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

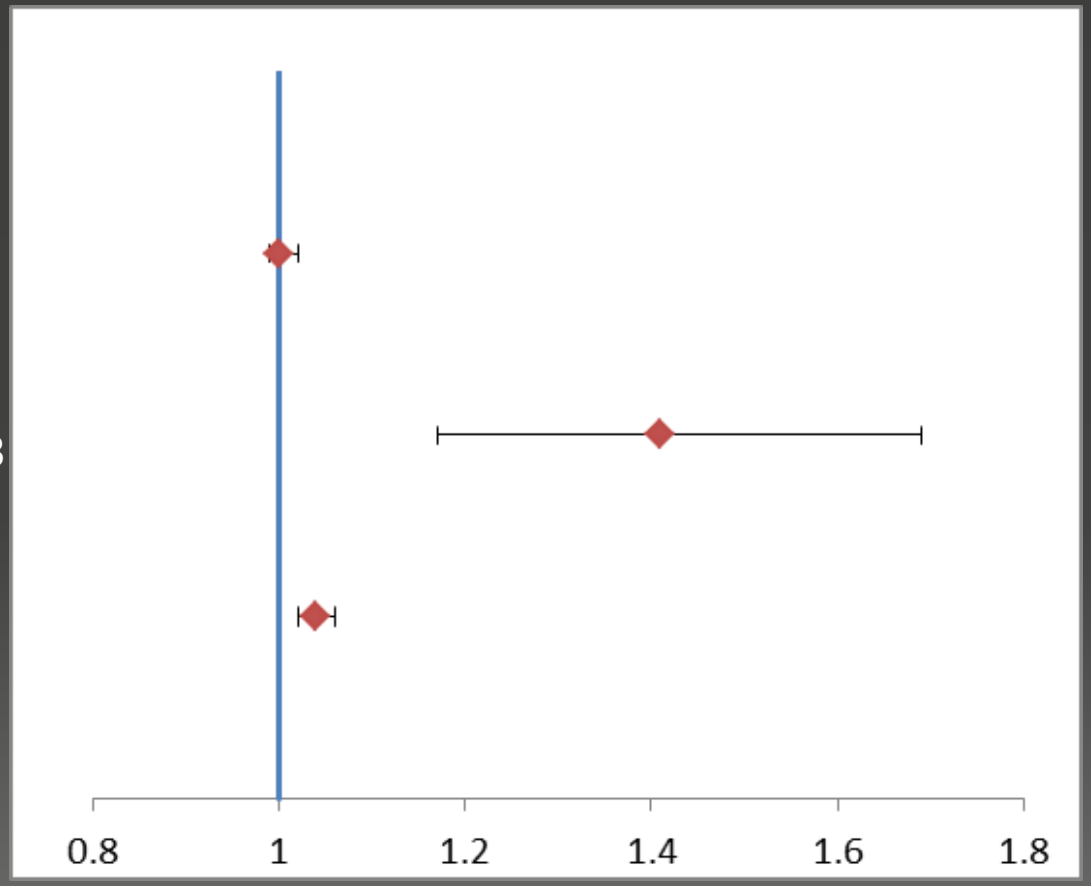
- Several reviews and a few meta-analyses
- Overview of 22 long-term exposure studies from PubMed search
  - “long-term, particulate, air pollution, diabetes”
  - Verification of diabetes
  - 2010-2018
  - Europe, North America, China
  - Sample size range 1775 – 2.1 million
  - ~ 25% women only cohorts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

Long-term Exposure Studies

- Mortality, Prevalence and Incidence
- Pollutants
  - Most particulate matter
  - ~50% NO_2, 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
  - Smoking
  - Sex
  - Exercise
  - Race/Ethnicity
  - Affluence (area/individual)
  - Comorbidities
  - BMI

