UNIVERSITY OF COPENHAGEN

Long-term exposure to air pollution and diabetes risk in Danish Nurse Cohort study

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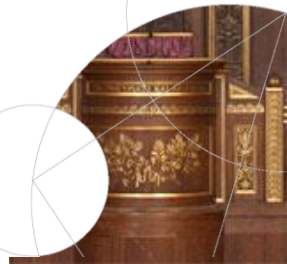
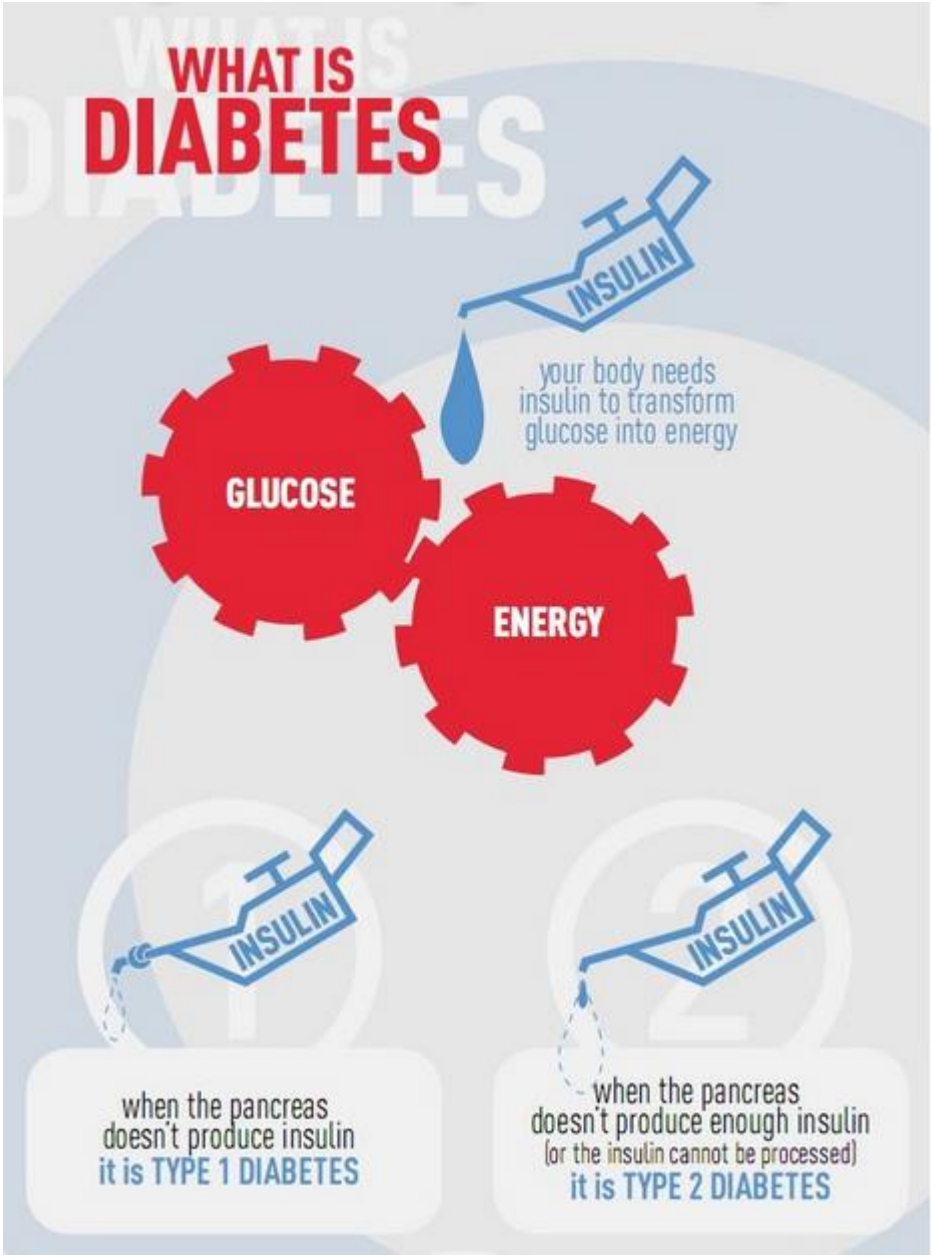
Presented by: Anne B. Hansen

Master student of Public Health Science (BSc)



Outline

- Aim
- Data
- Results
- Conclusion



From: http://www.idf.org/about-diabetes

Aim

- Air pollution → diabetes
  $PM_{2.5}$
  PM_{10}
  NO_2
  NO_x

Biological mechanism

Mice exposed to fine particles → Inflammation in visceral & brown adipose tissue

Insulin resistance

Published in final edited form as:
Circulation. 2009 February 3; 119(4): . doi:10.1161/CIRCULATIONAHA.108.799015.

