

Understanding potential lung recovery from coal mine fire smoke exposure



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Background

In 2014, residents of Morwell, Australia, were exposed to extreme concentrations of fine particulate matter ($PM_{2.5}$) $\leq 2.5\mu m$ diameter as the Hazelwood open cut brown coal mine burned for ~6 weeks. The Hazelwood Health Study (HHS) assessed the long term health consequences.

Respiratory stream aim

To determine the long term impact on lung function of exposure to fine particulate matter ($PM_{2.5}$) from coal mine fire smoke.



Photo of the Hazelwood mine fire courtesy of Keith Pakenham, Country Fire Authority

Methods

Respiratory function testing was conducted at 3 time points (Table 1). Exposed and unexposed participants performed **spirometry**, **gas transfer** (GLI z-scores) and **oscillometry** (FOT, non-linear transformations).

Individual $PM_{2.5}$ exposure was retrospectively estimated from emission, chemical transport models and time location diaries.

Mixed-effects regression models were fitted to analyse associations between $PM_{2.5}$ exposure and outcomes, controlling for key confounders.

Covariates included: age, sex, height, weight, education, employment, smoking, asthma, spirometric COPD (post-bd $FEV_1/FVC < LLN$), whether bronchodilators were withheld prior to testing, and town (Morwell / Sale).

Results

Town	Round 1 2017 - 18	Round 2 2021	Round 3 2023
Morwell (Exposed)	346	217	164
Sale (Unexposed)	173	112	80
Total	519	329	244

- Participants who completed all rounds were more likely to have a post-secondary education, be non- or ex-smokers, and report asthma.
- A trend for decreasing baseline FVC Z-scores with increasing $PM_{2.5}$ exposure observed at Round 1 was attenuated by Round 2 and maintained at Round 3 (Figure 1).
- Exposure to mine fire related $PM_{2.5}$ was not associated with gas exchange at any round, with no change in effect between rounds.
- At Round 1 $PM_{2.5}$ exposure was associated with stiffer lungs evidenced by transformed post-bronchodilator reactance (Xrs5) and area under the curve (AX5). This effect was attenuated at Round 2 and recovery was maintained at Round 3 (Figure 1).
- A trend for increased peripheral resistance (R5-R19) with $PM_{2.5}$ exposure reduced across assessment rounds with interaction p-value reaching significance at Round 3 (Figure 1).

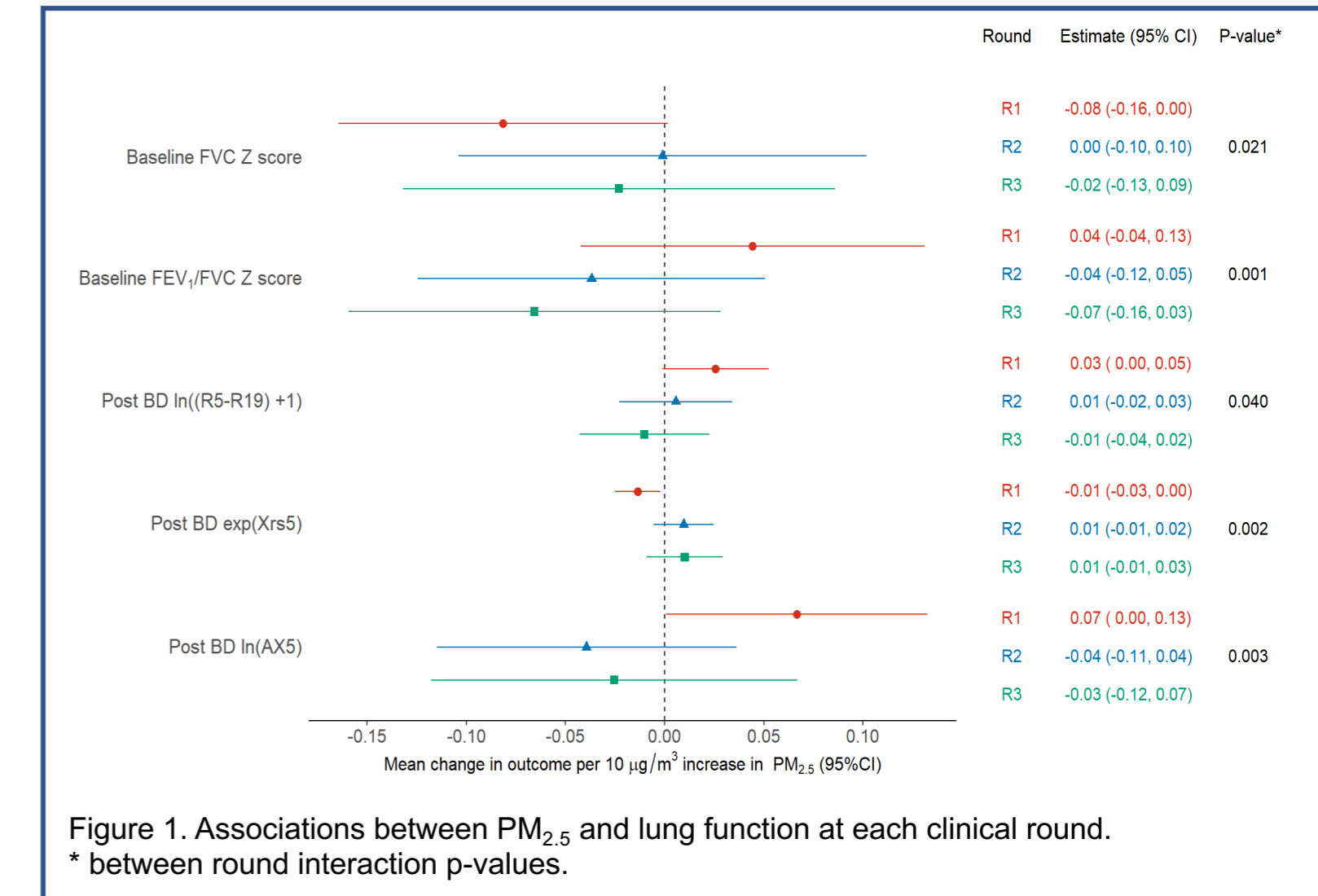


Figure 1. Associations between $PM_{2.5}$ and lung function at each clinical round. * between round interaction p-values.

Conclusions

Long-term follow up, 9 years after the fire, showed that resolution of reduced FVC and increased lung stiffness, associated with medium term $PM_{2.5}$ exposure, was maintained. A potential reduction in peripheral resistance, not seen at earlier assessment rounds, was also found.

Findings are consistent with slow recovery of lung function after exposure to coal mine fire smoke.

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