Diabetes Prevalence with Chronic PM_{10} Exposures

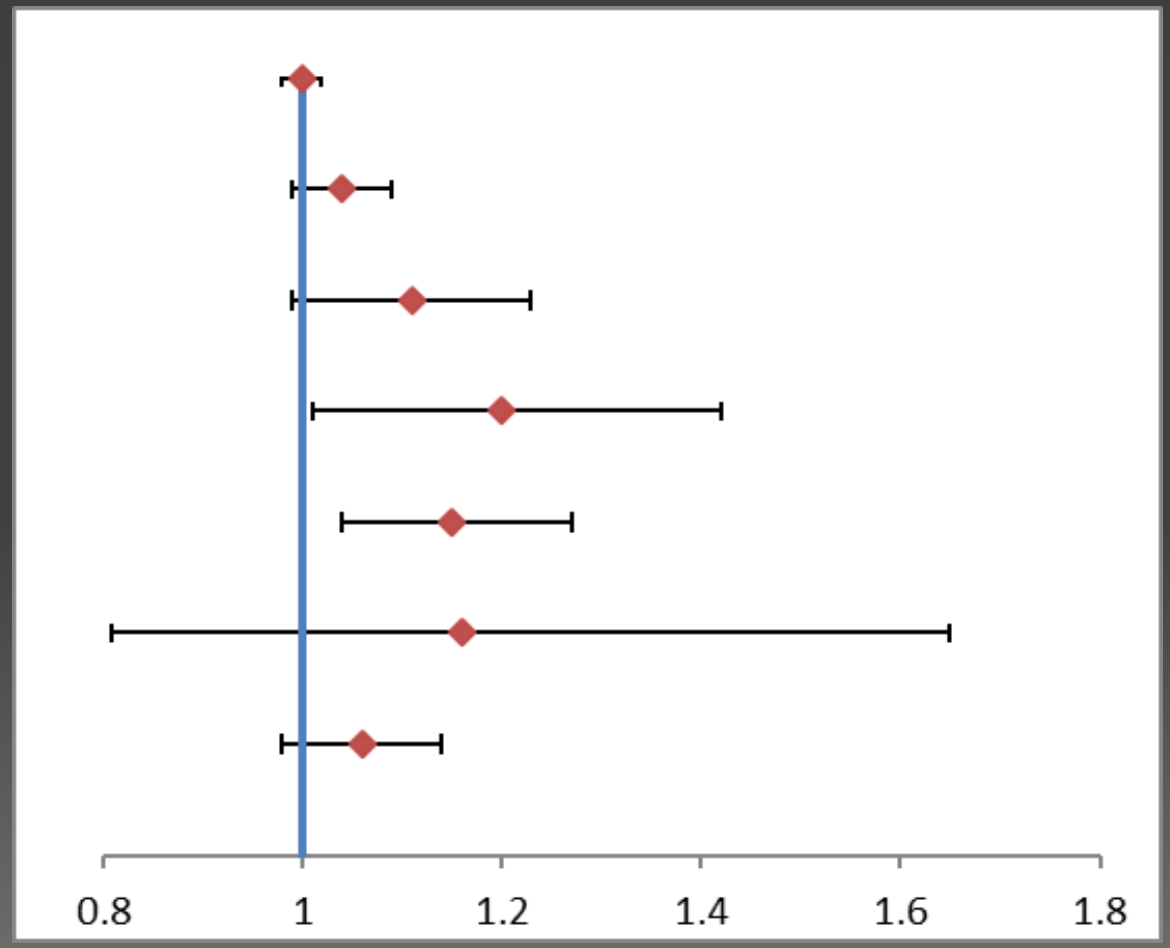
- Italy (Renzi et al 2018) 10 µg/m^3
- Switzerland (Eze et al 2014) 10 µg/m^3
- Netherlands (Strak et al, 2017) IQR



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)

