



An Roinn Iompair,  
Turasóireachta agus Spóirt  
Department of Transport,  
Tourism and Sport

Seirbhís Sláinte | Building a  
Níos Fearr | Better Health  
á Forbairt | Service

# Air Quality & Human Health

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1. *Department of Public Health, Health Service Executive (HSE) North-East, Meath*

## **Urban Transport-Related Air Pollution Inter-Agency Group Meeting**

Department of Transport, Tourism and Sport (DTTS), 2 Leeson Street, Dublin 2

11<sup>th</sup> December 2019

## Air Quality & Human Health

### CONFLICT OF INTEREST STATEMENT

**I certify that I have no affiliations** with or involvement in any organisation or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this presentation.



## Air Quality & Human Health

### PRESENTATION OUTLINE



**Why is poor Air Quality a major concern?**

**What are the different types of air pollution?**

**What harms can air pollution cause?**

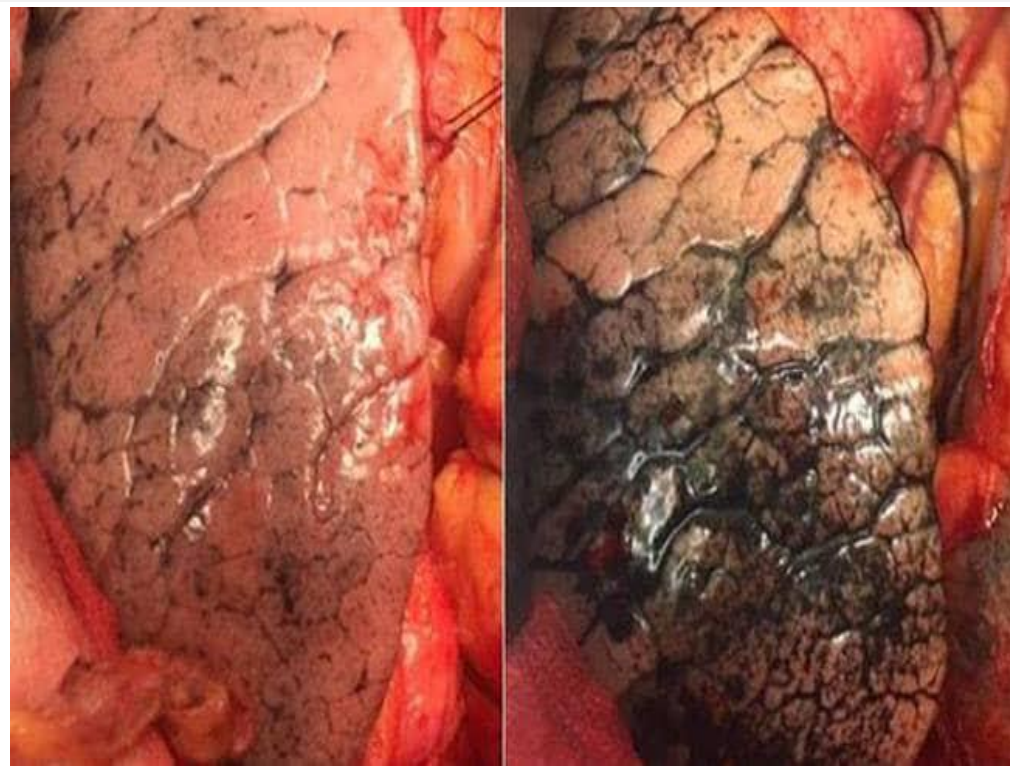
**How does air pollution cause human health impact?**

**The Irish perspective!**

**Where to next?**

## Air Quality & Human Health

### WHY IS AIR QUALITY A MAJOR CONCERN?



#### Nothing is more vital for life than breathing:

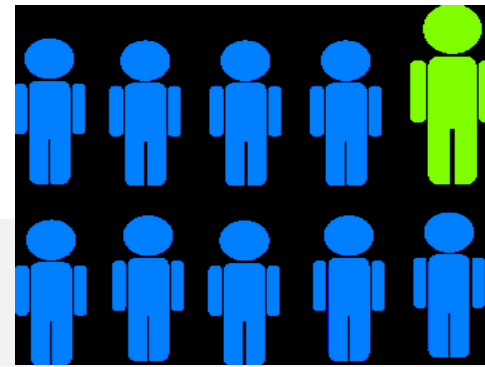
- In a lifetime, about **250 million litres of air passes through the lungs**; and
- Walking on a congested street, **20 million particles can be inhaled with every breath**.

*(RCP (UK) & RCPCH, 2016)*

#### Air pollution is now the largest risk factor for premature death:

- Responsible for fatalities in **1 in 9 persons**;
- It **reduces average life expectancy by 6 – 8 months**;
- It **kills 4.2 million people annually**; and
- The WHO states that '**it is a global public health emergency**'.

*(WHO, 2018)*



## Air Quality & Human Health

### WHAT ARE DIFFERENT TYPES OF AIR POLLUTION?

The EPA monitors air pollutants levels and compares them to EU legal limit values and World Health Organisation (WHO) guideline values. The following pollutants are assessed by the EPA

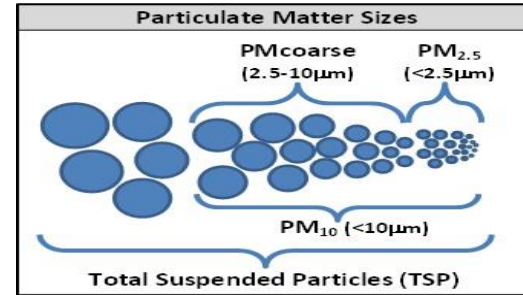
- Particulate matter – PM<sub>2.5</sub> and PM<sub>10</sub>
- Nitrogen oxides (NO<sub>2</sub> & NO)
- Sulphur dioxide (SO<sub>2</sub>)
- Ozone (O<sub>3</sub>)
- Carbon monoxide (CO)
- Benzene and ozone precursors
- Benzo(a)Pyrene, a Polycyclic Aromatic Hydrocarbon (PAH) - both in PM<sub>10</sub> and deposition
- Heavy metals - both in PM<sub>10</sub> and deposition
- Chemical composition of PM<sub>2.5</sub>
- Mercury

## Air Quality & Human Health

### WHAT ARE DIFFERENT TYPES OF AIR POLLUTION?

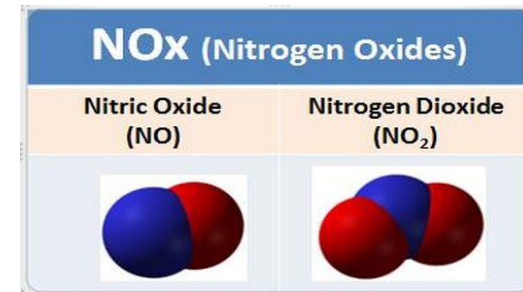
#### Particulate Matter (PM<sub>2.5</sub>) and (PM<sub>10</sub>)

- **Most of the PM emissions in Ireland are from solid burning fuels;** and
- Direct emissions such as dust, emissions from combustion engines, plant spores and pollen are also major sources of poor AQ, along with accidental fires and burning of waste.