Ambient Air Pollution Exaggerates Adipose Inflammation and Insulin Resistance in a Mouse Model of Diet-Induced Obesity

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Arterioscler Thromb Vasc Biol. 2010 December ; 30(12): 2518–2527. doi:10.1161/ATVBAHA.110.215350.

Effect of Early Particulate Air Pollution Exposure on Obesity in Mice Role of p47^{phox}

Xiaohua Xu, Zubin Yavar, Matt Verdin, Zhekang Ying, Georgeta Mihai, Thomas Kampfrath, Aixia Wang, Mianhua Zhong, Morton Lippmann, Lung-Chi Chen, Sanjay Rajagopalan, and Qinghua Sun
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Long-term Exposure to Ambient Fine Particulate Pollution Induces Insulin Resistance and Mitochondrial Alteration in Adipose Tissue

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informa
healthcare

RESEARCH ARTICLE

Enhanced insulin resistance in diet-induced obese rats exposed to fine particles by instillation

Yuan-Horng Yan[1,2], Charles CK Chou[3], Chung-Te Lee[4], Jung-Yen Liu[1], and Tsun-Jen Cheng[1]

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Current evidence

Research

All *EHP* content is accessible to individuals with disabilities. A fully accessible (Section 508–compliant) HTML version of this article is available at http://dx.doi.org/10.1289/ehp.1205958.

Risk of Incident Diabetes in Relation to Long-term Exposure to Fine Particulate Matter in Ontario, Canada

Hong Chen,[1,2] Richard T. Burnett,[3] Jeffrey C. Kwong,[1,4,5] Paul J. Villeneuve,[2,3] Mark S. Goldberg,[6,7] Robert D. Brook,[8] Aaron van Donkelaar,[9] Michael Jerrett,[10] Randall V. Martin,[9,11] Jeffrey R. Brook,[12] and Ray Copes[1,2]

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$PM_{2.5}$ 1.11; 1.02-1.21 per 10 µg/m³

Weinmayr *et al. Environmental Health* (2015) 14:53
DOI 10.1186/s12940-015-0031-x

ENVIRONMENTAL HEALTH

RESEARCH Open Access

Long-term exposure to fine particulate matter and incidence of type 2 diabetes mellitus in a cohort study: effects of total and traffic-specific air pollution

Gudrun Weinmayr[1,2*], Frauke Hennig[1], Kateryna Fuks[1], Michael Nonnemacher[3], Hermann Jakobs[4], Stefan Möhlenkamp[5], Raimund Erbel[5], Karl-Heinz Jöckel[3], Barbara Hoffmann[1,2†], Susanne Moebus[3†] and on behalf of the Heinz Nixdorf Recall Investigator Group

$PM_{2.5}$ 1.03; 0.89-1.29 per 2.3 µg/m³

Published in final edited form as:
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Air Pollution and Incidence of Hypertension and Diabetes in African American Women Living in Los Angeles

Patricia F. Coogan, ScD[1], Laura F. White, PhD[2], Michael Jerrett, PhD[3], Robert D. Brook, MD[4], Jason G. Su, PhD[3], Edmund Seto, PhD[3], Richard Burnett, PhD[5], Julie R. Palmer, ScD[1], and Lynn Rosenberg, ScD[1]

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$PM_{2.5}$ 1.63; 0.78-3.44 per 10 µg/m³

Environment International 70 (2014) 95–105

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/envint

Long-term air pollution exposure and diabetes in a population-based Swiss cohort

Ikenna C. Eze [a,b], Emmanuel Schaffner [a,b], Evelyn Fischer [a,b], Tamara Schikowski [a,b,c], Martin Adam [a,b], Medea Imboden [a,b], Ming Tsai [a,b], David Carballo [d], Arnold von Eckardstein [e], Nino Künzli [a,b], Christian Schindler [a,b], Nicole Probst-Hensch [a,b,*]

Research

Are Particulate Matter Exposures Associated with Risk of Type 2 Diabetes?

Robin C. Puett,[1] Jaime E. Hart,[2,3] Joel Schwartz,[2,3,4] Frank B. Hu,[2,3,5] Angela D. Liese,[6] and Francine Laden[2,3,4]

Research

Traffic-Related Air Pollution and Incident Type 2 Diabetes: Results from the SALIA Cohort Study

Ursula Krämer,[1] Christian Herder,[2]* Dorothea Sugiri,[1] Klaus Strassburger,[3] Tamara Schikowski,[1] Ulrich Ranft,[1] and Wolfgang Rathmann[3]*

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Epidemiology/Health Services Research