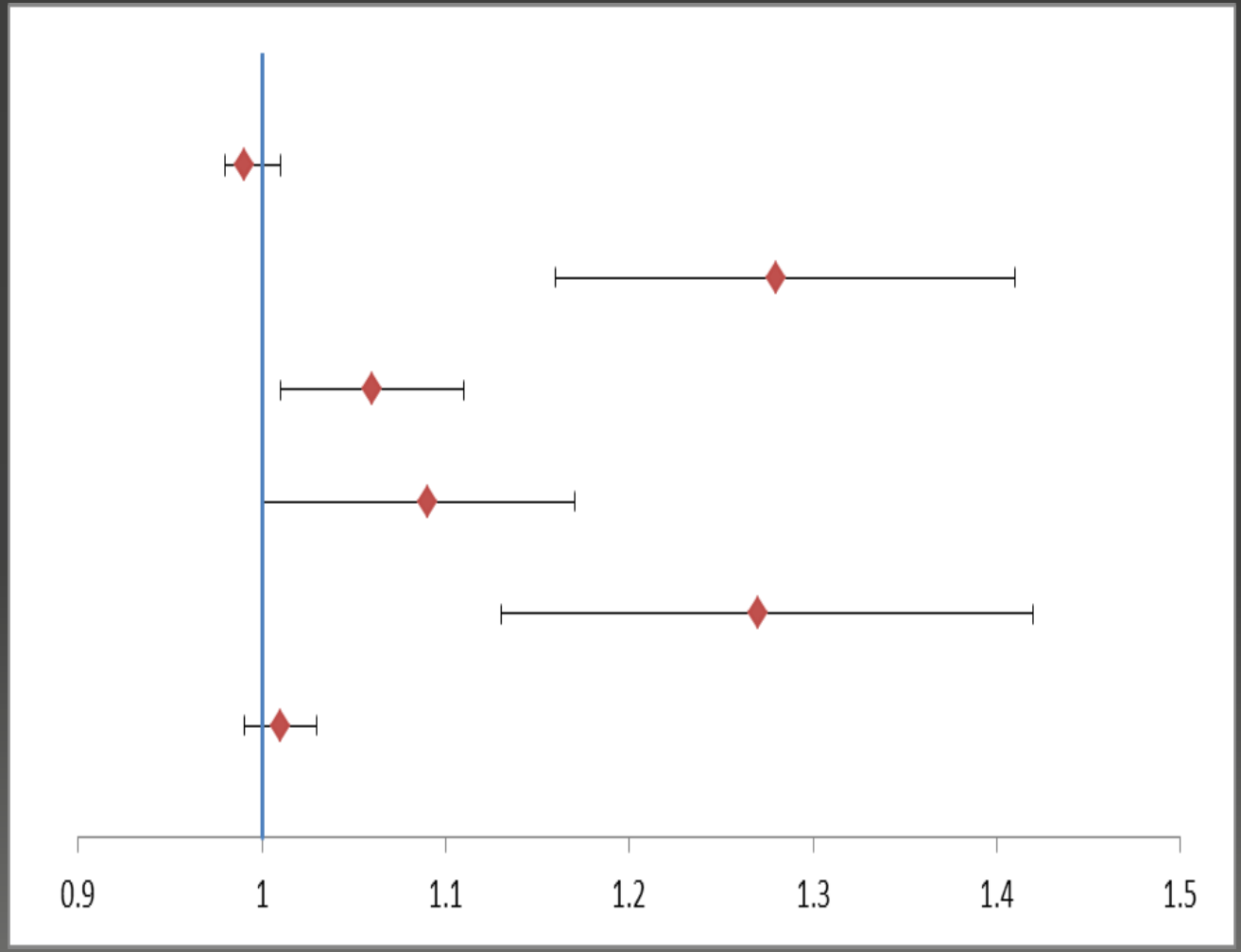


Fully-Adjusted Risk Estimates and 95% Confidence Intervals

= women-only cohort

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