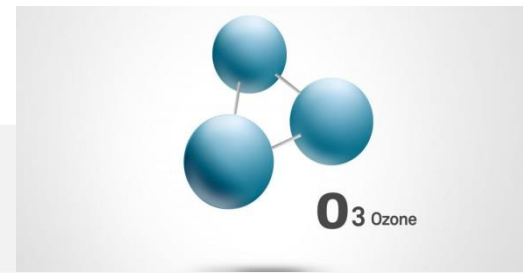
#### Nitrogen oxides (NO<sub>2</sub>) and (NO)

- All combustion processes produce oxides of nitrogen (NO<sub>x</sub>); and
- In Ireland, **road transport is the major source of these emissions.**



#### Ozone (O<sub>3</sub>)

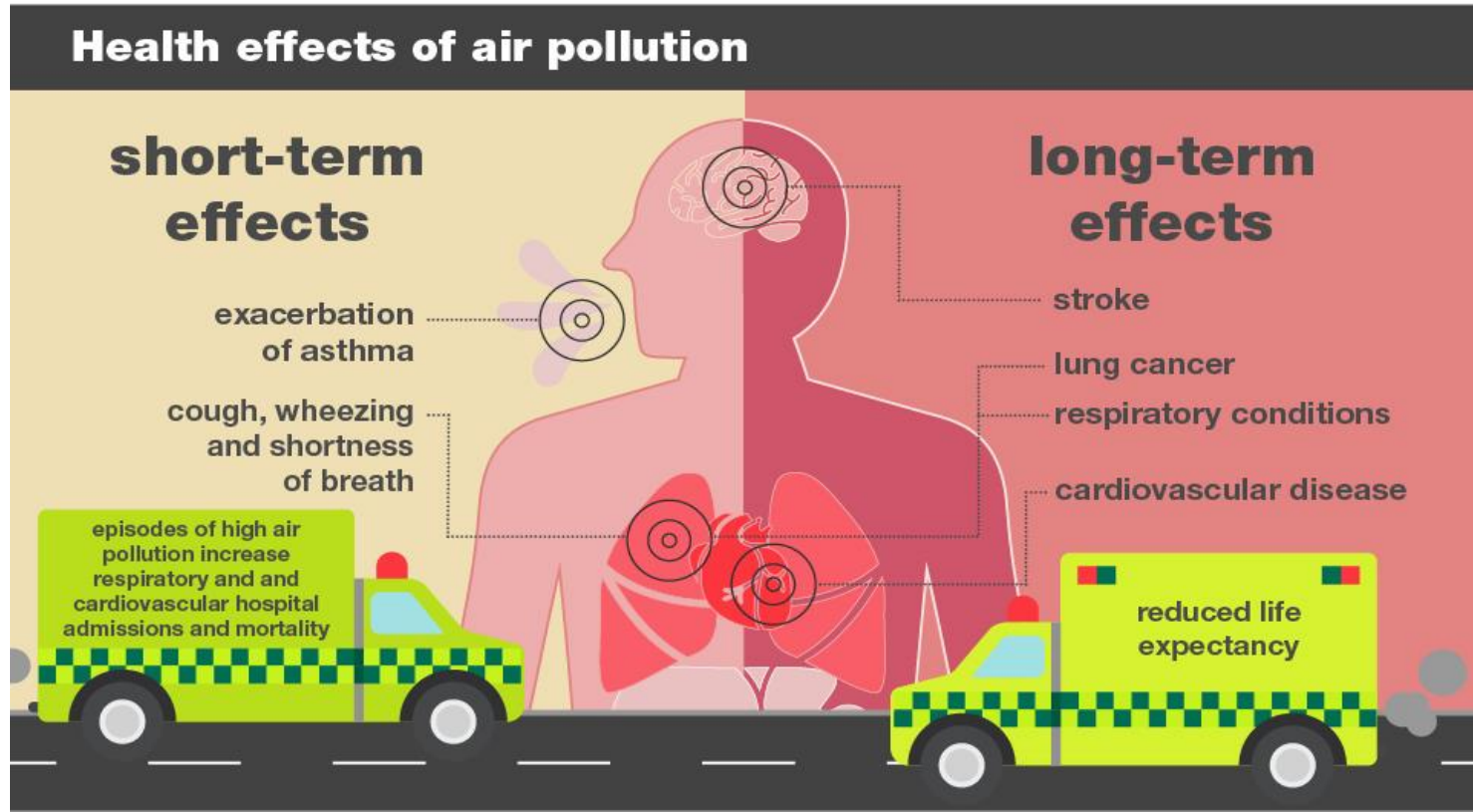
- Ground level ozone is another pollutant for which concentrations are at times high enough to impact on human health and which causes summer smogs during hot and sunny periods; and
- Formation takes place over several hours or days.



(EPA, 2019)

## Air Quality & Human Health

### WHAT HARMS CAN AIR POLLUTION CAUSE?





## Air Quality & Human Health

### WHAT HARMS CAN AIR POLLUTION CAUSE?

The landmark research linking air pollution to health was published in 1993:

- Observed statistically significant and robust association between air pollution and mortality;
- Air pollution was **positively associated with death from lung cancer and cardiopulmonary disease** but not with death from other causes considered together; and
- **Mortality was most strongly associated with air pollution with PM**, including sulphates.

