Transport Infrastructure and Air Pollution Exposure for Urban Commuters

Transport Knowledge Hub
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https://www.bikeradar.com/advice/buyers-guides/whats-the-best-bike-for-commuting/
Outline

• Results of recent research projects investigating the implications for urban planning and route optimisation associated with air pollution exposure, including the walking journey to school and travel to work via active modes.

• Some cost-effective strategies for minimising exposure will be presented as well as the air pollution exposure implications of large-sale infrastructure developments.
How well can we model roadside air pollution?

How well can we model the uptake of air pollution?

The Coburn, Forster and Kane (1965) model is known as the “best all round model for the prediction of COHb levels from CO concentrations” (WHO, 1999).

\[
V_B \frac{d[COHb]}{dt} = V_{co} - \left[ \frac{COHb}{[O_2Hb]} \right] \frac{P_cO_2}{MB} + \frac{P_{I}CO}{B}
\]

- \(B = \frac{1}{D_{L}CO} + \frac{P_L}{V_A}\)

**Rate of change of COHb**

**Endogenous production**

**Removal of COHb**

**Uptake due to exposure to CO**

\(M\) is the Haldane ratio

\(P_L\) is the pressure of dry gases in the lungs (713 mmHg)

\(V_B\) is the blood volume (5500 mL)

\([COHb]\) is the volume of CO per volume of blood (mLCO/mL blood)

\(P_cO_2\) is the average partial pressure of \(O_2\) in the lung capillaries (100 mmHg)

\([O_2Hb]\) is the maximum volume of \(O_2\) per mL of blood (0.2 mL \(O_2\)/mL blood)

\(V_{co}\) is the endogenous production of CO (0.007 mLCO/min)

\(V_A\) is the alveolar ventilation rate (sleeping 300 mL/min, light work 500 mL/min)

\(D_{L}CO\) is the pulmonary diffusing capacity for CO (30 mL/min mmHg)

\(P_{I}CO\) is the partial pressure of CO in inhaled air (mmHg)
COHb Modelling

DIRKS et al (2009) ‘Blood carboxyhemoglobin levels as a biomarker for urban air pollution’
International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne, February 2009
Mode Choice
Seven Modes Study
A 5-km journey along a popular commuting route –
7 modes, summer and winter data collection, carbon monoxide
(Illustrative…)

When looking at average air pollution exposure....

When taking into account breathing rate and travel time....

Route Choice
When looking at average air pollution exposure...
Air Pollution Exposure in Walking School Bus Routes: A New Zealand Case Study
Air Pollution Exposure in Walking School Bus Routes: A New Zealand Case Study

Air Pollution Exposure in Walking School Bus Routes: Bradford, UK

Air Pollution Exposure in Walking School Bus Routes: Bradford, UK

Air pollution exposure while walking through a park

Lin, H. 2013 Exposure of school children to traffic-related ultrafine particles during travel to school and school hours. Masters Thesis, University of Auckland, Faculty of Science,
The Role of Urban Design and Transport Infrastructure
When looking at average air pollution exposure....

Increasing distance from the road centreline

Mode

Average [CO] (ppm)

Winter

Summer

Meola Road Layout Design for Equal Air Pollution Dose
Meola Road Layout Design for Equal Air Pollution Dose

Meola Road, Pt Chevalier Study

Time Series of Concentrations for Three Modes of Commuting

Meola Road Layout Design for Equal Air Pollution Dose

Meola Road, Pt. Chevalier (proposed)

https://at.govt.nz/projects-roadworks/pt-chevalier-to-westmere/#map
Innsbruck, Austria
Northwestern Motorway
Dedicated Lanes for Cyclists

Dedicated Cycleway/Footbath – Grafton Gully
Northern Busway
T2/T3/Bus Lanes

TRANSIT LANE

T3

4PM - 6PM
MON - FRI
Queen Street-Walkability

https://commons.wikimedia.org/wiki/File:Queen_Street,_Auckland.jpg
Strategies for Minimising Traffic-Related Air Pollution for Active Mode Commuters

• Increase separation from road traffic

• Avoid walking/cycling routes alongside queued traffic

• Avoid waiting time at traffic lights
Impacts of Travel Choice

- Finances (personal and societal)
- Environmental (local and global)
- Health (physical and mental)
- Available Time
- Social Connectedness
- Educational

**Physical Health**
- Physical Activity
- Accident rates
- Air pollution exposure

**Mental Health**
- Exposure to Green Space
- Noise Exposure