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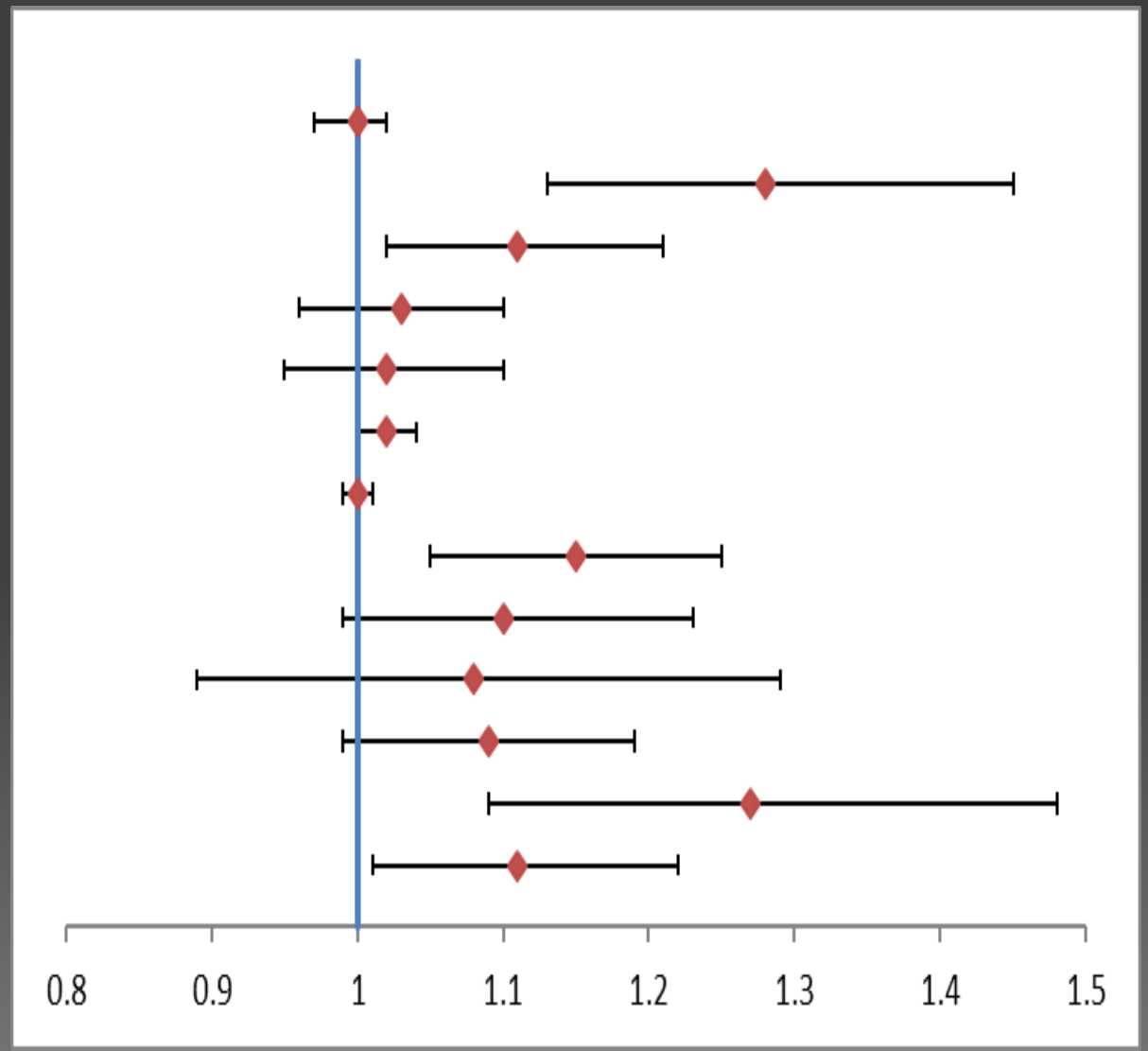
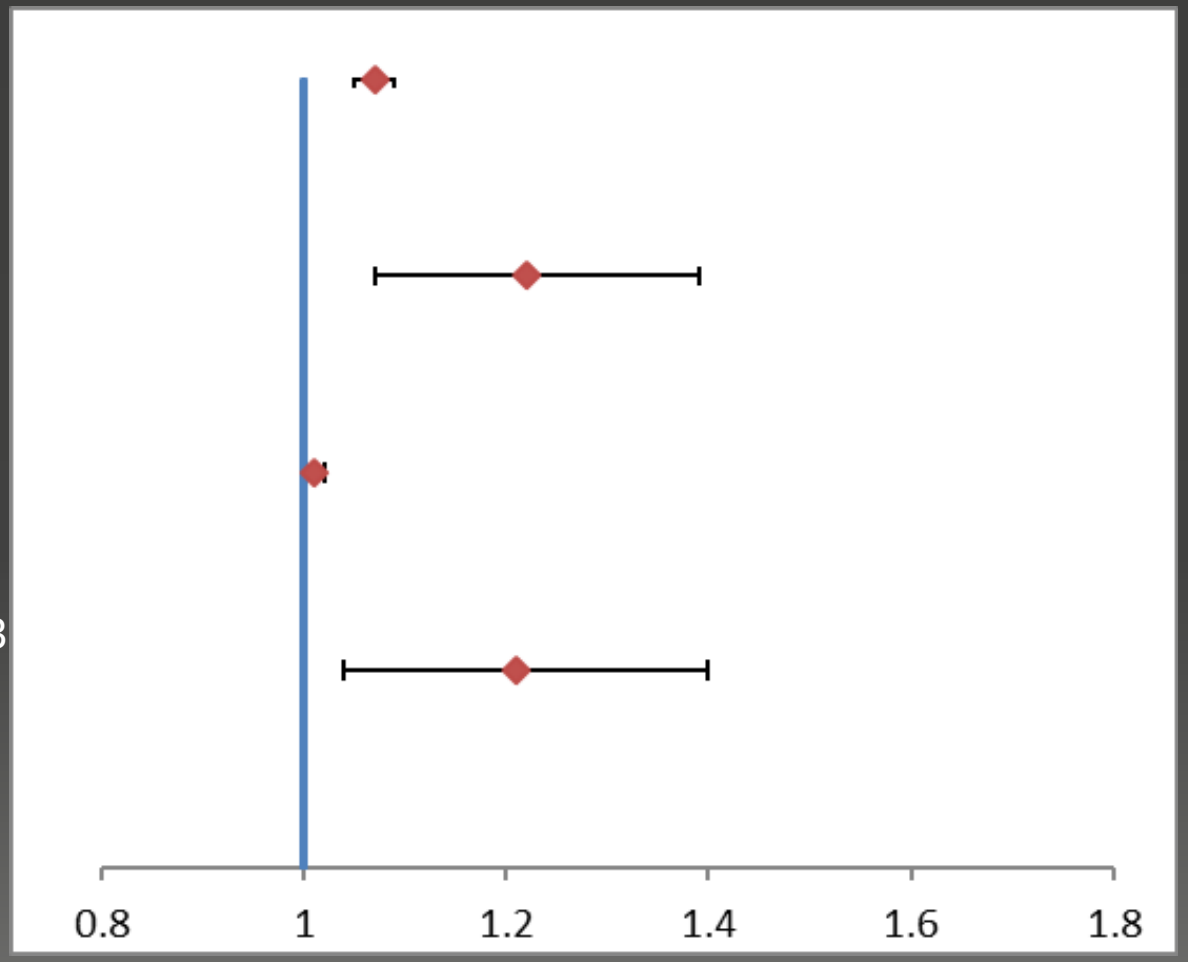
- USA (Park et al, 2015)
- Canada (Clark et al, 2017)
- Canada (Bai et al, 2018)
- China (Qiu et al, 2018) elder
- Germany (Weinmayer et al, 2015) traffic
- Germany (Weinmayer et al, 2015)
- USA (Coogan et al, 2016)
- Germany (Kramer et al, 2010)
- Denmark (Hansen et al, 2016)

