Government of **Western Australia**
Department of **Health**

Port Hedland Health Risk Assessment: what does risk mean?

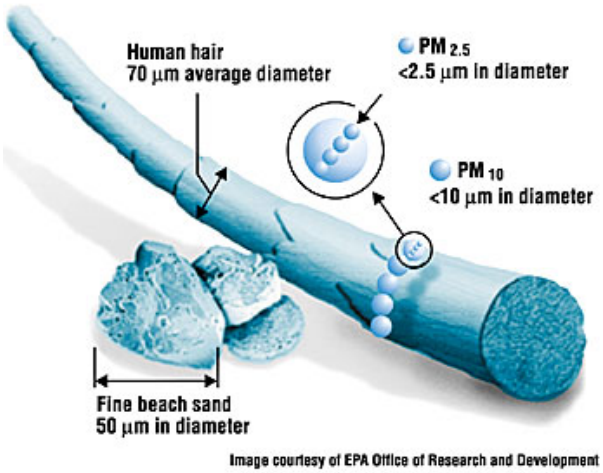
Dr Peter Franklin
Senior Scientific Officer, Environmental Health Directorate, DOH
Senior Research Fellow, School of Population and Global Health, UWA
(Environmental and occupational epidemiologist)

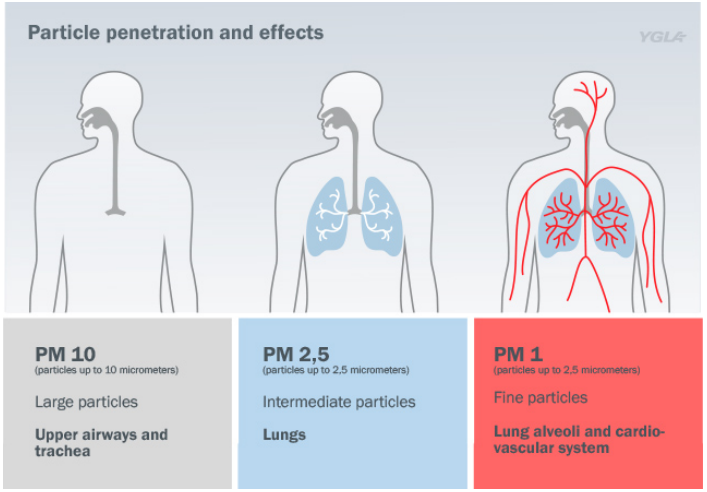
Outline

- Health effects of dust
  - Brief overview
  - Measure health effects
    - Importance of population size
  - ‘Safe’ thresholds and standards
- What does ‘risk’ mean?
  - how does this relate to the PH HRA
- Why do environmental and occupational standards differ?

Dust and Health

- Particulate Matter (PM)
  - Small particles in the air that we inhale
  - Enters upper (nose/pharynx) and lower (trachea, bronchi, bronchioles, alveoli) airways, and bloodstream
  - Size matters
    - TSP –Mostly captured in upper airways
    - **PM_{10} – upper airway and trachea**
    - **$PM_{2.5}$ – alveoli**
    - PM_1 (UFP) – bloodstream





Sources

- $PM_{2.5}$: mostly anthropogenic and includes combustion particles, such as industrial processes, vehicle exhaust, landscape fires
- **PM_{10}**: anthropogenic and natural. Crustal and biological material
  - Major component of PM_{10} in the PH region is coarse particulate $PM_{2.5\text{-}10}$

*PM measured in the air as $\mu g/m^3$

Health effects

Acute (day-to-day)

- Cardiovascular (heart)
  - Heart attack
  - Irregular heart beat
- Respiratory
  - Cough, wheeze, SOB
  - Asthma & COPD symptoms
- Death
  - Mostly in susceptible individuals

Chronic (long term)

- Heart disease
- Respiratory disease
  - Asthma
  - COPD
  - Reduced lung function
- Neurological
- Lung cancer
- Birth (smaller babies)
- Death