ORIGINAL ARTICLE

Diabetes Incidence and Long-Term Exposure to Air Pollution

A cohort study

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Matthias Ketzel, phd[2]
Steen S. Jensen, phd[2]
Martin Hvidberg, bs[2]
Steffen Loft, dmsc[3]
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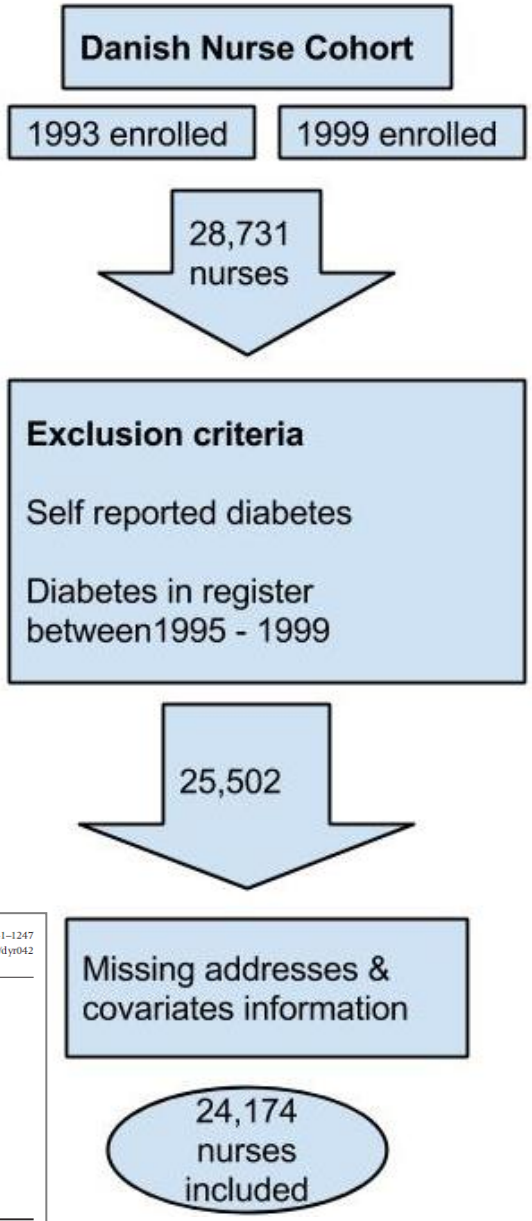
Kim Overvad, phd[4,5]
Mette Sørensen, phd[1]

diabetes correlated with the release of toxicants into the air (3), whereas diabetic people appeared more vulnerable than nondiabetic people to cardiovascular health effects associated with exposure to

Data



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doi:10.1093/ije/dyr042

COHORT PROFILE

Cohort Profile: The Danish nurse cohort

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Accepted 15 February 2011

How did the cohort come about?

From the 1970s to the mid-1990s, ~20–30% of Danish women between 55 and 65 years of age used hormone replacement therapy (HRT).[1,2] It was primarily used

In 1993, a questionnaire was mailed to 23 170 female Danish nurses >44 years of age. Followed by two reminders, a total of 19 898 (86%) nurses replied with a completed questionnaire. The cohort was rein-

Danish Diabetes Register

All the participants were merged with diabetes status from the Danish Diabetes Register.

We categorized the cohort members as diabetic if they fulfilled either of the following criteria:

1) was hospitalized with diabetes as discharge diagnosis (ICD-10 code E10-14, DH36.0, DO24) in the National Patient Register

2) used chiropody as a diabetic patient

3) made a second purchase of insulin or oral anti-diabetic drugs within 6 months, registered in Danish National Prescription Registry.

Type 2 diabetes

Scandinavian Journal of Public Health, 2011; 39(Suppl 7): 58–61

SJPH

DESCRIPTION OF DANISH REGISTERS

The National Diabetes Register

BENDIX CARSTENSEN[1,2], JETTE KOLDING KRISTENSEN[3], MORTEN MUNK MARCUSSEN[4] & KNUT BORCH-JOHNSEN[5]

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Method - analyses

Cox Proportional hazards regression model with age as underlying time, adjusted for:

Model 1: Adjusted for age

Model 2: Adjusted for age, calendar time, smoking status, smoked gram of tobacco, level of physical activity, consumed gram of alcohol per week, avoidance of fatty meat, eat fruit or vegetables, employment status and marital status.

Model 3: Model 2 + hypertension, MI (myocardial infarct)

