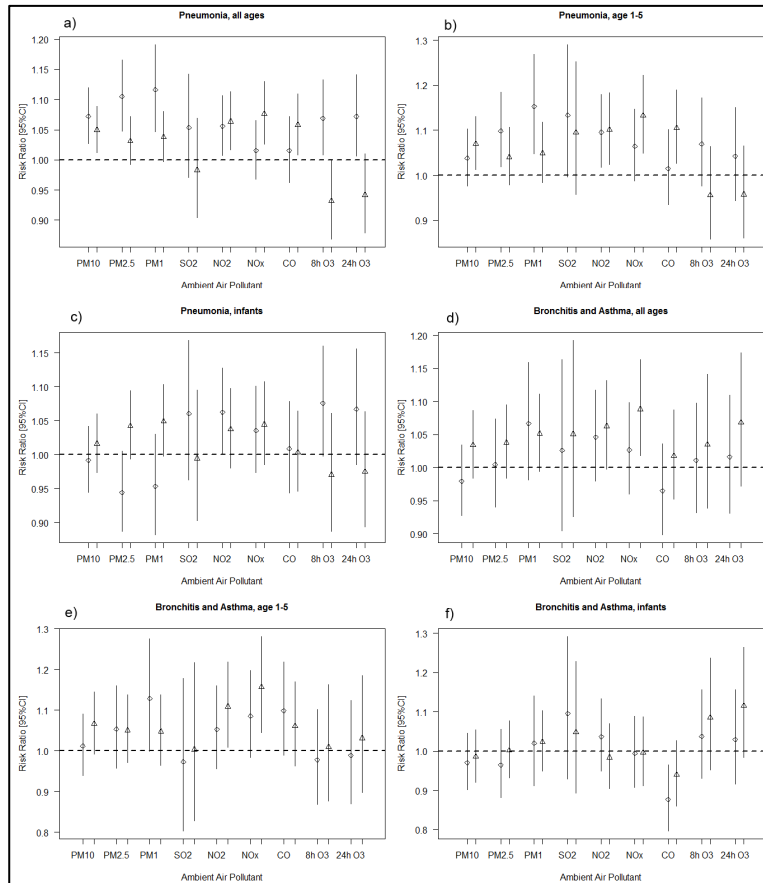
Season–specific risk ratios per interquartile range increase in the seven-day moving average ambient air pollutant concentrations (lag 0–6)
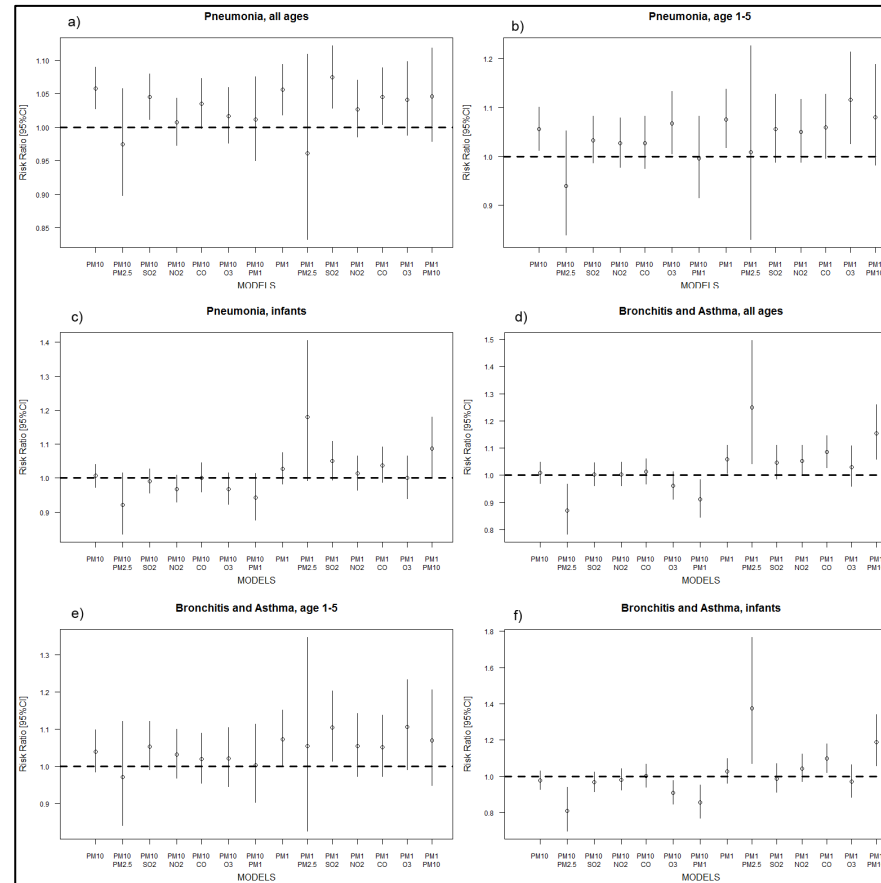
Two pollutant model

Gender-specific risk ratios (with 95%-confidence intervals) per interquartile range of ambient air pollutants for a) Pneumonia in children age < 6 and b) Bronchitis and asthma at age < 6, Hanoi.

