Long-Term Exposure to Air Pollution and Type 2 Diabetes in Adults

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Background

- Diabetes modified effect of air pollution exposure on cardiovascular health
- Studies of diabetes as an outcome began around 2010
- New areas for recent research...
  - modification by genetics and polymorphisms
  - ozone as an exposure
  - confounding by noise pollution
Long-term Exposure Studies

- Several reviews and a few meta-analyses
- Overview of 22 long-term exposure studies from PubMed search
  - “long-term, particulate, air pollution, diabetes”
  - Verification of diabetes
- 2010-2018
- Europe, North America, China
- Sample size range 1775 – 2.1 million
- ~ 25% women only cohorts
- Mean age most studies >50
Long-term Exposure Studies

- Mortality, Prevalence and Incidence
- Pollutants
  - Most particulate matter
  - ~50% NO₂, NO, NOx
  - Few ozone
  - Few traffic density or distance to heavily travelled roads
- Exposure models mainly land use regression (LUR) and/or dispersion
- Interquartile range (IQR) change in exposure
- Fully adjusted models
  - Age
  - Sex
  - Race/Ethnicity
  - Smoking
  - Exercise
  - Affluence (area/individual)
  - Comorbidities
  - BMI
Diabetes Prevalence with Chronic PM$_{10}$ Exposures

- Italy (Renzi et al 2018) 10 µg/m$^3$
- Switzerland (Eze et al 2014) 10 µg/m$^3$
- Netherlands (Strak et al, 2017) IQR

Fully-Adjusted Risk Estimates and 95% Confidence Intervals
Diabetes Incidence with Chronic PM$_{10}$ Exposures

- Italy (Renzi et al, 2018) 10 µg/m$^3$
- USA (Puett et al, 2011)
- Germany (Weinmayr et al, 2015) traffic
- Germany (Weinmayr et al, 2015)
- Germany (Kramer et al, 2010) traffic
- Germany (Kramer et al, 2010)
- Denmark (Hansen et al, 2016)

= women-only cohort

Fully-Adjusted Risk Estimates and 95% Confidence Intervals
Diabetes Prevalence with Chronic PM$_{2.5}$ Exposures

- Italy (Renzi et al, 2018) 5 µg/m$^3$
- Canada (To et al, 2015) 10 µg/m$^3$
- China (Qiu et al, 2018)
- USA (Park et al, 2015)
- USA (Honda et al, 2017)
- Netherlands (Strak et al, 2017)

Fully-Adjusted Risk Estimates and 95% Confidence Intervals
Diabetes Incidence with Chronic PM$_{2.5}$ Exposures

- Italy (Renzi et al, 2018) 5 µg/m$^3$
- Canada (To et al, 2015) 10 µg/m$^3$
- Canada (Chen et al, 2013) 10 µg/m$^3$
- USA (Puett et al, 2011)
- USA (Park et al, 2015)
- Canada (Clark et al, 2017)
- Canada (Bai et al, 2018)
- China (Qiu et al, 2018) elder
- Germany (Weinmayer et al, 2015) traffic
- Germany (Weinmayer et al, 2015)
- USA (Coogan et al, 2016)
- Germany (Kramer et al, 2010)
- Denmark (Hansen et al, 2016)
Diabetes Prevalence with Chronic NO$_2$ Exposures

- Netherlands (Strak et al, 2017)
- USA (Honda et al, 2017) IQR
- Italy (Renzi et al 2018) 10 µg/m$^3$
- Switzerland (Eze et al 2014) 10 µg/m$^3$

Fully-Adjusted Risk Estimates and 95% Confidence Intervals
Diabetes Incidence with Chronic NO$_2$ Exposures

- Italy (Renzi et al, 2018) 5 µg/m$^3$
- Canada (Clark et al, 2017)
- Canada (Bai et al, 2018)
- Denmark (Andersen et al, 2012)
- Germany (Kramer et al, 2010) traffic
- Germany (Kramer et al, 2010)
- USA (Coogan et al, 2016)
- Denmark (Hansen et al, 2016)