# The New England Journal of Medicine

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Number 24

### AN ASSOCIATION BETWEEN AIR POLLUTION AND MORTALITY IN SIX U.S. CITIES

DOUGLAS W. DOCKERY, SC.D., C. ARDEN POPE III, PH.D., XIPING XU, M.D., PH.D.,  
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BENJAMIN G. FERRIS, JR., M.D., AND FRANK E. SPEIZER, M.D.

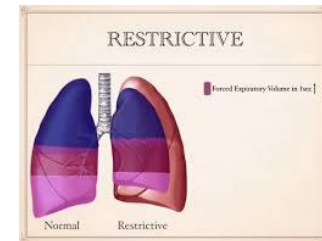
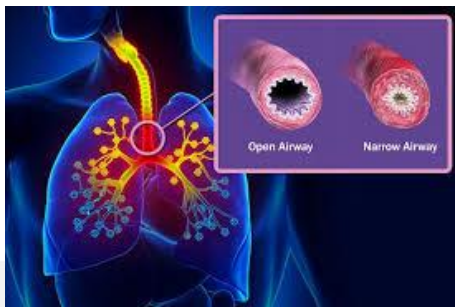




## Air Quality & Human Health

### WHAT HARMS CAN AIR POLLUTION CAUSE?

AUTHORS	POLLUTANT(S)	POPULATION	IMPACT	OUTCOME
Zhao et al, 2017	PM <sub>2.5</sub> (China)	All ages	Short-term	↑ out of hospital cardiac arrest
Weinmayr et al, 2019	PM <sub>10</sub> (Europe)	5 – 14 years	Short-term	↑ asthmatic episodes
Walton et al, 2019	NO <sub>2</sub> (London) O <sub>3</sub> (Warsaw)	0 – 14 years	Short-term	↑ asthma admissions
Walton et al, 2019 Atkinson et al, 2001	NO <sub>2</sub> (London) PM <sub>10</sub> (Warsaw)	15 – 65 years	Short-term	↑ asthma admissions
Shah et al, 2015	NO <sub>2</sub> (Worldwide)	All ages	Short-term	↑ hospital admissions for stroke
Quintyne et al, 2019	AQIH (i.e. combined PM <sub>2.5</sub> , PM <sub>10</sub> , SO <sub>2</sub> & O <sub>3</sub> ) (Dublin)	All ages	Short-term	↑ asthma & atrial fibrillation admissions
Raaschou et al, 2013	PM <sub>2.5</sub> (Europe)	All ages	Long-term	↑ lung cancer cases
Pederrsen et al, 2013	NO <sub>2</sub> (Europe)	New-born babies	Long-term	↑ low term birth weight cases
Gehring et al, 2013	NO <sub>2</sub> (London) PM <sub>10</sub> (Warsaw)	6 – 8 years living near to busy roads	Long-term	↑ low lung function cases
Gauderman et al, 2015	NO <sub>2</sub> (Europe)	11 – 15 years living near to busy roads	Long-term	↑ cases with reduced lung growth



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### WHAT HARMS CAN AIR POLLUTION CAUSE?

#### IARC Hazard Assessment

##### Volume 109 (2016)

**Outdoor air pollution classified as human carcinogen**

**Particulate matter in outdoor air pollution classified as human carcinogen**

- Sufficient evidence for lung cancer.
- Positive associations with urinary bladder cancer.

Data includes general population studies/environmental levels of exposures.

##### Volume 105 (2014)

**Diesel engine exhaust classified as human carcinogen**

- Sufficient evidence for lung cancer
- Positive associations with urinary bladder cancer

Data mostly from occupational exposure settings.

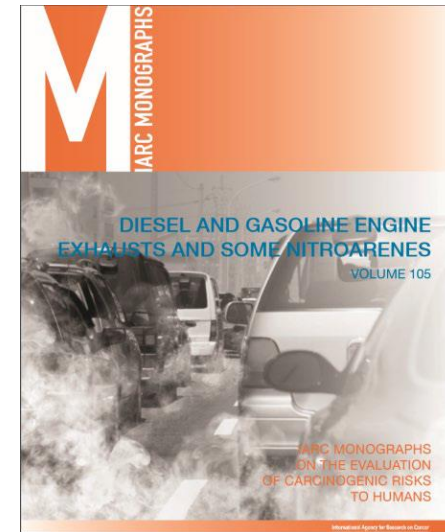
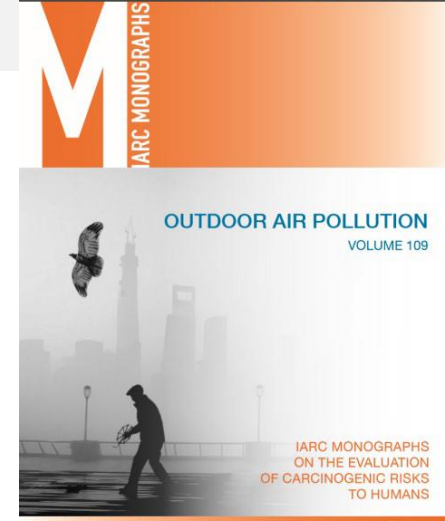
Uncertainty of effect at low dose environmental exposure levels. Less data for other cancers.