Health effects of air pollution –
Length of hospital stay due to respiratory diseases of children in Ha Noi

Main findings

	0-5	0-1	2-5
PM$_{10}$	–	–	▼6%
PM$_{2.5}$	–	–	–
PM$_1$	–	–	–
SO$_2$	▲6.9%	▲9.5%	–
NO	▲2.6%	–	–
NO$_2$	–	–	–
NO$_x$	–	–	–
CO	▲3.1%	▲2.8%	–
O3	▼5.0%	▼5.0%	–

% change of odds of LOS per an IQR increase of air pollutant from lag 1-4

Association of ambient air pollution with lengths of hospital stay for hanoi children with acute lower-respiratory infection, 2007−2016☆

Nguyen Thi Trang Nhung [a, b, c, *], Christian Schindler [a, b], Tran Minh Dien [d], Nicole Probst-Hensch [a, b], Nino Künzli [a, b]

[a] *Swiss Tropical and Public Health Institute, Basel, Switzerland*
[b] *University of Basel, Basel, Switzerland*
[c] *Hanoi University of Public Health, Hanoi, Viet Nam*
[d] *Vietnam National Children's Hospital, Hanoi, Viet Nam*

Check for updates

Data source

Health data:
- Vietnam National Children's hospital
- 2007 - 2016

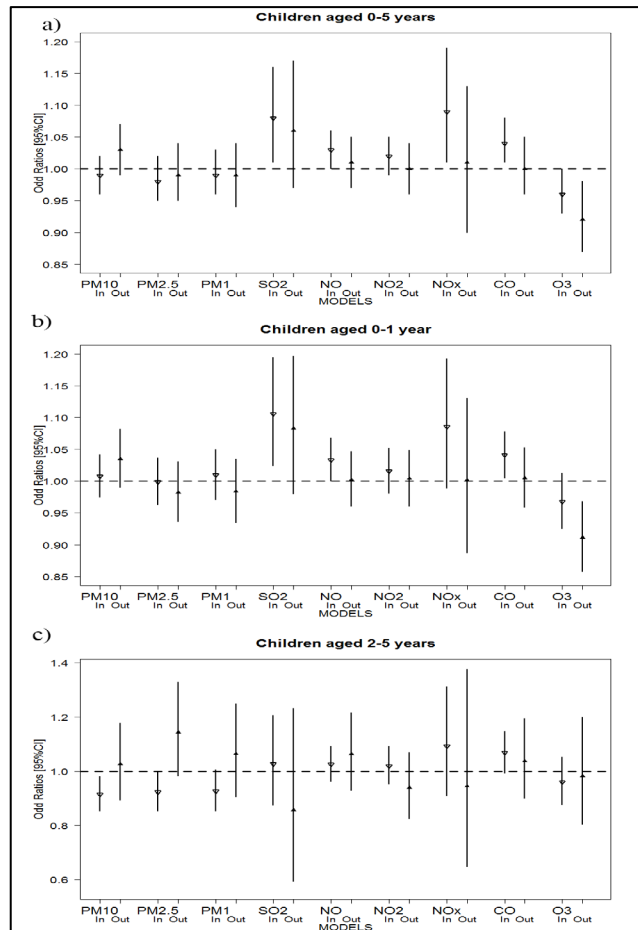**Monitoring station data:**
- Air pollutant (NVC, LH, USE)
- Meteorological data (BV, L, ST, HD)

Health endpoint:
- *LOS of acute lower respiratory infection* = Pneumonia (J12 – J18) + Bronchitis (J20, J21)
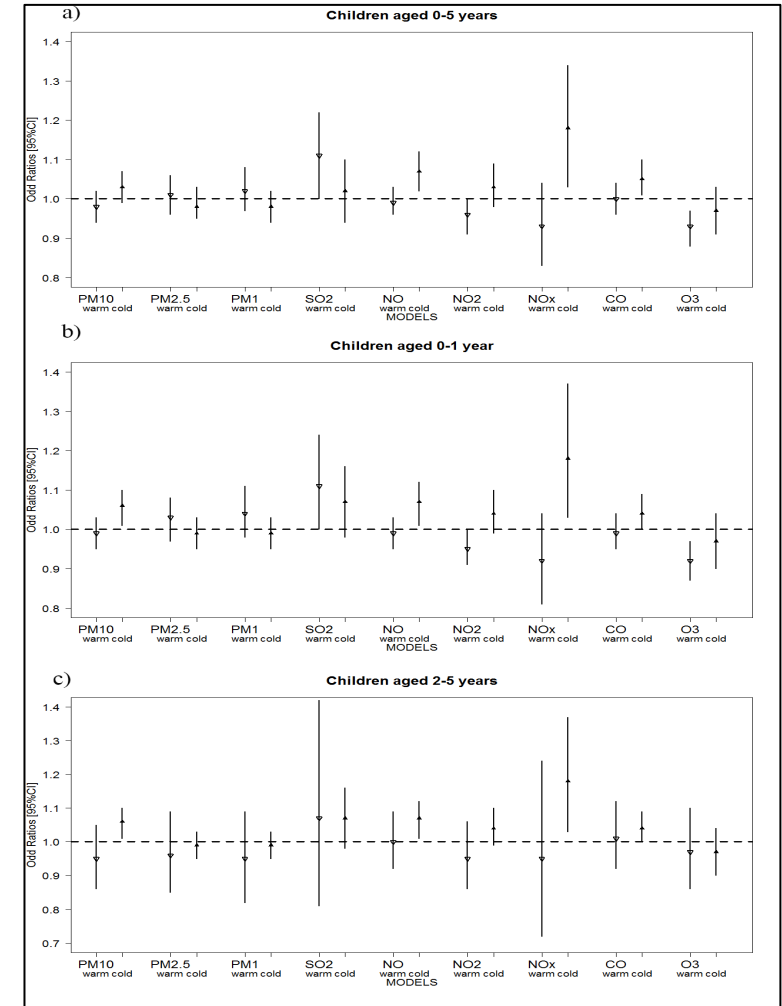
Health effects of air pollution –
Length of hospital stay due to respiratory diseases of children in Ha Noi