Magnitude of effects

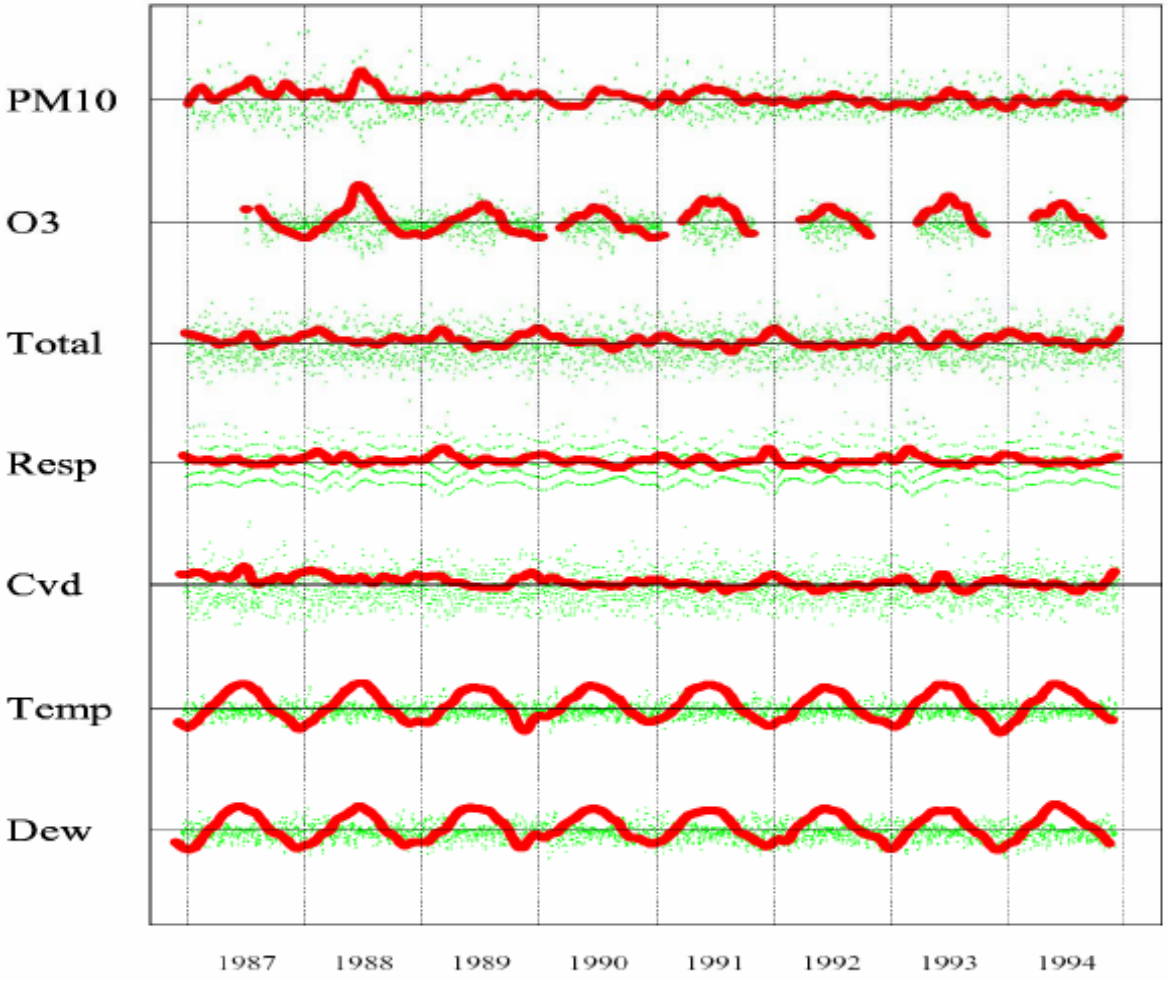
Outcome	Averaging Period	Relative risk per 1 μg/m^3 increase in PM_{10}
Annual all-cause mortality (non-accidental) 30+ years	Annual Average	0.004
Daily all-cause mortality(non-accidental) all ages	24 hours	0.002
Daily mortality cardiovascular disease - all ages	24 hours	0.002
Hospital Admissions respiratory disease 65+ years	24 hours	0.003
Hospital Admissions cardiac disease 65+ years	24 hours	0.002
Hospital Admissions pneumonia and bronchitis 65+ years	24 hours	0.0013
Hospital Admissions respiratory disease 15-64 years	24 hours	0.003
ED Visits Asthma 1-14 years	24 hours	0.015

Measuring AP effects: issues

- Health outcomes of concern are not specific to air pollution
- Air pollution is one of many contributing factors to these outcomes
- At low levels of exposure, it only contributes a small percentage of the overall disease burden for each outcome
- Therefore, you need large populations to observe these effects and determine risk
  - (again) size matters!