##### Volume 100e (2012)

**Indoor emissions from household combustion of coal classified as human carcinogen (lung cancer).**

##### Volume 95 (2010)

**Household use of solid fuels (biomass) classified as probable human carcinogen.**



## Air Quality & Human Health

### WHAT HARMS CAN AIR POLLUTION CAUSE?

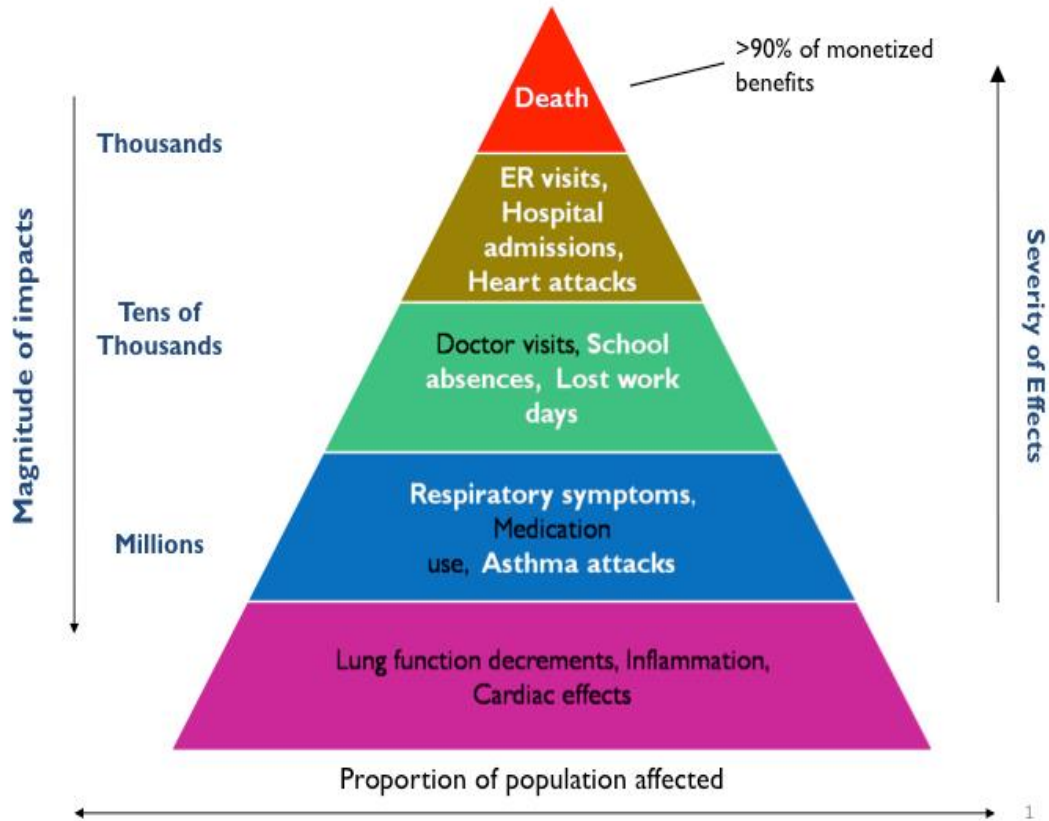
#### Cancer Facts & Figures

- The American Cancer Society (ACS) study reported that each **10µg/m<sup>3</sup> increment in PM<sub>2.5</sub> was associated with an 8 - 14% increase in lung cancer.** (*Turner et al, 2016*)
- Increased **lung cancer has also been reported among workers occupationally exposed** to components of urban air pollution such as polycyclic aromatic hydrocarbons and diesel exhaust. (*IARC, 2014*)
- Exposure to **air pollution is estimated to contribute to 62,000 lung cancer deaths per year** (these impacts are largely borne by the populations of highly polluted cities in developing countries – roughly 60% of the world's burden of air pollution attributed disease):
  - In **Chinese cities**, where air pollution levels are many times greater than those in cities of the developed West, **outdoor air pollution may contribute to as much as 10% of lung cancer overall**, and perhaps a larger proportion of non-smoking women.

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### WHAT HARMS CAN AIR POLLUTION CAUSE?

#### A “Pyramid of Effects” from Air Pollution



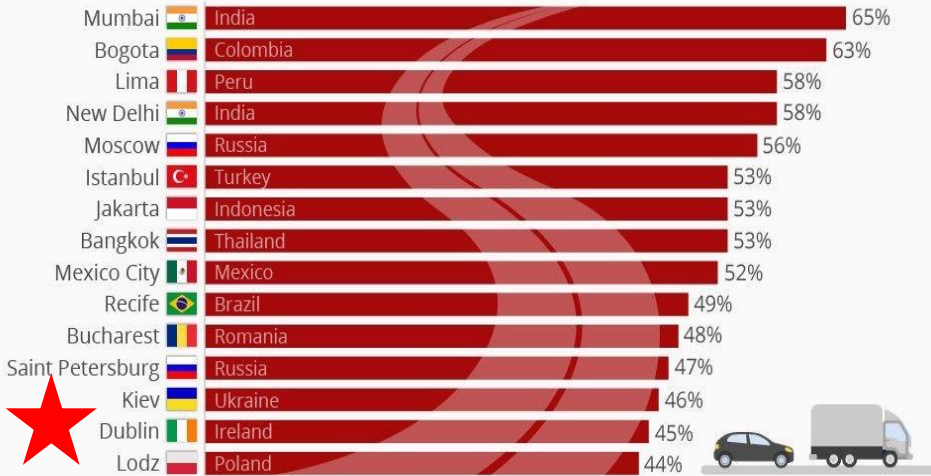
(WHO, 2016)

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### WHAT HARMS CAN AIR POLLUTION CAUSE?

#### The Cities With The Worst Traffic Congestion

Percentage of extra travel time due to congestion in 2018\*



\* 0% = uncongested free flow of traffic



@StatistaCharts Source: TomTom Traffic Index

statista

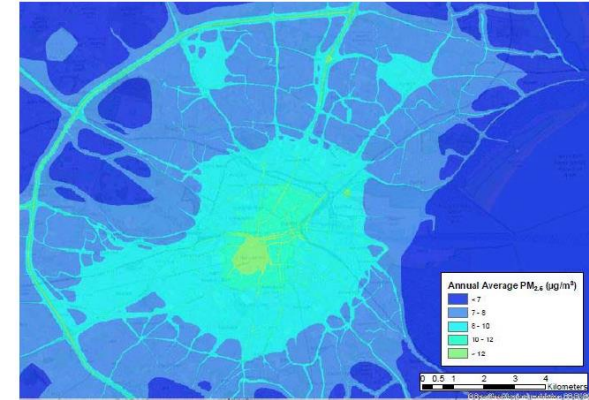
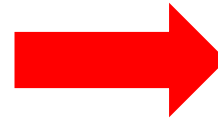


Figure 7 Modelled annual average PM<sub>2.5</sub> concentrations for 2015 in Dublin