Odd ratios of being discharged from hospital per interquartile range increments in 4-day mean levels of different pollutants prior to admission among children from Hanoi hospitalized for acute lower respiratory between 2007 and 2016 by area of residence: (Inner and outer city)
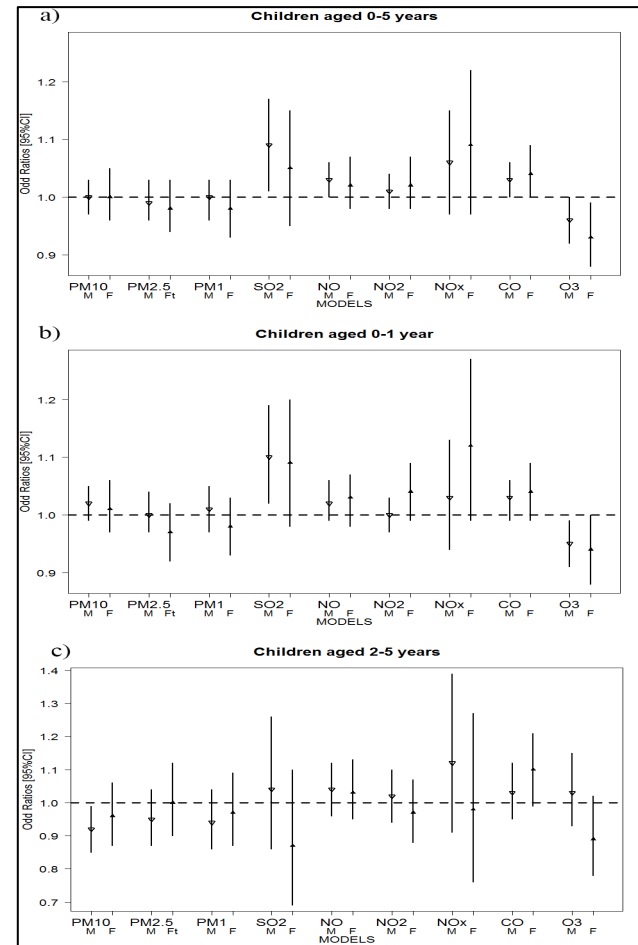
Gender-specific odd ratios of being discharged from hospital per interquartile range increment in 4-day mean levels of different pollutants among children from Hanoi hospitalized for acute lower respiratory infection between 2007 and 2016

Odd ratios of being discharged from hospital per interquartile range increment in 4-day mean levels of different pollutants prior to admission among Hanoi children hospitalized for acute lower respiratory between 2007 and 2016 by season

Health effects of air pollution –
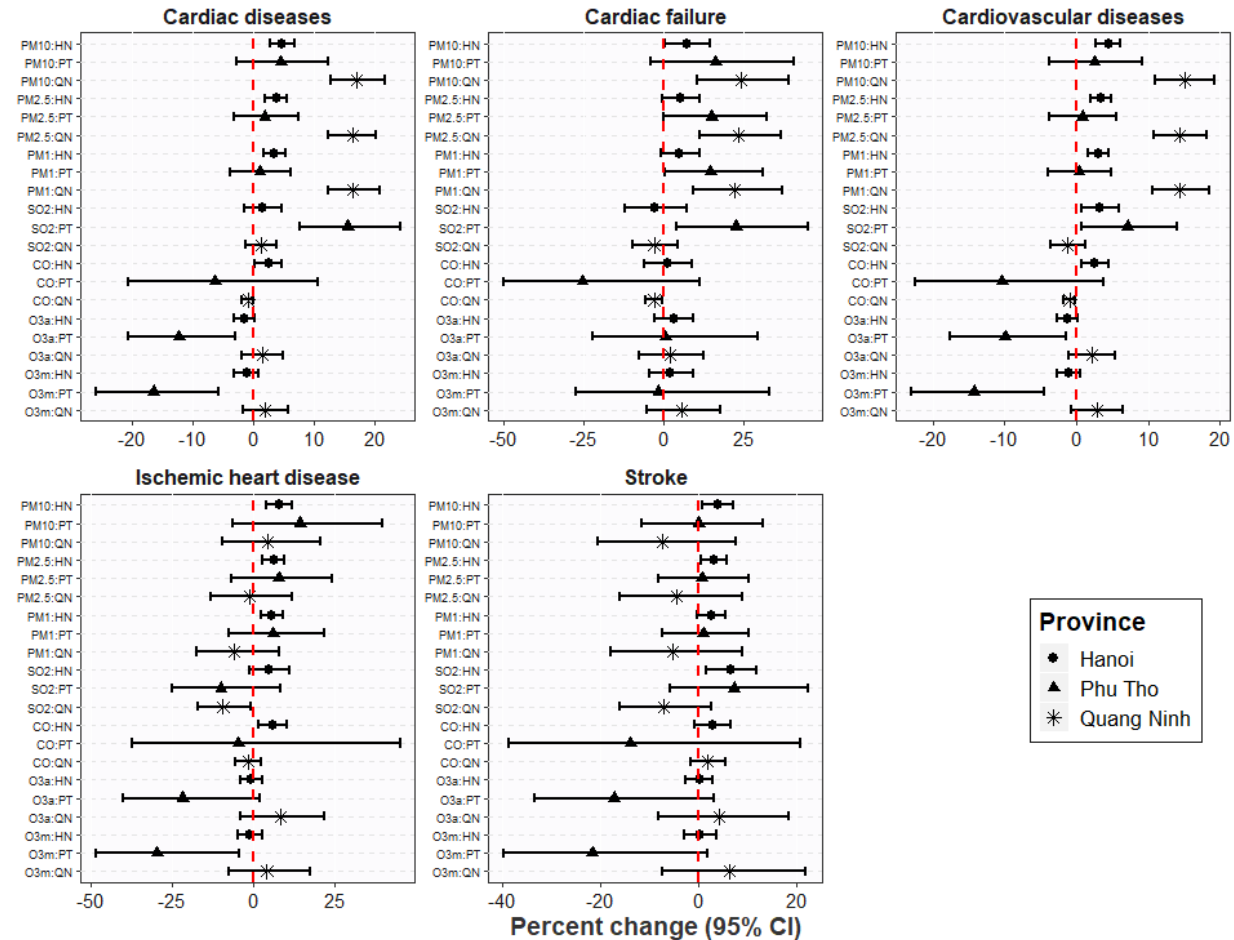## *Cardiovascular admission among adults in Ha Noi, Phu Tho, and Quang Ninh*