Model 4: Model 3 + BMI

Method - Air Pollution exposure

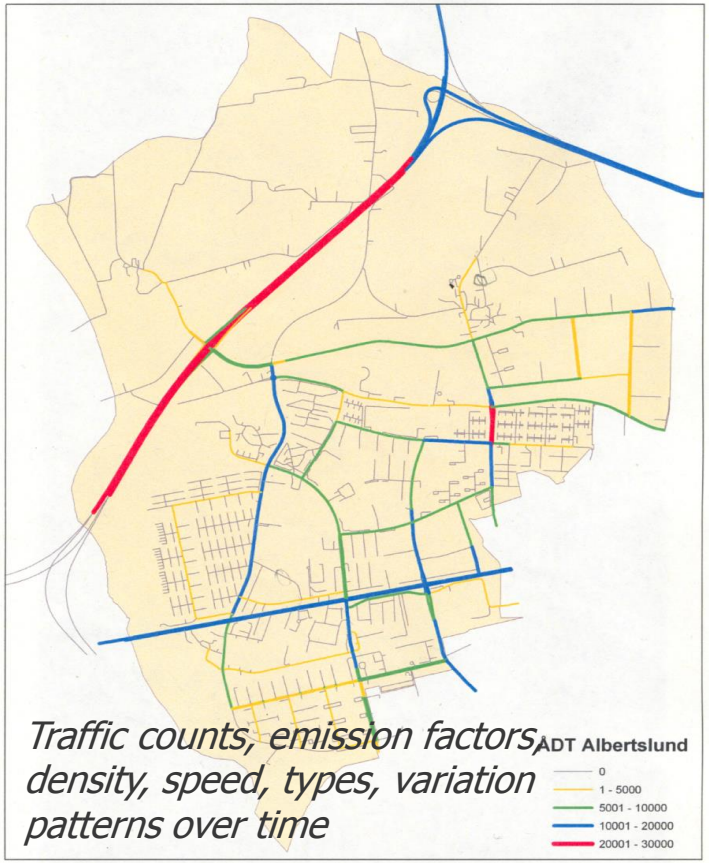
AirGIS dispersion model, sum of:

1) **regional** background, 2) **urban** background, &
3) **street level** contribution

Input for AirGIS model

- Street/building geometry
- Street network and traffic data
- Meteorology

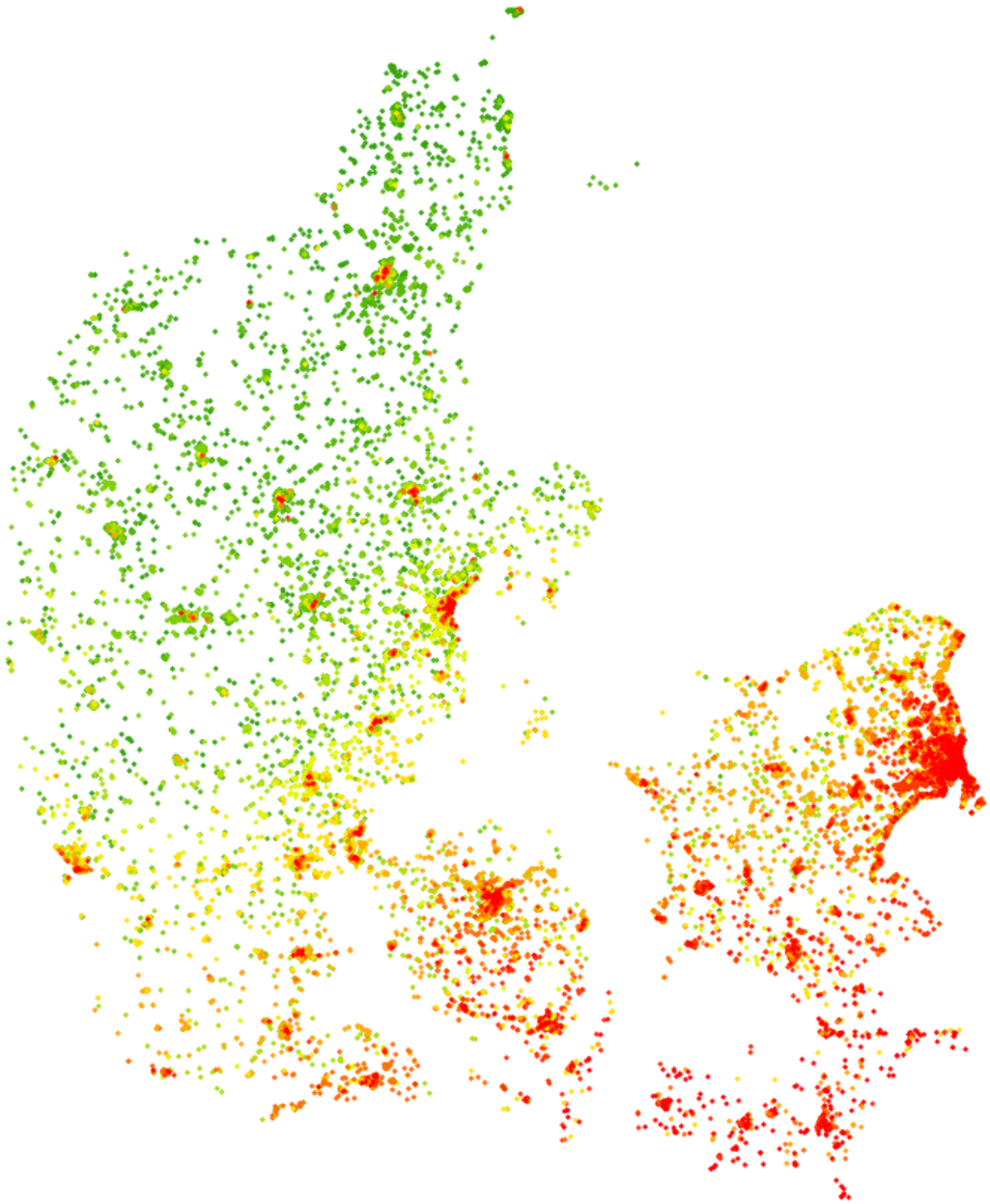
GIS Maps building height, street width, open sector