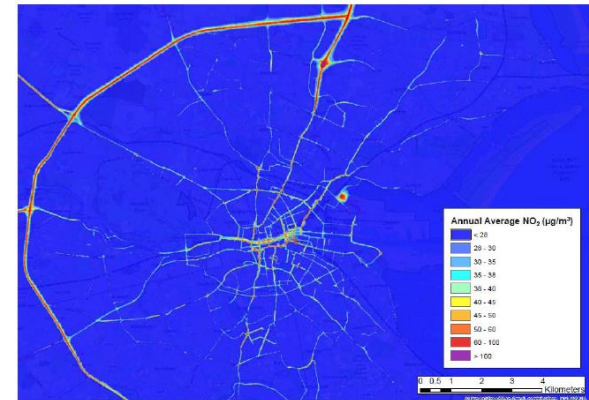
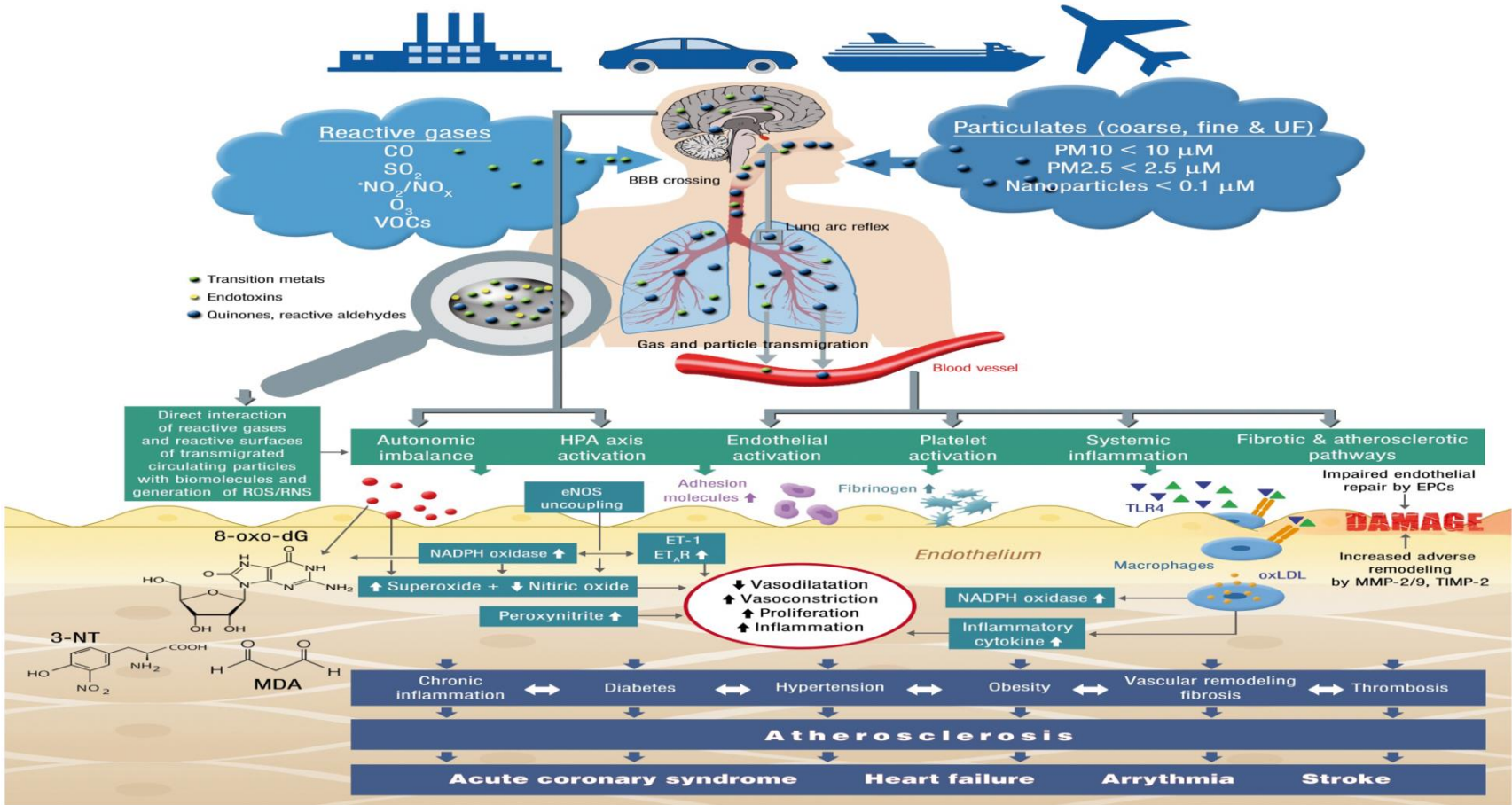


Figure 9 Modelled annual average NO<sub>2</sub> concentrations for 2015 in Dublin



# Air Quality & Human Health

## HOW DOES AIR POLLUTION CAUSE HUMAN HEALTH IMPACT?



## Air Quality & Human Health

### THE IRISH PERSPECTIVE

# Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study

Luke Clancy, Pat Goodman, Hamish Sinclair, Douglas W Dockery

### Findings:

- Average black smoke fell by 50% after the ban on smoky coal sales;
- Adjusted **non-trauma** mortality fell by 10% (95% CI 5-15%);
- Adjusted **respiratory** mortality fell by 15% (95% CI 10-20%);
- Adjusted **cardiovascular** mortality fell by 10% (95% CI 5-15%).



Ballyfermot, Thursday 24 November 1988, 4pm

er the ban on smoky

01); and

001).

ratory and cardiovascular  
: control of particulate air  
ish daily death. The net

benefit of the reduced death rate was greater than predicted from results of previous time-series studies.]

Lancet 2002; 360: 1210-14

See Commentary page 1184



# Air Quality & Human Health

## THE IRISH PERSPECTIVE

Quintyne et al, 2019



***HSE & EPA arranged to explore the relationship between the short-term AQIH and acute hospital admissions for specific CVS and RS in Dublin city and county.***

Four bands of air quality:	Index (1-10):	Five air pollutants which can harm your health:				
		Ozone Running 8-hour mean (µg/m³)	Nitrogen dioxide 1-hour mean (µg/m³)	Sulphur dioxide 1-hour mean (µg/m³)	PM <sub>2.5</sub> particles Running 24-hour mean (µg/m³)	PM <sub>10</sub> particles Running 24-hour mean (µg/m³)
Good air quality	1	0-33	0-67	0-29	0-11	0-16
	2	34-65	68-134	30-59	12-23	17-33
	3	67-100	135-200	60-89	24-35	34-50
Fair air quality	4	101-120	201-267	90-119	36-41	51-58
	5	121-140	268-334	120-149	42-47	59-66
	6	141-160	335-400	150-179	48-53	67-75
Poor air quality	7	161-187	401-467	180-236	54-58	76-83
	8	188-213	468-534	237-295	59-64	84-91
	9	214-240	535-600	296-354	65-70	92-100
Very Poor air quality	10	241 or more	601 or more	355 or more	71 or more	101 or more