Exposure to air pollution and risk of hospitalization for cardiovascular diseases amongst Vietnamese adults: Case-crossover study

Nguyen Thi Trang Nhung [a,b,c,*], Christian Schindler [b,c], Ngo Quy Chau [d], Phan Thi Hanh [d], Le Tu Hoang [a], Tran Minh Dien [e], Nguyen Thi Nhat Thanh [f], Nino Künzli [b,c]

[a] Hanoi University of Public Health, Hanoi, Viet Nam
[b] Swiss Tropical and Public Health Institute, Basel, Switzerland
[c] University of Basel, Basel, Switzerland
[d] Bach Mai Hospital, Hanoi, Viet Nam
[e] Vietnam National Children's Hospital, Hanoi, Viet Nam
[f] University of Engineering and Technology, Vietnam National University, Hanoi, Viet Nam

Data source

Health data:
- Hospitals from Ha Noi (2011-2016), Phu Tho (2013-2015), and Quang Ninh (2014-2016)

Monitoring station data:
- Air pollutant (NVC, LH, USE)
- Meteorological data (BV, L, ST, HD)

Health endpoint:
- **CVD** (I00-I99)
- **Cardiac diseases** (I00-I059, I97.1, I98.1)
- **Cardiac failure** (I50)
- **IHD** (I20, I21, I22, I24, I25.2)
- **Stroke** (I60-I66, I67 (except I67.0, I67.3), I68 (except I68.0), I69))

Associations between hospital admissions and ambient air pollutants in Hanoi (2011-2016), Phu Tho (2013-2015) and Quang Ninh (2014-2016)

Health effects of air pollution –
Cardiovascular admission among adults in Ha Noi , Phu Tho, and Quang Ninh
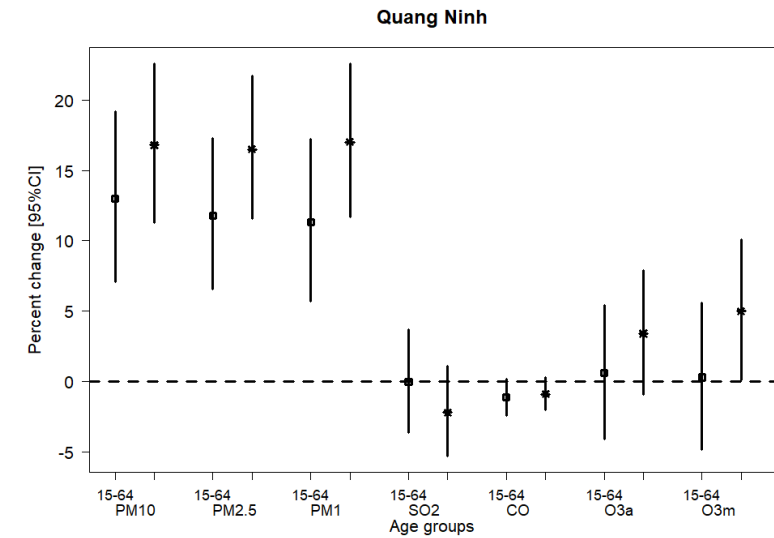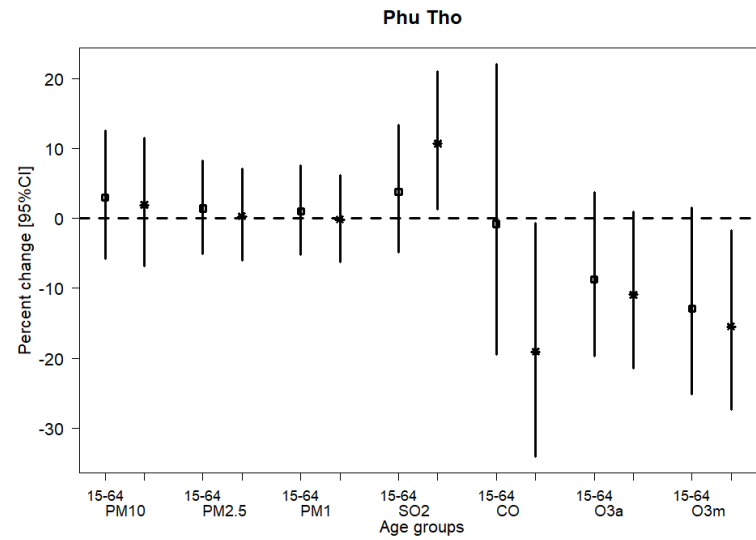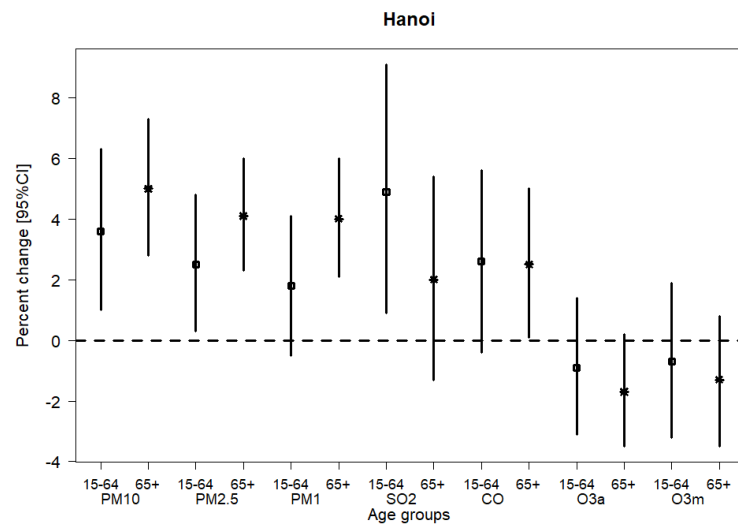
Age-specific risks (expressed as percent change) and 95% confidence interval (bar) in the odds of hospital admissions for cardiovascular diseases per interquartile range (IQR) increase in mean concentrations of ambient air pollutants on the two days before admission among adults (age 15+) in Hanoi (2011–2016), Phu Tho (2013–2015) and Quang Ninh (2014–2016).*