Traffic counts, emission factors, density, speed, types, variation patterns over time

Method - Air Pollution exposure

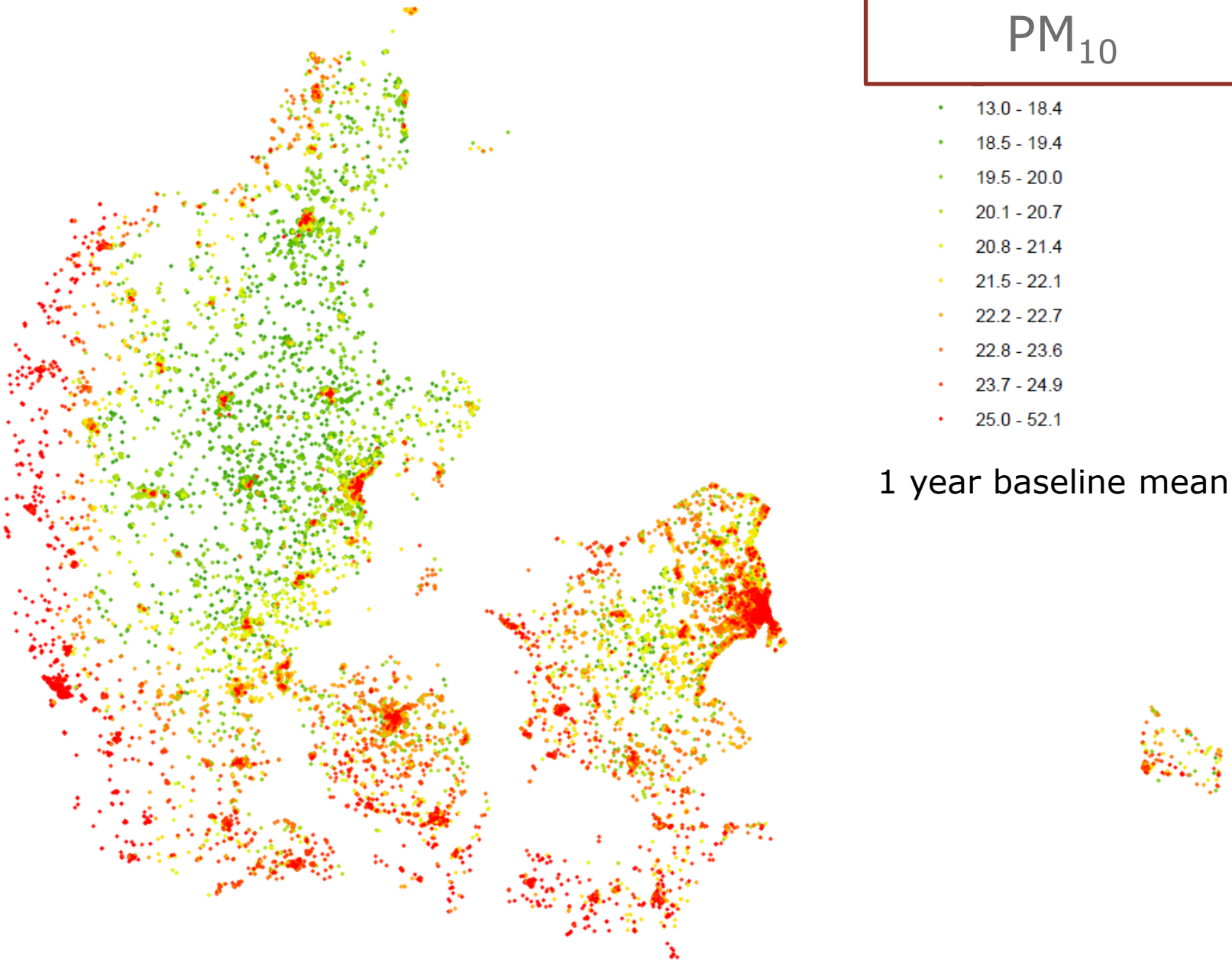
AirGIS collected annual concentration, in a 5 year time window, since 1990 to 2013, at each address for each participants.