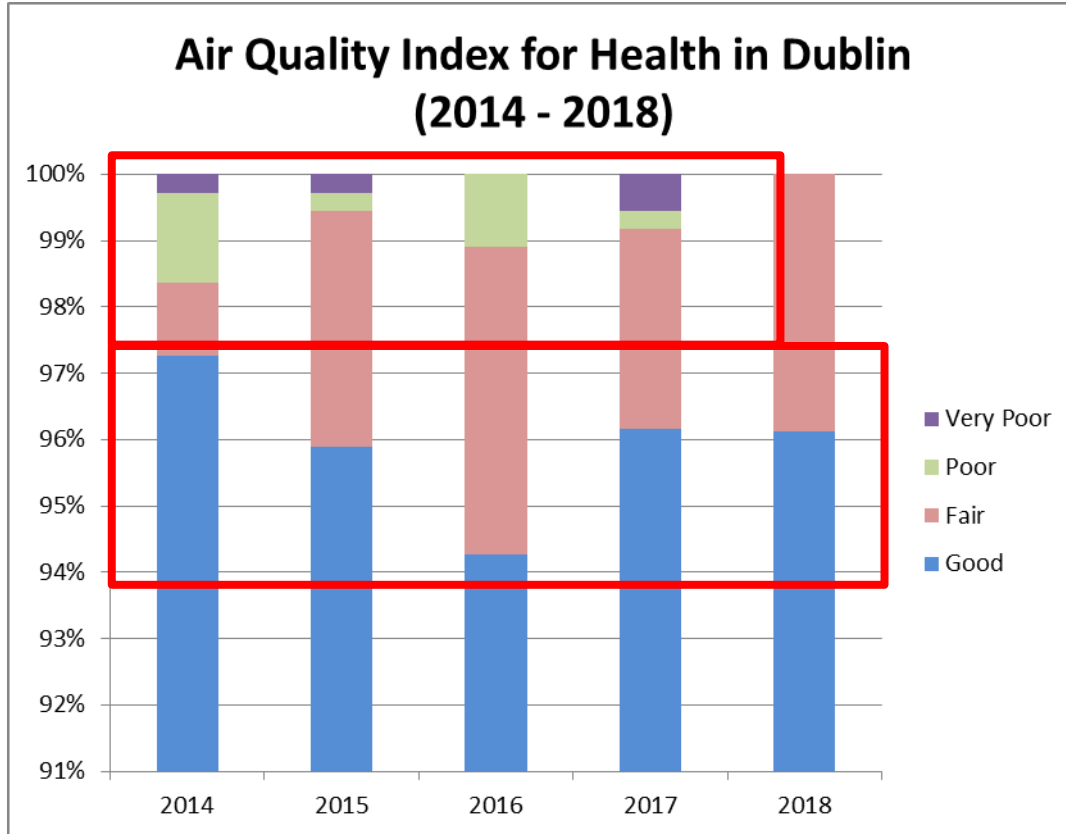


Band	Index	Accompanying health messages for at-risk groups and the general population	
		At-risk individuals *	General population
Good	1	Enjoy your usual outdoor activities.	Enjoy your usual outdoor activities.
	2		
	3		
Fair	4	Adults and children with lung problems, and adults with heart problems, who experience symptoms, should consider reducing strenuous physical activity, particularly outdoors.	Enjoy your usual outdoor activities.
	5		
	6		
Poor	7	Adults and children with lung problems, and adults with heart problems, should reduce strenuous physical activity, particularly outdoors, and particularly if they experience symptoms.  People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should consider reducing activity, particularly outdoors.
	8		
	9		
Very Poor	10	Adults and children with lung problems, adults with heart problems, and older people, should avoid strenuous physical activity.  People with asthma may find they need to use their reliever inhaler more often.	Reduce physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.