Health burden of air pollution –
Mortality attributed to PM2.5 in Ha Noi, 2017
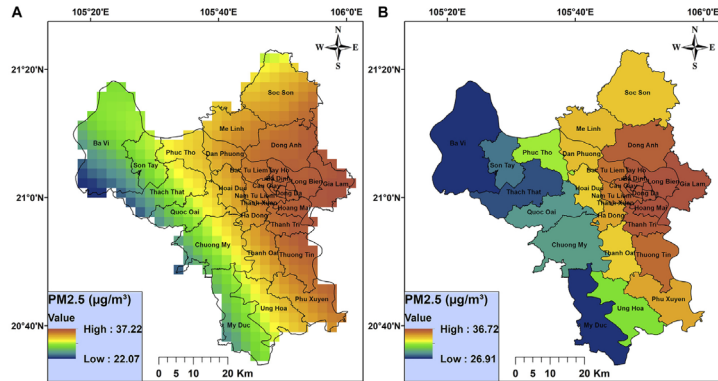
Annual average fine particulate matter concentration map at (A) 3 × 3 km resolution and (B) district level (Hanoi, Vietnam, 2017

Attributable deaths and years of life lost were highest in Dong Da. Loss of life expectancy were highest in Gia Lam.

Mortality Burden due to Exposure to Outdoor Fine Particulate Matter in Hanoi, Vietnam: Health Impact Assessment

Nguyen T. T. Nhung[1,2]*, Edward Jegasothy[3,4], Nguyen T. K. Ngan[1†], Ngo X. Truong[5], Nguyen T. N. Thanh[5], Guy B. Marks[4] and Geoffrey G. Morgan[3,4]

[1]Biostatistics Department, Hanoi University of Public Health, Hanoi, Vietnam
[2]Training and Research Institute for Child Health, Vietnam National Children's Hospital, Hanoi, Vietnam
[3]Sydney School of Public Health and University Centre for Rural Health, Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia
[4]Centre for Air Pollution, Energy and Health Research, University of New South Wales, Sydney, NSW, Australia
[5]University of Engineering and Technology, Vietnam National University, Hanoi, Vietnam
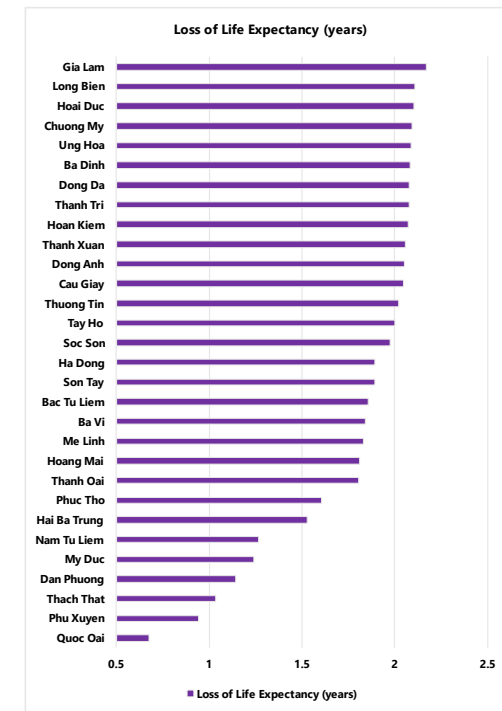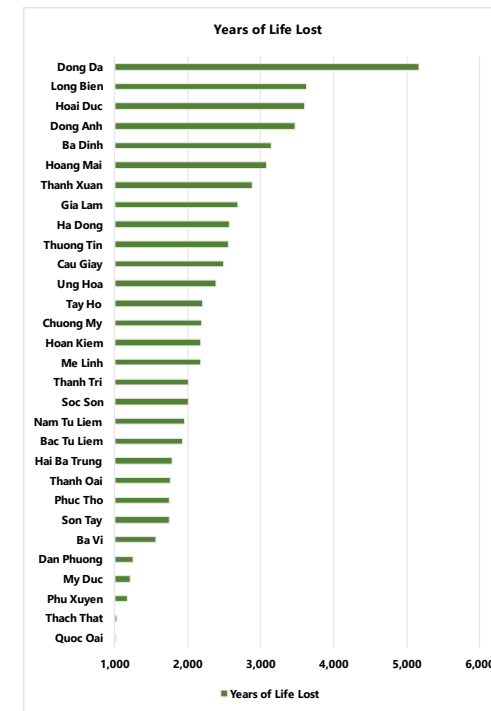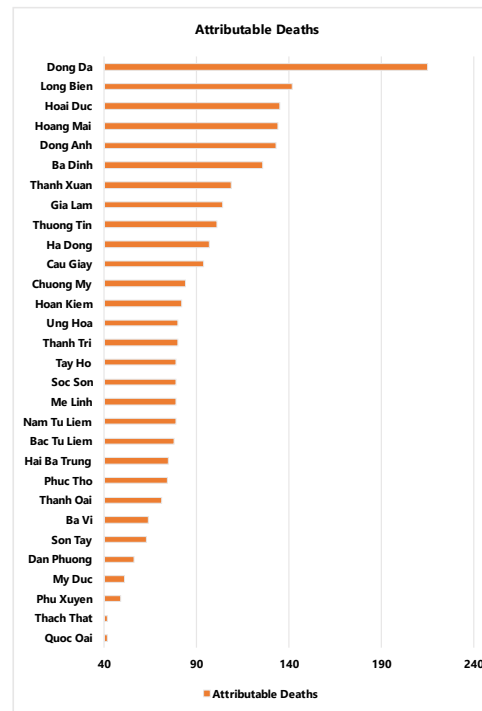
The annual burden of mortality relating to exposure to fine particulate matter (Hanoi, Vietnam. 2017). Counterfactual level is the QCVN 05:2013 (25 µg/m³)