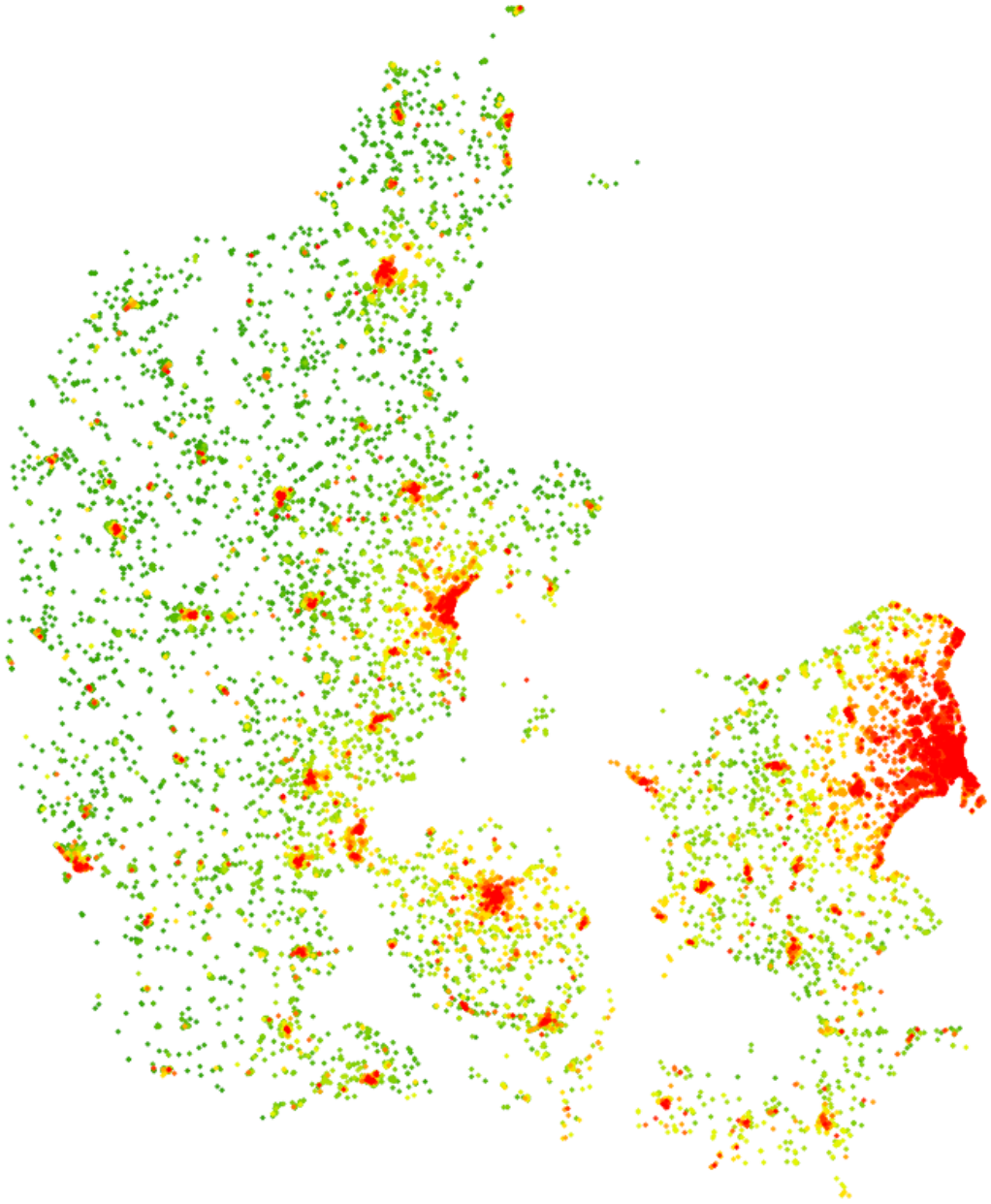
$PM_{2.5}$

- 7.0 - 14.8
- 14.9 - 15.6
- 15.7 - 16.5
- 16.6 - 17.4
- 17.5 - 17.9
- 18.0 - 18.8
- 18.9 - 19.6
- 19.7 - 20.3
- 20.4 - 21.1
- 21.2 - 42.1

