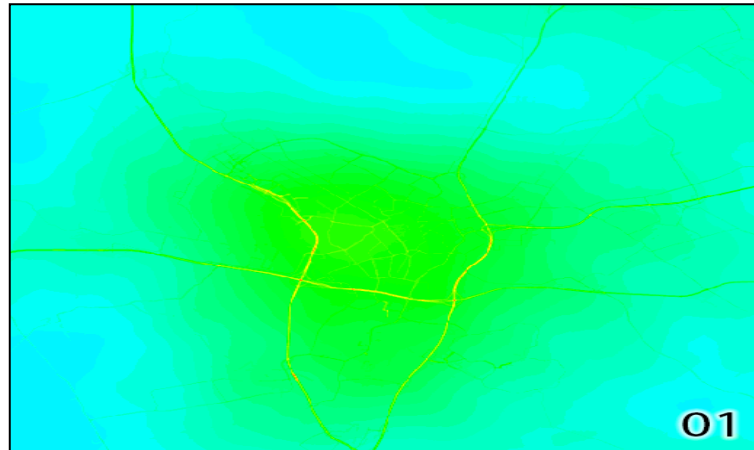


# Environmental risk factors

Ilonca Vaartjes, PhD

March 7, 2024



# Outline

- **Relevance environmental risk factors**
  - Climate change
  - More evidence impact CVD risk
  
- **Current work**
  - Indices: walkability index and OBCT index
  - ecosyndemics

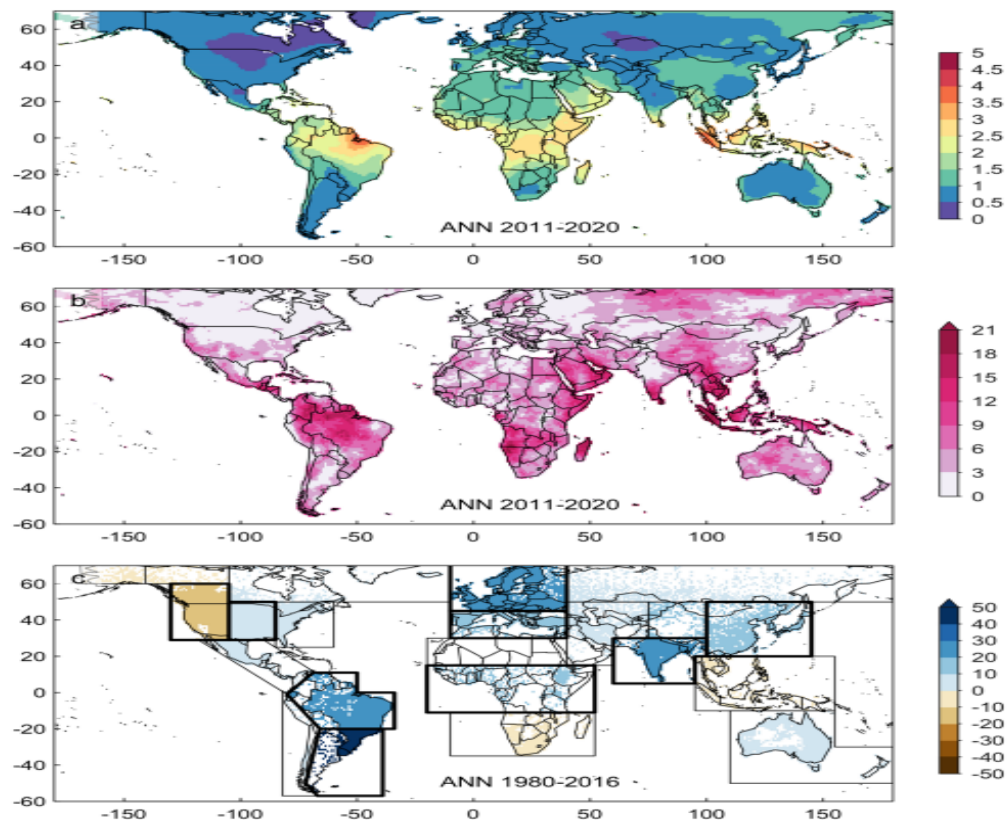
# Attention for environmental risk factors is not new