Measuring AP effects

Data for Baltimore, Maryland



‘Safe’ levels

- For PM, there are no known threshold below which health effects are not observed
- This means that some individuals, particularly in ‘sensitive’ sub-groups, may be affected even when air quality standards are met.

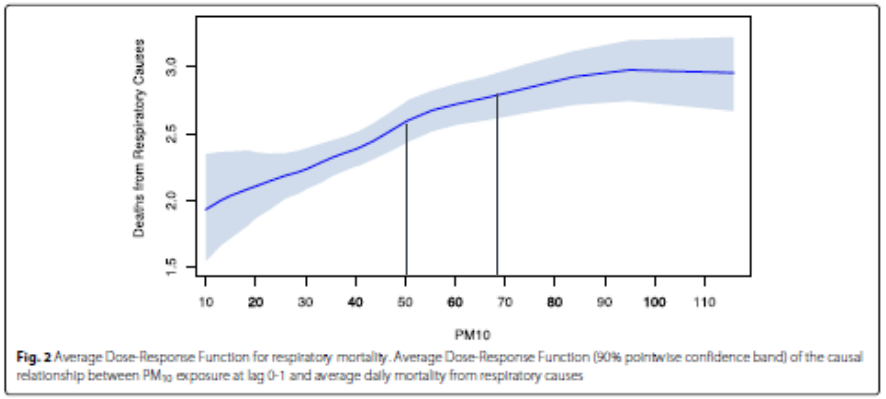


Fig. 2 Average Dose-Response Function for respiratory mortality. Average Dose-Response Function (90% pointwise confidence band) of the causal relationship between PM_{10} exposure at lag 0-1 and average daily mortality from respiratory causes

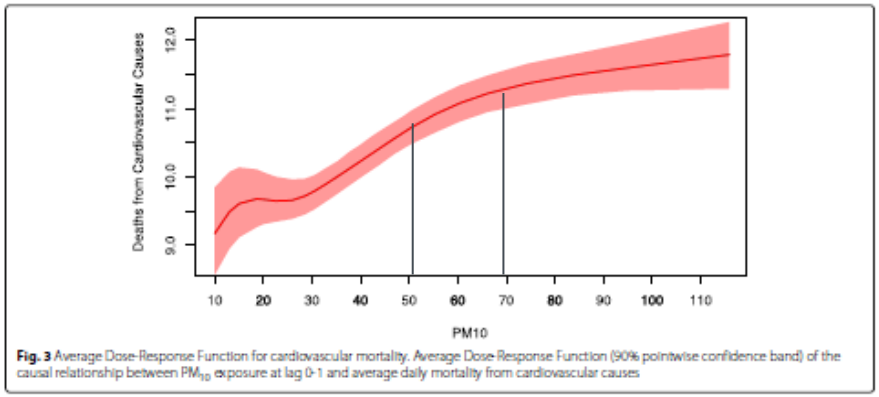


Fig. 3 Average Dose-Response Function for cardiovascular mortality. Average Dose-Response Function (90% pointwise confidence band) of the causal relationship between PM_{10} exposure at lag 0-1 and average daily mortality from cardiovascular causes

Setting standards: do they protect everyone?

- The process of setting air quality standards involves considering a range of scientific, social, economic and political issues. In many cases the final standards are a balance of all of these issues and are set with an inherent level of human health risk associated with them
- The intention is to protect the vast majority of an exposed population from serious health effects. However, an air quality standard does not necessarily protect all of the people, all of the time, from all possible health effects…..
- Having no identified threshold complicates the setting of standards, as it requires the assumption of a level of risk that is 'acceptable'

Source: NHMRC. Ambient Air Quality Standards Setting: An Approach to Health-Based Hazard Assessment

NEPM Monitoring

- NEPM (standards) monitoring is for regions with a population of >25,000

- Based on population level risk
  - That is why HRA is done for smaller populations

Risk

What is risk?