1 year baseline mean level



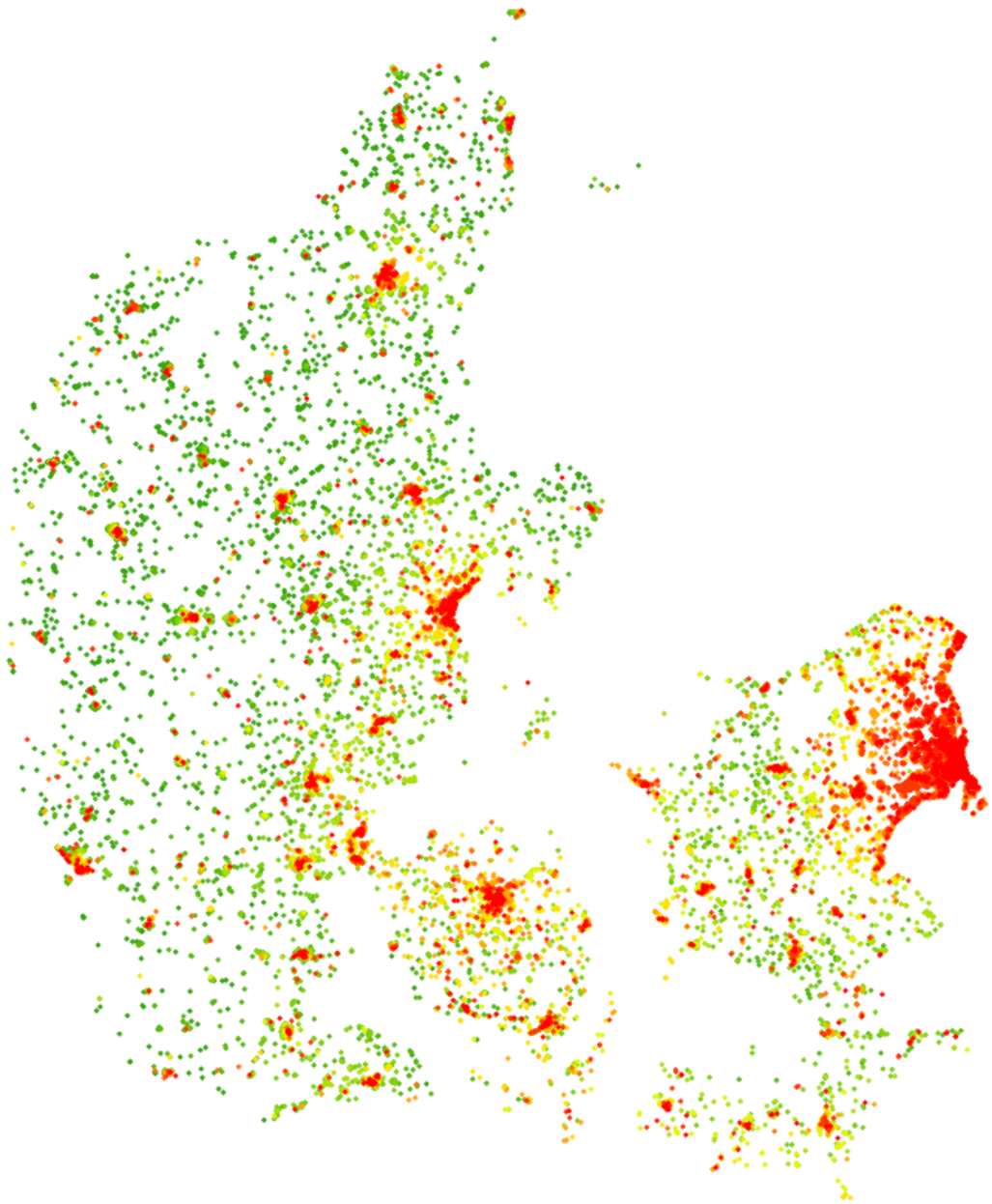
1 year baseline mean level



NO_2

- 3.3 - 5.8
- 5.9 - 7.0
- 7.1 - 7.9
- 8.0 - 8.9
- 9.0 - 10.2
- 10.3 - 12.0
- 12.1 - 14.4
- 14.5 - 16.5
- 16.6 - 20.0
- 20.1 - 76.5

1 year baseline mean level



NO_x

- 3.5 - 6.3
- 6.4 - 7.6
- 7.7 - 8.8
- 8.9 - 10.0
- 10.1 - 11.8
- 11.9 - 14.6
- 14.7 - 17.7
- 17.8 - 20.5
- 20.6 - 33.2
- 33.3 - 389.1

1 year baseline mean level

Results

Follow-up from: 1995 or 1999 until 2013

Mean follow up time: 15.3 years, 370,367 person-years

Incident diabetes cases: 3 new cases per 1,000 person-years

Baseline mean age: 54.0

The nurses who developed diabetes:

↑higher BMI, smoked more, consumed more fat and had higher rate of hypertension and MI at baseline

↓had lower physical activity level, less fruit and vegetables intake, consumed less alcohol

	Total N = 24,174	Diabetes N = 1,137	Non diabetic N=23,037
Exposure measures, baseline values			
$PM_{2.5}$ (μg/m^3), mean(SD)	18.1 (2.8)	18.7 (2.8)	18.1 (2.8)
PM_{10} (μg/m^3), mean(SD)	21.7 (2.9)	22.3 (2.9)	21.7 (2.9)
NO_2 (μg/m^3), mean(SD)	12.5 (7.9)	13.4 (8.7)	12.5 (7.9)
NO_x (μg/m^3), mean(SD)	18.4 (22.7)	19.9 (23.2)	18.3 (22.6)

Results – cont.