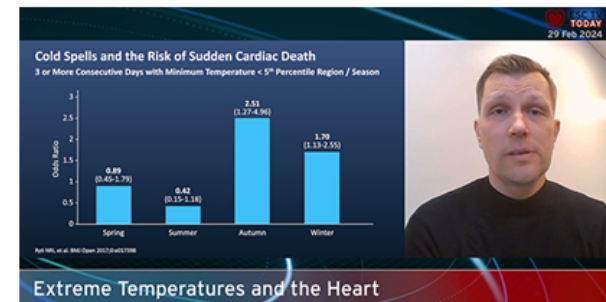
## **Hippocrates in *On Airs, Waters and Places* (400 BC):**

“Whoever wishes to investigate medicine should properly consider the seasons of the year, and what effects of them produces.”

“When one comes into a city to which he is a stranger, he should consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or to the setting sun.”



**Fig. 2 Extremes and records of the last decade.** Top panel: annual mean temperature anomalies (units of  $\sigma$ ) for 2011–2020. Middle panel: total number of monthly temperature records for 2011–2020 (the maximum possible value at each grid point is 120 = 12 months  $\times$  10 years). Bottom panel: Deviation of observed daily-rainfall records from those expected in a stationary climate (in %), aggregated for SREX regions and averaged between 1980 and 2016. Regions with statistically significant deviations from a stationary climate are highlighted with bold frames.



## LATEST UPDATES

Extreme temperatures, whether in the form of cold spells or heat waves, are becoming increasingly common. But which poses a greater threat to cardiovascular health? Prof. Juhani Junntila explains.

[WATCH NOW \(5 mins\)](#)

[ESC 365 - Episode 10: Extreme temperatures and the heart - Paravalvular leak closure \(escardio.org\)](#)



## Air pollution

### Strong evidence

PM2.5 & stroke, SO<sub>2</sub> & AF, CO & AF, NO<sub>2</sub> & IHD events

### Highly suggestive evidence

PM2.5 for MI, IHD mortality, CeVD mortality, CVD mortality, CVD events, stroke events. PM10 for AF.

NO<sub>2</sub> for CVD mortality, ICH mortality, CHD mortality

Meta-meta-analyses per 10 µg/m<sup>3</sup> increase

**PM2.5 & IHD mortality: 1.64 (1.62 to 1.66)**

**PM2.5 & CVD mortality: 1.06 (1.04 to 1.08)**

**NO<sub>2</sub> & CeVD mortality: 1.01 (0.98 to 1.05)**

## Ambient temperature



### Suggestive evidence

Temperature for CVD mortality

Heat for CVD mortality, combined CVD mortality

Cold for CVD mortality, CeVD mortality, ICH morbidity, combined CVD mortality

### Highly suggestive evidence

Meta-meta analysis per 1 °C increase

**Heat & CVD mortality: 1.013 (1.010 to 1.015)**

## Current evidence on built environment and CVD

MEDLINE, EMBASE, CINAHL, Scopus, CDSR, JBI, and PROSPERO till April 16th, 2021



**3304**

Records after duplicates removed



**51**

Studies included in qualitative synthesis

**4 meta-meta-analysis**

Studies included in quantitative synthesis

**Gaps** found in light pollution, food & physical activity environment, urbanisation

### Strong evidence

Aircraft traffic noise increase the risk of CVD mortality



Residential noise

### Suggestive evidence

Greenspace lower the risk of CVD mortality

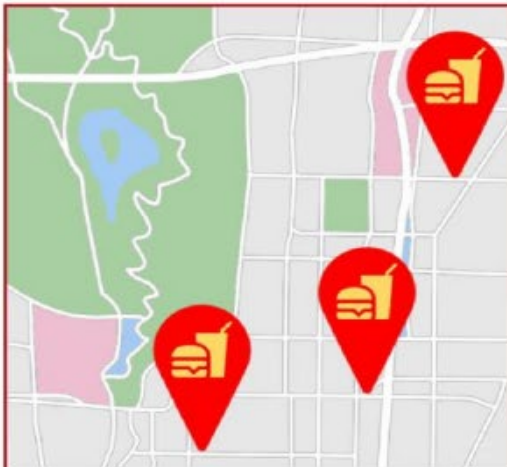


Green space

We searched **3** databases, screened **5,915** records, and included **15** studies



Most studies were conducted in North-America and Europe



**9** studies examined fast-food restaurant density (FFRD) and **4** fast-food restaurant availability

Other exposures were food service restaurants, healthy food outlets, and a food access score.