Health burden of air pollution –
Mortality attributed to PM$_{2.5}$ in 11 Vietnamese provinces, 2019

Mortality benefits of reduction fine particulate matter in Vietnam, 2019

Nguyen Thi Trang Nhung,[1,2,*] Vu Tri Duc,[2] Vo Duc Ngoc,[2] Tran Minh Dien,[2] Le Tu Hoang,[1] Tran Thi Thuy Ha,[3] Pham Minh Khue,[3] Ngo Xuan Truong,[4] Nguyen Thi Nhat Thanh,[4] Edward Jegasothy,[5] Guy B. Marks,[5,6] and Geoffrey Morgan[5,6]
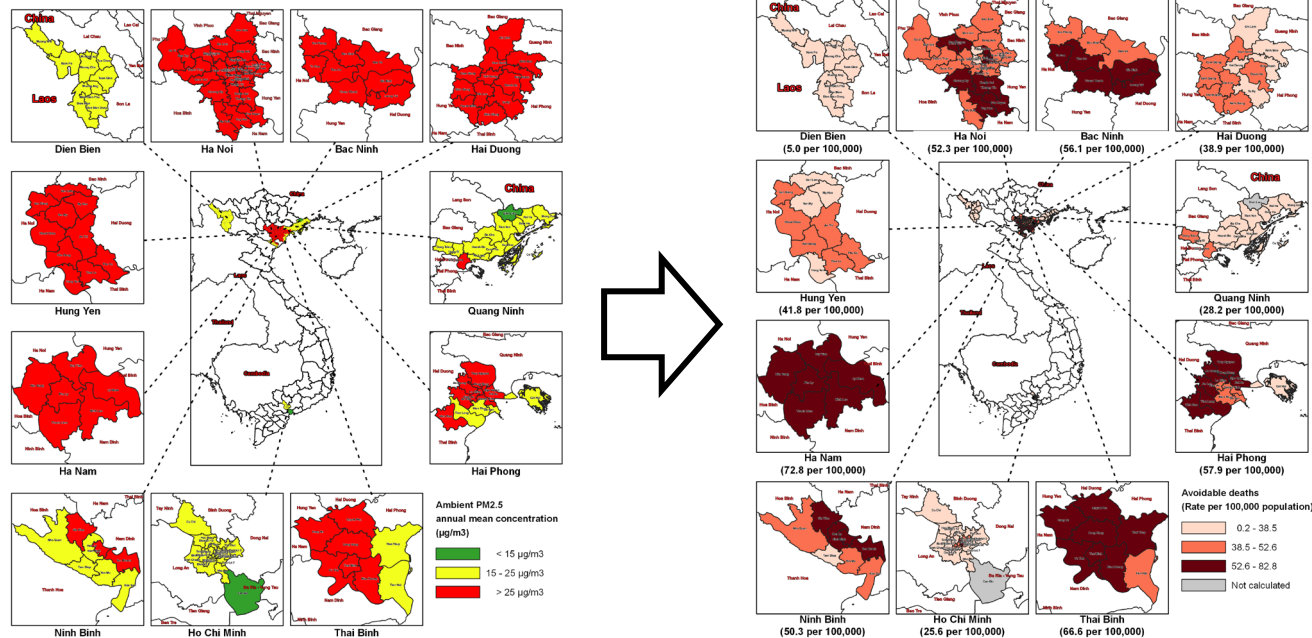
PM$_{2.5}$ concentrations by districts in the 11 study region provinces of Vietnam, 2019

Attributable deaths (expressed in rate per 100,000 population) by districts in 11 provinces in Vietnam due to PM$_{2.5}$ concentrations above the proposed QCVN (15 µg/m3) 2019.

Attributable deaths (rate per 100,000) between the calculation by Log–linear model in AirQ+ and the calculation by GEMM for each province.

Province's name	Attributable deaths (Rate per 100,000 population) by Log-linear model in AirQ+	Attributable deaths (Rate per 100,000 population) by GEMM
Ha Noi	103.7	63.2
Bac Ninh	118.8	69.1
Hung Yen	79.3	52.5
Ha Nam	132.8	95.1
Hai Duong	70.5	51.1
Thai Binh	115.2	93.4
Hai Phong	103.7	81.9
Ninh Binh	95.4	77.1
Ho Chi Minh	53	45.3
Quang Ninh	59.7	52.5
Dien Bien	46.6	37.0

Compliance with WHO guidelines (5µg/m³) could have helped avoiding at least 222 premature deaths (Dien Bien) and could have reached 5,090 deaths (Ha Noi).
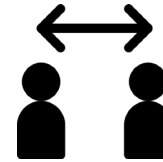
Health burden of air pollution –
Avoidable mortality in Vietnam attributed to COVID-19 preventive measures

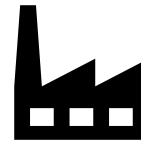Reduce travelling

Partial or total social distancing

Interrupt factory activities

Hypothesis:

