



THE UNIVERSITY OF  
WESTERN AUSTRALIA

FACULTY OF MEDICINE, DENTISTRY AND HEALTH SCIENCES

# Quantitative levels of diesel exhaust exposure in the contemporary Australian mining industry

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## Background & Objective

- ↘ Working in the mining industry is characterised by high levels of exposure to diesel exhaust (a human carcinogen) due to the wide use of heavy machinery
- ↘ Current guideline in Australia is an exposure limit of 100  $\mu\text{g}/\text{m}^3$  elemental carbon (EC)

### Objective:

To estimate quantitative levels of exposure to diesel exhaust expressed by EC in the contemporary mining industry



## Methods

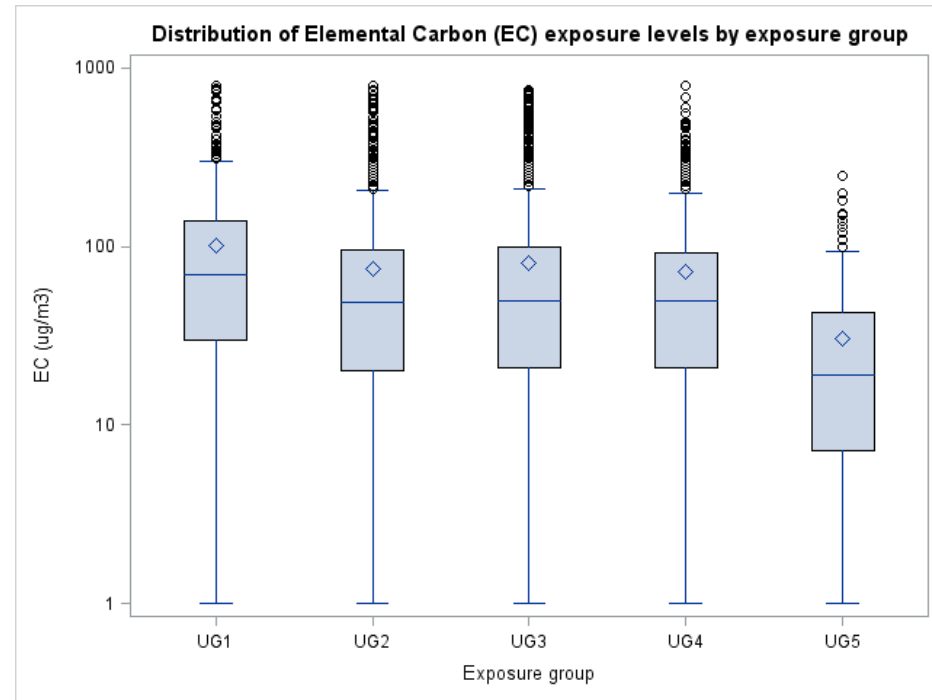
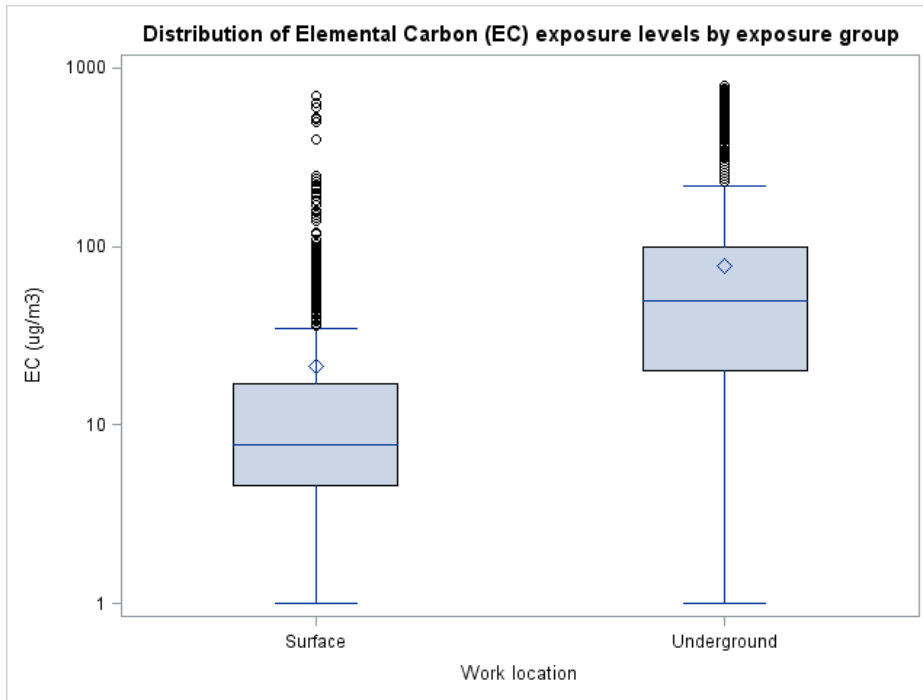
- ↘ CONTAM monitoring database
  - 8,558 personal EC measurements (2003-2015; median 2011)
  - 119 mine sites in Western Australia
    - 52% Gold
    - 22% Nickel
    - 10% Base metals
    - 8% Iron ore
    - 8% Other
  - 5,336 individuals representing 145 occupations