Current evidence suggests that



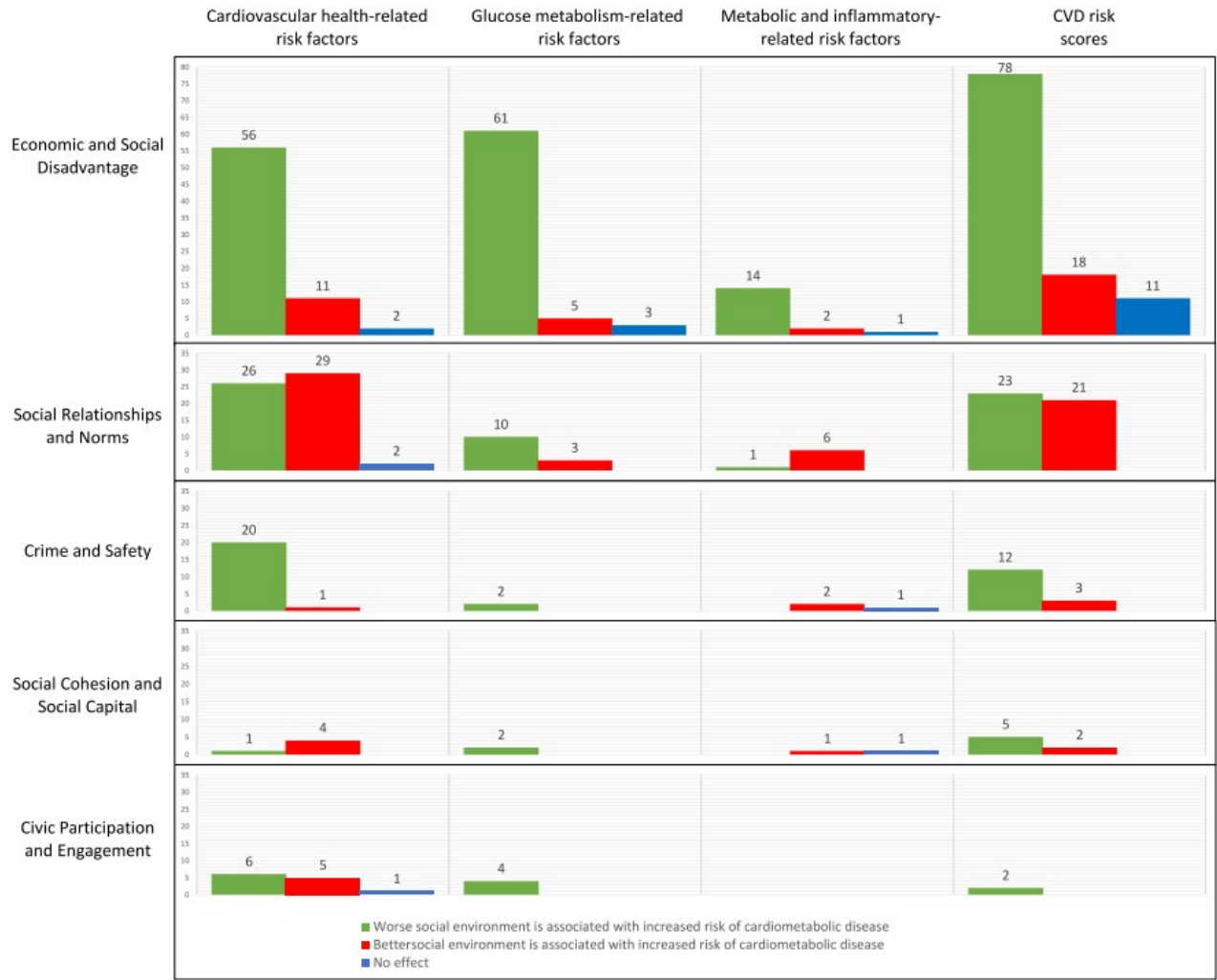
**Higher** FFRD is associated with **higher** CVD/CVD mortality.