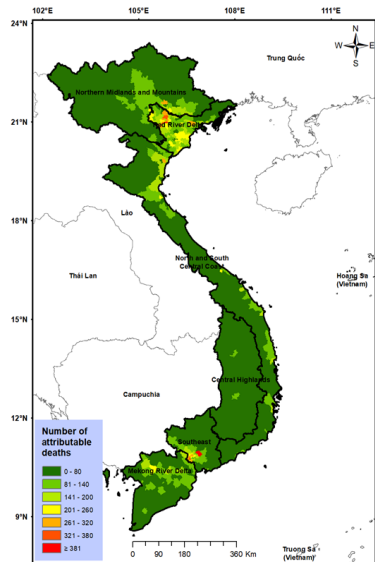? → **Before 2019, if Viet Nam had applied the same interventions as those in 2020** → **PM$_{2.5}$ concentration in 2019 could have been equal to the concentration in 2021** → **The number of premature deaths in 2019 would have been avoided**
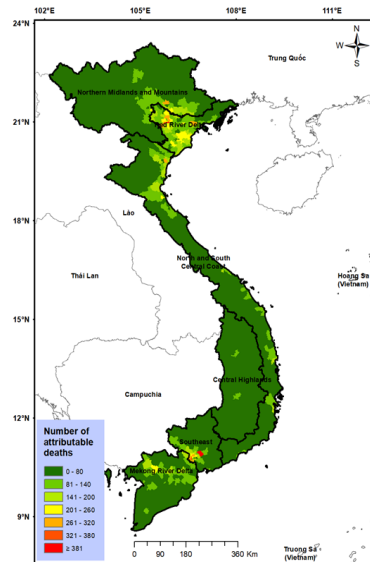
Health burden of air pollution –
Avoidable mortality in Vietnam attributed to COVID-19 preventive measures
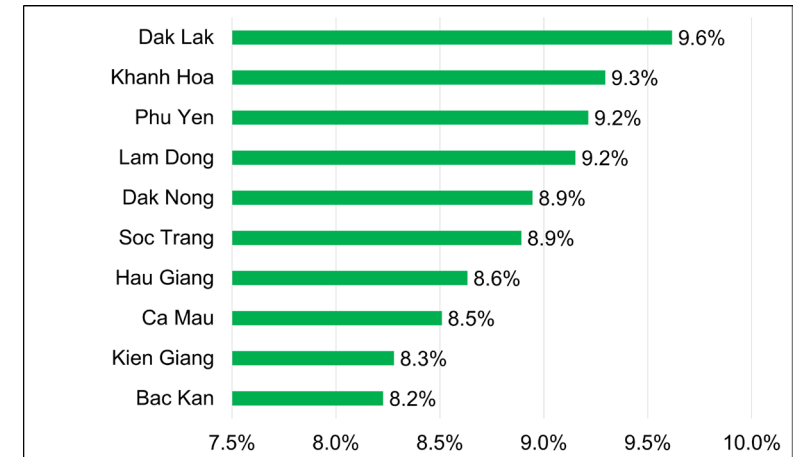
56.808
premature
deaths
attributed to
PM$_{2.5}$ (9,9%)

Number of premature deaths attributed to
PM$_{2.5}$ in 2019 in Viet Nam **(using 2019
concentration)**

52.993
premature
deaths
attributed to
PM$_{2.5}$ (9,2%)

Number of premature deaths attributed to
PM$_{2.5}$ in 2019 in Viet Nam **(if 2021
concentration had been met)**

Province	Percentage
Dak Lak	9.6%
Khanh Hoa	9.3%
Phu Yen	9.2%
Lam Dong	9.2%
Dak Nong	8.9%
Soc Trang	8.9%
Hau Giang	8.6%
Ca Mau	8.5%
Kien Giang	8.3%
Bac Kan	8.2%

*List of 10 provinces with the highest percentages of
potentially avoidable premature deaths if PM$_{2.5}$ control
measures had been implemented*

Summary of evidence
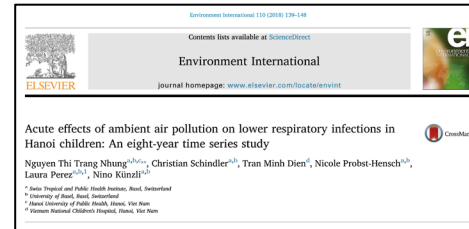
Use data at Vietnam National Children's hospital (2007-2014)

Use data at multiple hospitals from Ha Noi, Phu Tho, and Quang Ninh

One of the first health impact assessment of air pollution in Ha Noi
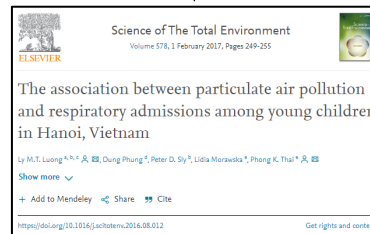
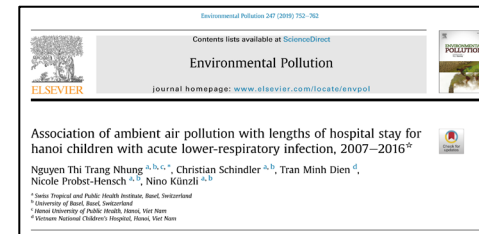2012   2017   2018   2019   2020   2022

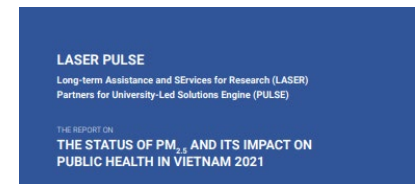One of the first reports health effects of air pollution in Vietnam

Use data at Vietnam National Children's hospital (2010-2011)

Use data at Vietnam National Children's hospital (2007-2016)

First health impact assessment of air pollution in multiple provinces of Viet Nam

First health impact assessment of air pollution for all Viet Nam

Upcoming study

"Adverse health effect of ambient air pollution in Hanoi children during 2007-2019: a case-crossover analysis " – Not circulated