Fully-Adjusted Risk Estimates and 95% Confidence Intervals
Ultrafine Particulates (UFP) and Road Proximity

- **Canada (Bai et al, 2018)**
  - IQR change in UFP: 1.06 (1.05-1.08)*

- **Denmark (Andersen et al, 2012)**
  - major road within 50m: 1.06 (0.94–1.20)
  - traffic load within 100m: 1.02 (1.00–1.04)

- **Germany (Weinmayer et al, 2015)**
  - major road within 100 m: 1.37 (1.04-1.81)*

- **USA (Puett et al, 2011)**
  - major road within 50m: 1.11 (1.01-1.23)* pooled
# Other pollutants

## NOx
- Denmark (Hansen et al, 2016)  
  - Incidence: 1.01 (0.98, 1.05) IQR change
- USA (Park et al, 2015)  
  - Incidence: 1.00 (0.86, 1.16) IQR change
  - Incidence: 1.04 (0.77, 1.40) site adjustment
  - Prevalence: 1.18 (1.01, 1.38)* IQR change
  - Prevalence: 1.29 (0.94, 1.76) site adjustment
- Italy (Renzi et al, 2018)  
  - Incidence: 1.006 (1.00, 1.01) per 20 µg/m³
  - Prevalence: 1.015 (1.01, 1.02)* per 20 µg/m³

## Ozone
- Italy (Renzi et al, 2018)  
  - Incidence: 1.02 (1.01, 1.03)* per 10 µg/m³
  - Prevalence: 1.00 (0.99, 1.01) per 10 µg/m³
- USA (Jerrett et al, 2017)  
  - Incidence: 1.18 (1.04, 1.34)* per IQR
Mortality

- **Denmark (Raaschou-Nielsen et al, 2013)**
  - 1.31 (0.98,1.76) per 10 µg/m³ of NO₂ since 1971
  - 1.18 (0.92,1.50) per 10 µg/m³ of NO₂ since 1991
  - 1.30 (1.03,1.63)* per 10 µg/m³ in year before death
  - 1.16 (0.66,2.02) road within 50m
  - 1.04 (1.02,1.07)* traffic load within 200m

- **USA (Pope et al, 2014)**
  - 1.13 (1.02–1.26)* per 10 µg/m³ PM₂.₅

- **Canada (Brook et al, 2013)**
  - 1.47 (1.16,1.72)* per 10 µg/m³ PM₂.₅
Effect Modification

- Majority of studies considered similar variables
  - Age
  - Smoking
  - Affluence (Area)
  - Sex
  - Diet
  - Exercise
  - Comorbidities (hypertension, COPD, cancer, asthma)

- Sex
  - NO$_2$/NOx some evidence risks stronger for women
  - PM inconsistent
  - Very limited evidence for closer proximity to road stronger for women
  - Both ozone studies found stronger risks for women

COPD = chronic obstructive pulmonary disease; PM = particulate matter; NO$_2$ = nitrogen dioxide; NOx = oxides of nitrogen
Effect Modification

- Age
  - Suggestive evidence of modification but few able to examine
  - Under age 60 stronger for UFP, NOx and Ozone
  - Over age 65 stronger for PM$_{10}$
- Limited evidence of stronger risks with obesity for PM
- Some evidence of stronger risks among never smokers for NOx
- Limited evidence of stronger risks with exercise
- Some evidence of stronger risks for individuals without comorbidities (e.g. hypertension), particularly for NOx


Dijkema, MBA, S F Mallant, U Gehring, Katja van den Hurk, M Alssema, R T van Strien, P H Fischer, G Nijpels, C DA Stehouwer, G Hoek, J M Dekker, B Brunekreef. Long-term Exposure to Traffic-related Air Pollution and Type 2 Diabetes Prevalence in a Cross-sectional Screening-study in the Netherlands. Environmental Health 2011, 10:76