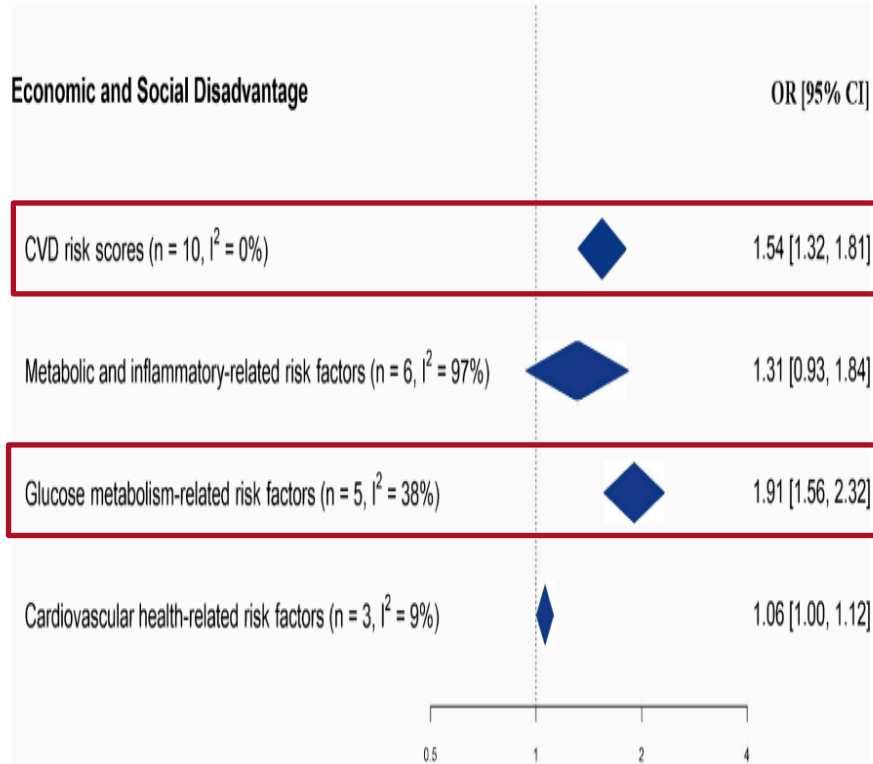


Effect sizes were small, but important given the large population that is exposed.

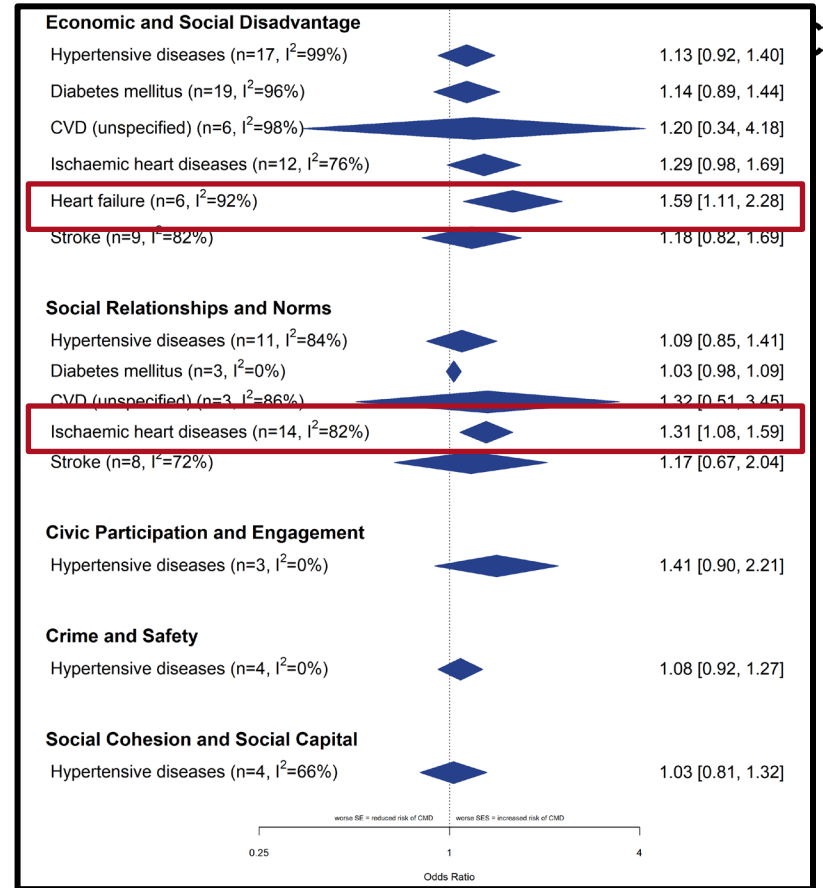
Research is needed to assess other aspects of the food environment besides fast-food. The use of standardized measures will improve study comparability. Different geographic, cultural and socio-economic contexts should be investigated.