- Probability/likelihood of an event occurring
- For environmental exposures we calculate relative risk
  - Probablity of event in exposed relative to the probability of the event in non-exposed
- Therefore it is dependent on the background (non-exposed) rate of a health event, eg
  - Deaths per day/year
  - Hospitalisations per day
  - Asthma attacks per day

Air pollution risk estimates

Outcome	Averaging Period	Relative risk per 1 µg/m^3 increase in PM_{10}
Annual all-cause mortality (non-accidental) 30+ years	Annual Average	0.004
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Risk and numbers

- if on average 1 person per 100,000 in the population were admitted to hospital for a respiratory disease each day, and the relative risk associated with an increase in 24-hour PM_{10} of 10 $\mu g/m^3$ was 1.03, then the risk in the population of hospital admission for a respiratory disease when the 24-hour PM_{10} was background +10 $\mu g/m^3$ would be 1.03 persons per 100,000 (or 1 person per 97,000).
- In a population of 2,000,000 (eg. Perth), that equates to ~21 individuals (extra) per day

- Small risks in large populations can still affect a large number of people
- Small risks in small populations may not be observed

PH HRA Calculations (per 100,000)

Table 11: Increase in health outcome attributable to PM_{10} per 100,000 population

Outcome*	Port Hedland using Richardson St data current	Port Hedland using Richardson St data meeting 70 µg/m³	Port Hedland using Richardson St data meeting 50 µg/m³	Port Hedland using Taplin St data current	Port Hedland using Taplin St data meeting 70 µg/m³	Port Hedland using Taplin St data meeting 50 µg/m³	South Hedland current	South Hedland meeting 70 µg/m³	South Hedland meeting 50 µg/m³
Long-term all-cause mortality	29	12	6	26	23	16	15	5	3
Daily all-cause mortality	13	4	3	12	11	8	5	2	1.6
Daily Mortality cardiovascular causes	6	2	1	5	5	3	2	0.5	0.4
Hospital Admissions Respiratory Disease 65+ years	1682	521	370	1581	1375	980	1435	390	278
Hospital Admissions Pneumonia and Bronchitis 65 + years	729	223	160	685	596	425	185	50	36
Hospital Admissions Respiratory Disease 15-64 years	80	25	18	76	66	47	122	33	24

PH HRA Calculations (for pop^{n})

Table 12: Annual number of Health Outcomes Attributable to PM_{10}

Outcome	Port Hedland Richardson St data current	Port Hedland Richardson St current 17,000 population	Port Hedland Richardson St data meeting 70 µg/m3	Port Hedland Richardson St data meeting 70 µg/m3 17,000 population	Port Hedland Richardson St data meeting 50 µg/m3	Port Hedland Richardson St data meeting 50 µg/m3 17,000 population
Long-term all-cause mortality	1.3	5	0.4	1.5	0.3	1
Daily all-cause mortality	0.6	2	0.2	0.7	0.1	0.5
Daily Mortality Cardiovascular Disease	0.3	1	0.08	0.3	0.06	0.2
Hospital Admissions Respiratory Disease 65+ years	2	7	0.6	2.2	0.4	1.6
Hospital Admissions Pneumonia and Bronchitis 65 + years	0.9	3	0.3	1	0.2	0.7
Hospital Admissions Respiratory Disease 15-64 years	2.7	10	0.9	3	0.6	2.2

PM_{10} and health - summary

- PM_{10} health effects include;
  - Annual mortality
  - Daily mortality
  - Respiratory and cardiovascular hospitalisation
- There is no ‘safe’ threshold
  - However, population level risks are small
- Small risks in a large population can still affect a large number of people
- In PH, the number of affected individuals is very low but only because the population is small

- Even though risks are small, a public health response still requires strategies to minimise exposure
  - Ensure dust is managed as much as possible
  - Restrict the number of people who are exposed
  - Move from areas of high exposure

Environmental v Occupational standards

- Environmental standards
  - 24 hours per day over a lifetime
  - Env standards for PM
    - PM_{10} 50 ug/m^3
    - $PM_{2.5}$ 25 ug/m^3

- Occupational standards
  - 8 hours per day for 5 days/week over working life
    - lower frequency and duration of exposure
    - 'Healthy worker'
    - Health surveillance
  - Occ standard for 'non-toxic' (nuisance) dusts
    - Inhalable 10 mg/m^3 (10,000ug/m^3)
    - Respirable (<PM_{10}) 5 mg/m^3