Data source

Health data:
- Vietnam National Children's hospital
- 2007 - 2019

Monitoring station data:
- Air pollutant (NVC, LH, USE)
- Meteorological data (BV, L)

Health endpoint:
- Pneumonia (J12 – J18)
- Bronchitis (J20, J21)
- Asthma (J45)
- Upper Respiratory Diseases – URD (J00-J06)

Number of admissions due to respiratory diseases, pneumonia, and bronchitis attributed to excess concentrations of PM10, PM2.5, and NO2 during 2007-2019

		WHO air quality guideline		QCVN 05:2013	
		N (95% CI)	Percent (95% CI)	N (95% CI)	Percent (95% CI)
Respiratory diseases	PM10	4,749 (3,514 - 5,969)	1.6% (1.2% - 2.0%)	476 (352 - 598)	0.2% (0.1% - 0.2%)
	PM2.5	9,091 (7,126 - 11,030)	3.0% (2.3% - 3.6%)	2,507 (1,964 - 3,044)	0.8% (0.6% - 1.0%)
	NO2	6,302 (4,926 - 7,661)	2.1% (1.6% - 2.5%)	32 (25 - 39)	0.0% (0.0% - 0.0%)
Pneumonia	PM10	2,590 (1,717 - 3,447)	1.8% (1.2% - 2.4%)	256 (169 - 340)	0.2% (0.1% - 0.2%)
	PM2.5	4,179 (2,801 - 5,530)	2.9% (1.9% - 3.8%)	1,166 (781 - 1,544)	0.8% (0.5% - 1.1%)
	NO2	2,899 (1,920 - 3,862)	2.0% (1.3% - 2.6%)	13 (9 - 18)	0.0% (0.0% - 0.0%)
Bronchitis	PM10	852 (154 - 1,527)	1.4% (0.3% - 2.6%)	85 (15 - 153)	0.1% (0.0% - 0.3%)
	PM2.5	2,185 (1,071 - 3,258)	3.7% (1.8% - 5.5%)	628 (307 - 937)	1.1% (0.5% - 1.6%)
	NO2	2,478 (1,690 - 3,239)	4.2% (2.8% - 5.5%)	13 (8 - 16)	0.0% (0.0% - 0.0%)
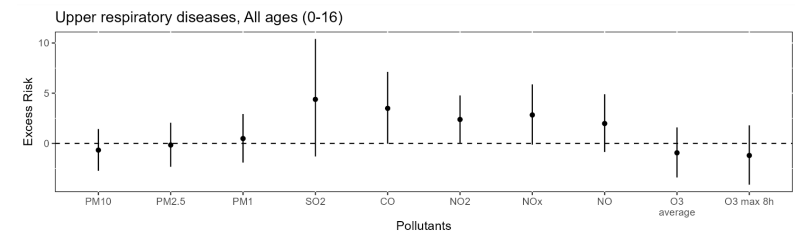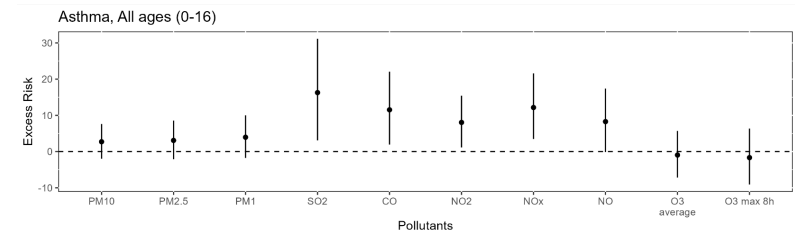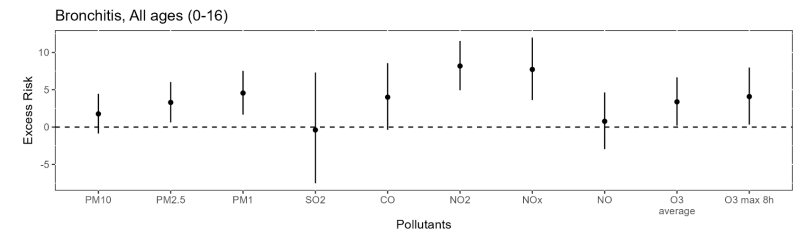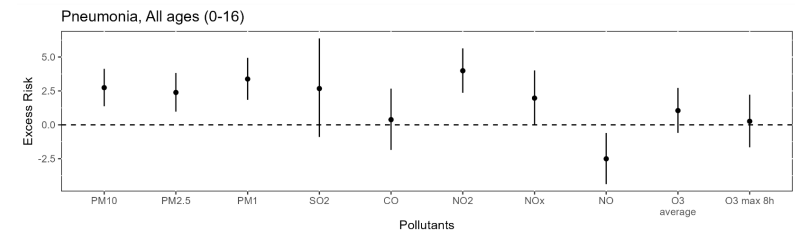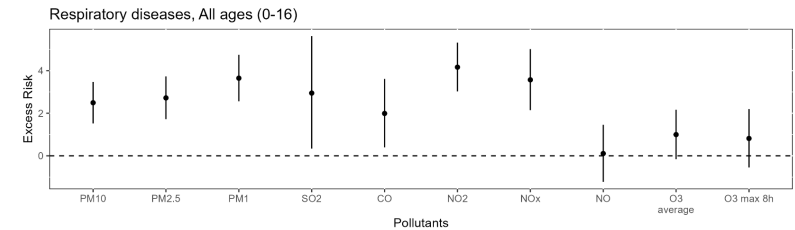
Discussion

- Evidence show the effect of air pollution on respiratory diseases among children and cardiovascular diseases among adults

- Health impact assessment has mainly been conducted for mortality burden in Vietnam. However, we also need to pay attention for hospitalization burden.

- Air pollution affect wide range of diseases and people ➔ We need disease-specific and human-specific guidelines.

Thank you for your attention!