## Methods

### ↘ Statistical analyses

- Multiple imputation for measurements below limit of detection (25%)
- Summary statistics: arithmetic mean (AM) and geometric mean (GM)
- Mixed-effects models to estimate GMs in 2011
  - Fixed effects
    - Year of measurement (interaction with exposure group)
    - Exposure group
    - Mineral type
    - Sampling duration
  - Random effects
    - Job title
    - Minesite ID
    - Worker ID



	<b>Surface jobs:</b>	<b>UG jobs:</b>
AM	21 $\mu\text{g}/\text{m}^3$	77 $\mu\text{g}/\text{m}^3$
GM	9 $\mu\text{g}/\text{m}^3$	41 $\mu\text{g}/\text{m}^3$

- UG1:** General miner
- UG2:** Drilling/blasting
- UG3:** Transport/loading
- UG4:** Ground/roof support and other service occupations
- UG5:** Winding/hoisting/crushing operators, managers/foremen, other professionals



## Estimations EC exposure levels for 2011 (12-hr shift)

Underground exposure groups	EC exposure level (GM)
General miner	43 $\mu\text{g}/\text{m}^3$
Drilling/blasting	34 $\mu\text{g}/\text{m}^3$
Transport/loading	35 $\mu\text{g}/\text{m}^3$
Ground/roof support and other service occupations	35 $\mu\text{g}/\text{m}^3$
Winding/hoisting/crushing operators, managers/foremen, other professionals	17 $\mu\text{g}/\text{m}^3$



## Estimations EC exposure levels for 2011 (12-hr shift)

Top 5 highest exposed underground occupations

Job title	EC exposure level (GM)
Diesel loader operator	59 $\mu\text{g}/\text{m}^3$
Ground or roof support occupations	54 $\mu\text{g}/\text{m}^3$
Non-contract miner	53 $\mu\text{g}/\text{m}^3$
Contract miner	51 $\mu\text{g}/\text{m}^3$
Loading or transport occupation	51 $\mu\text{g}/\text{m}^3$



## Discussion

Current GM exposures are below the recommendation of  $100 \mu\text{g}/\text{m}^3$  EC.

However:

a recent study by Vermeulen et al. (EHP, 2014) shows the following excess lifetime risks of dying from lung cancer in the US:

**689/10,000** when 45 year occupationally exposed to  **$25 \mu\text{g}/\text{m}^3$**

**200/10,000** when 45 year occupationally exposed to  **$10 \mu\text{g}/\text{m}^3$**

**17/10,000** when 45 year occupationally exposed to  **$1 \mu\text{g}/\text{m}^3$**





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**17/10,000** when 45 year occupationally exposed to  **$1 \mu\text{g}/\text{m}^3$**

**$923/10,000$  when 45 year occupationally exposed to  $59 \mu\text{g}/\text{m}^3$   
in Western Australian males**



## Discussion

- ↘ Recent measurements representing present-day exposures
  
- ↘ Limitations of measurement data
  - Measurements generally more often taken in situations where exposures are expected
    - Surface jobs may be overestimated - underground jobs probably ok
  - Monitoring data may be provided predominantly by 'best practice' mining companies, leading to underestimation of the exposure levels



## Conclusion

Levels of exposure to diesel exhaust in the contemporary Australian mining industry are substantial, particularly for underground workers.

Even though GM exposure levels are well below the recommendation of 100  $\mu\text{g}/\text{m}^3$  EC, the estimated excess number of lung cancer deaths associated with these levels support the need for more stringent OELs for diesel exhaust.



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Many thanks for your  
attention!

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