Fully-Adjusted Risk Estimates and 95% Confidence Intervals



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
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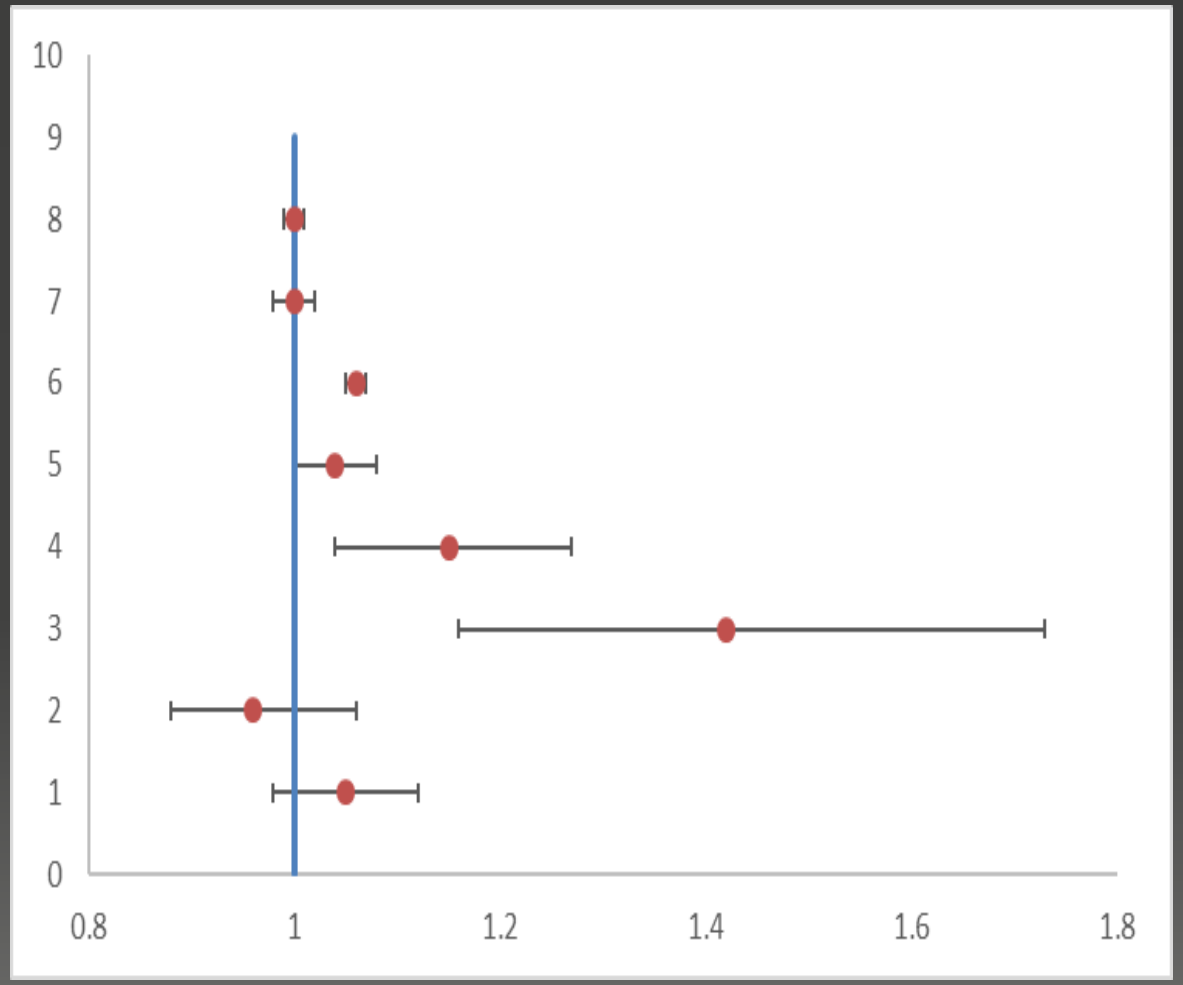
- USA (Coogan et al, 2016)
- Denmark (Hansen et al, 2016)



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/m^3
    - prevalence 1.015 (1.01,1.02)* per 20 µg/m^3
- Ozone
  - Italy (Renzi et al, 2018) 
    - incidence 1.02 (1.01,1.03)* per 10 µg/m^3
    - prevalence 1.00 (0.99,1.01) per 10 µg/m^3
  - 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/m^3 of NO_2 since 1971
  - 1.18 (0.92,1.50) per 10 µg/m^3 of NO_2 since 1991
  - 1.30 (1.03,1.63)* per 10 µg/m^3 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/m^3 $PM_{2.5}$
- Canada (Brook et al, 2013)
  - 1.47 (1.16,1.72)* per 10 µg/m^3 $PM_{2.5}$

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

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