- Main results of estimated risk of diabetes from pollutants
- Increase per unit

Pollu-tant	Unit (µg/m³)	Model 1[a] HR (95% CI)	Model 2[b] HR (95% CI)	Model 3[c] HR (95% CI)	Model 4[d] HR (95% CI)
$PM_{2.5}$	3.1	1.14 (1.04-1.24)	1.11 (1.02-1.22)	1.11 (1.01-1.22)	**1.11 (1.02-1.22)**
PM_{10}	2.8	1.08 (1.00-1.16)	1.06 (0.99-1.14)	1.06 (0.99-1.14)	1.06 (0.98-1.14)
NO_2	7.5	1.06 (1.00-1.12)	1.03 (0.97-1.10)	1.03 (0.97-1.10)	1.05 (0.99-1.12)
NO_x	10.2	1.02 (0.99-1.05)	1.01 (0.98-1.04)	1.01 (0.98-1.04)	1.01 (0.98-1.05)
$PM_{2.5}$	10	1.50 (1.13-2.00)	1.41 (1.06-1.88)	1.39 (1.04-1.86)	1.41 (1.05-1.88)
PM_{10}	10	1.32 (1.02-1.72)	1.24 (0.95-1.62)	1.24 (0.95-1.62)	1.22 (0.93-1.59)

[A] Adjusted for age at entry

[b] Included covariates in Model 1[a] + calendar time, smoking status, smoked gram of tobacco, level of physical activity, consumed gram of alcohol per week, avoidance of fatty meat, eat fruit or vegetables, employment status and marital status.

[c] Included covariates in Model 2[b] + hypertension, MI (myocardial infarct)

[d] Included covariates in Model 3[c] + body mass index.

Results – cont.

Table - Modification of associations[a] between diabetes incidence and $PM_{2.5}$ per interquartile range by baseline characteristics and co-morbid conditions among 24,174 participants in Danish Nurse cohort.

Covariates	Covariate level	n	IR	HR (95%CI)	p[b]
Smoking status	Never	358	2.7	1.24 (1.09-1.42)	0.01
	Previous	455	3.5	1.19 (1.03-1.36)	
	Current	324	2.8	0.97 (0.86-1.10)	
BMI	Underweight (BMI < 25)	13	1.5	0.86 (0.43-1.75)	0.37
	Normal	470	1.7	1.08 (0.96-1.22)	
	Overweight (25 ≤ BMI < 30)	433	5.3	1.09 (0.96-1.24)	
	Obese (BMI ≥ 30)	221	12.4	1.25 (1.06-1.47)	
MI	Yes	19	9.3	1.32 (0.86-2.02)	0.43
	No	1,118	3.0	1.11 (1.01-1.21)	
Hypertension	Yes	313	7.5	1.15 (1.00-1.33)	0.55
	No	824	2.5	1.10 (0.99-1.21)	
Urbanity	Urban	197	3.5	1.10 (0.92-1.31)	0.33
	Rural	446	2.9	1.16 (1.01-1.33)	
	Provincial	494	3.0	1.02 (0.88-1.18)	

[a]Fully adjusted for age, calendar time, smoking status, smoked gram of tobacco, level of physical activity, consumed gram of alcohol per week, avoidance of fatty meat, eat fruit or vegetables, hypertension, MI (myocardial infarct), employment status, marital status and BMI (body mass index).
[b]From likelihood ratio test for interaction.
IR, incidence; HR, hazard ratio; CI, confidence interval

Strengths and Limitations

Strengths

- Big cohort, well defined covariate information
- Diabetes register, objective measure of incidence
- High response rate with high accuracy in answers

Limitations

- Misclassification in modeled concentrations since these are only proxies of personal exposure
- Missing information on indoor exposures (gas cooking, passive tobacco smoke, air conditioning ventilation habits), air pollution at work, commuting habits & personal activity patterns
- Type 2 diabetes status
- Family history of diabetes unknown

Conclusion

Epidemiology/Health Services Research

ORIGINAL ARTICLE

Diabetes Incidence and Long-Term Exposure to Air Pollution

A cohort study

Zorana J. Andersen, phd[1]
Ole Raaschou-Nielsen, phd[1]
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Kim Overvad, phd[4,5]
Mette Sørensen, phd[1]

diabetes correlated with the release of toxicants into the air (3), whereas diabetic people appeared more vulnerable than nondiabetic people to cardiovascular health effects associated with exposure to

- 7.5 µg/m^3 NO_2 increases the risk of diabetes with 5% insignificantly (1.05; 0.99-1.12)

Author	Hazard ratio in fully adjusted model, incl. HP, MI & BMI
Andersen et al., 2012	HR = 1.04 (1.01-1.07) NO_2 per 4.9 µg/m^3

- Long-term exposure to air pollution increases risk of diabetes, fine particles are most relevant

- 3.1 µg/m^3 $PM_{2.5}$ increases the risk of diabetes with 11% significantly

Declaration

No conflict-of-interest

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Yan Y-H, Chou CCK, Lee C-T, et al. 2011. Enhanced insulin resistance in dietinduced obese rats exposed to fine particles by instillation. *Inhal Toxicol* 23:507-519.

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