## Air Quality & Human Health

### THE IRISH PERSPECTIVE



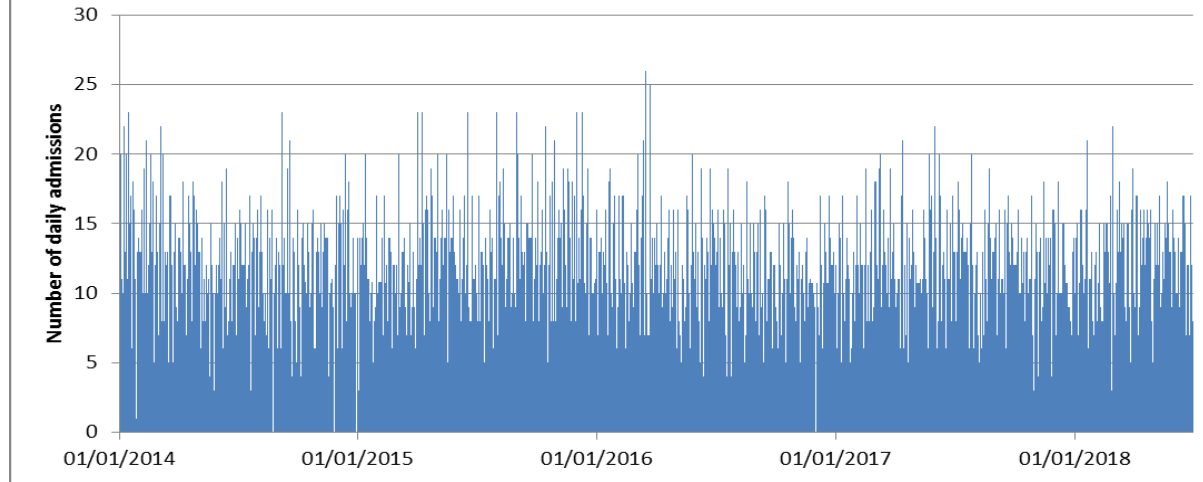
## Air Quality & Human Health

### THE IRISH PERSPECTIVE

### CVS Diseases

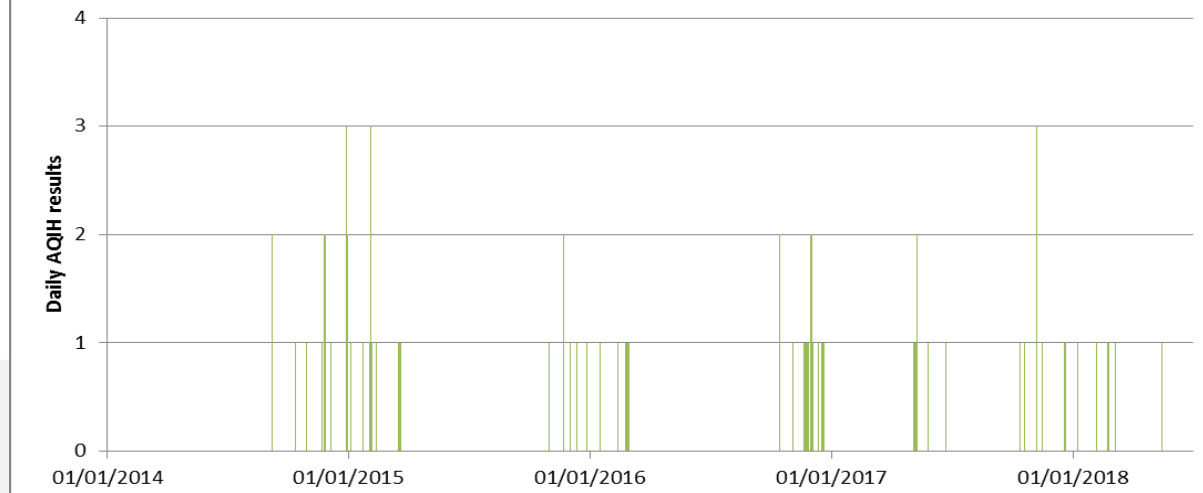


### All Cardiovascular Same Day Admissions in Dublin (2014 - 2018)



### Daily AQIH Results in Dublin (2014 - 2018)

0: Good; 1: Fair; 2: Poor; 3: Very Poor



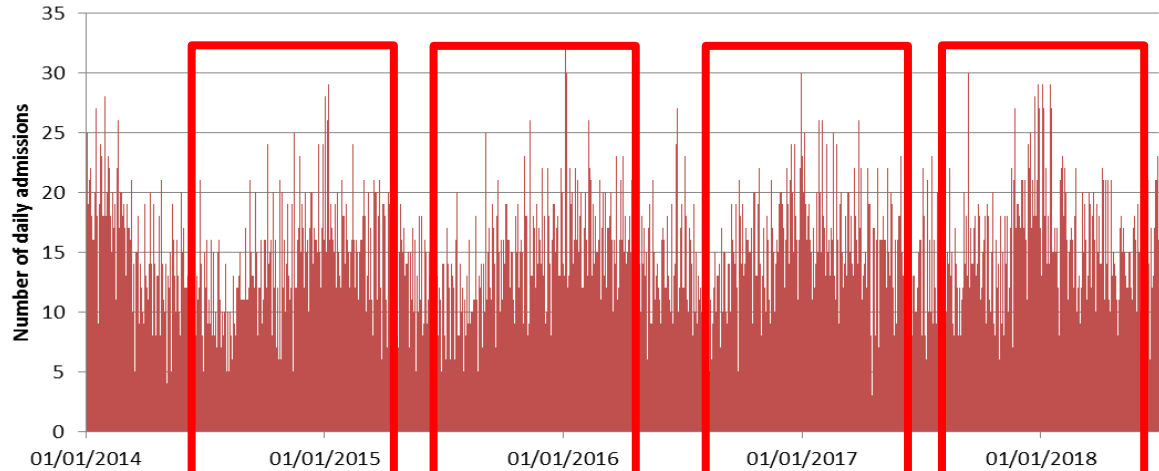
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### THE IRISH PERSPECTIVE

### RS Diseases

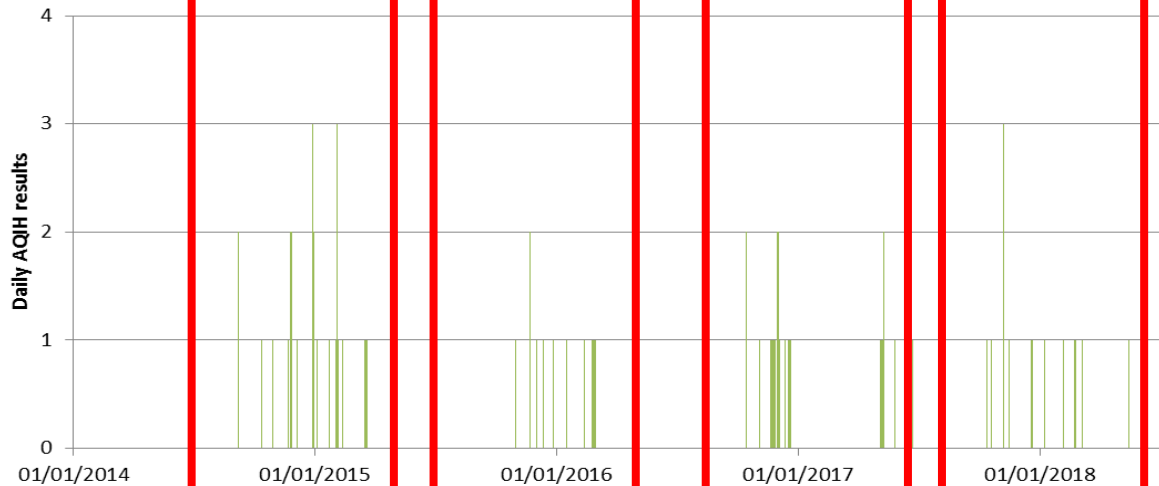


### All Respiratory Same Day Admissions in Dublin (2014 - 2018)



### Daily AQIH Results in Dublin (2014 - 2018)

0: Good; 1: Fair; 2: Poor; 3: Very Poor



## Air Quality & Human Health

### SUMMARY

#### The findings have highlighted that:

1. Ambient **AQIH for Dublin city and county is predominantly good**, most of time;
2. When AQIH is fair/poor – there is an impact on hospital admission rates for individuals with certain diseases; and
3. AQIH is **suitable short-term measure for providing/raising awareness** for the general population and persons at high-risk of cardiopulmonary diseases.

# Air Quality & Human Health

## WHERE TO NEXT?

### Personal level

- Use of personal protective products (i.e. masks);
- Dietary adjustments (i.e. foods rich in omega oils and vitamin B); and
- **Increasing awareness and education** for general population and high-risk groups.

### Population level

- Ensuring and sustaining **greater green space development**; and
- Using **modern technology**: pollution-monitoring apps, so population can choose to avoid the worst times, and alternative city walking routes that keep pedestrians away from poor AQ hotspots.

### Policy level

- Enforcing higher **vehicle emission standards**;
- Improving **fuel efficiency in vehicles**;
- Development of **active transport networks**;
- Ensuring **sustainable building design**; and
- Consideration for **creation of low emission air quality zones** in city centre.



Climate Change Adaptation Plan for the health sector (2019 – 2024)





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11<sup>th</sup> December 2019

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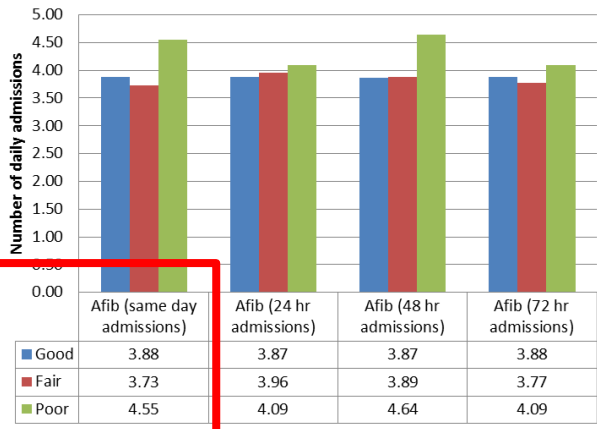


# Air Quality & Human Health

## ADDITIONAL SLIDE 1

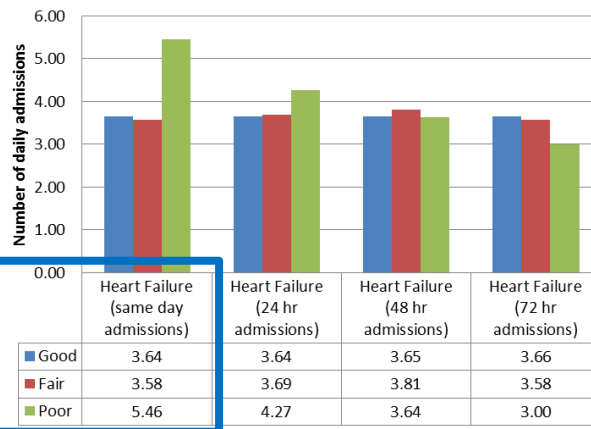
### Cardiovascular Diseases

**Atrial Fibrillation Admission Rates in Dublin (2014 - 2018)**



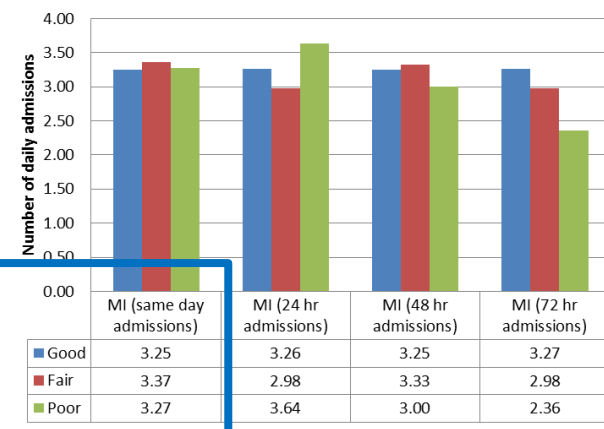
**p = 0.005**

**Heart Failure Admission Rates in Dublin (2014 - 2018)**



**p = 0.529**

**Myocardial Infarction Admission Rates in Dublin (2014 - 2018)**

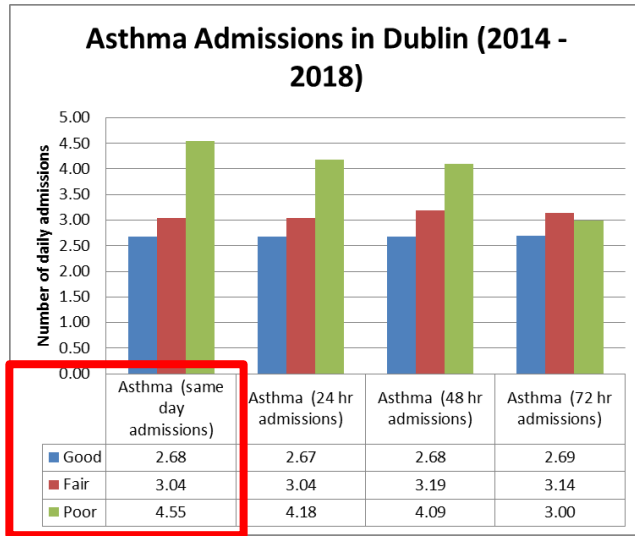


**p = 0.737**

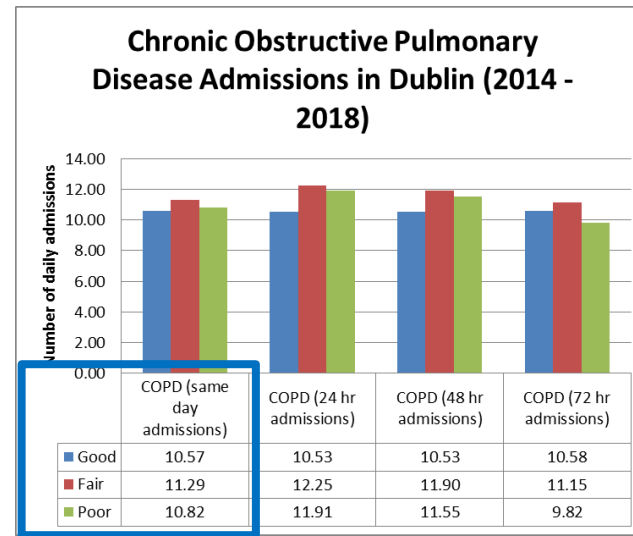
## Air Quality & Human Health

### ADDITIONAL SLIDE 2

### Respiratory System Diseases



**p = 0.004**



**p = 0.087**