Meijer et al. European Journal of Preventive Cardiology (2023) 30, 1840–1850





Abreu et al. *SSM popul Health* (2023) 25, 101559



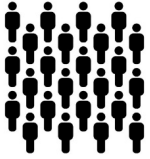
Abreu et al. *Submitted*



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# Built environment and physical activity



Population density



Retail & service density



Land use mix



Street connectivity



Green space density



Sidewalk density



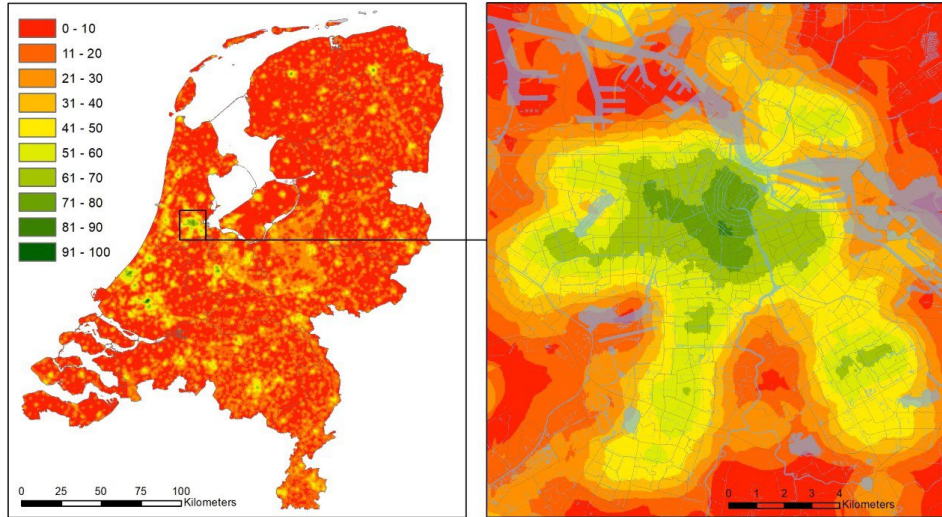
Public transport  
density

In general, these seven factors are positively associated with walking in adults.

Studies often examine built environmental characteristics in isolation, but do not consider that people are exposed to multiple factors at the same time.

Lam et al. J Behav Nutr Phys Act 2022;19:50.

# Composite approach: walkability index



The index represents the degree to which neighbourhoods are conducive to walking (0 (low) – 100 (high)).

The index can be calculated for buffer zones around addresses, postal code areas and neighbourhoods.

Lam et al. J Behav Nutr Phys Act 2022;19:50.

# Walkability index and physical activity

Dutch national travel survey



10%

Increase in walkability in 150m buffer zones  
around the center of residential six-digit  
postal codes

**Total walking:**

8.5 minutes (95% CI=7.0 – 9.9)

**Discretionary walking:**

8.5 minutes/day (95% CI=6.8 – 10.2)

**Non-discretionary walking:**

6.9 minutes/day (95% CI=5.1 – 8.7)

**Results were consistent across other buffers**

# Geoscience and Health Cohort Consortium



Timmermans et al. *BMJ Open* 2018;8(6):e021597.

Lakerveld et al. *Int J Health Geogr.* 2020 13;19(1):49

Open access
Cohort profile

## BMJ Open Cohort profile: the Geoscience and Health Cohort Consortium (GECCO) in the Netherlands

Erik J Timmermans,<sup>1</sup> Jorren Lakerveld,<sup>1</sup> Jolien W J Boukens,<sup>1,2</sup> Dorine I Boomsma,<sup>3</sup> Sophie E Kraemer,<sup>4</sup> Marjam Oudamsmans,<sup>5</sup> Geertruida HJ Hermans,<sup>6</sup> Marjolita Stam,<sup>7</sup> Giel Nijssen,<sup>8</sup> Carlo Schuengel,<sup>9</sup> Jan H Buit<sup>7,8</sup>, Bert Brunekreef,<sup>1,9</sup> Jasper E C Dekkers,<sup>10</sup> Dory J H Deeg,<sup>11</sup> Brenda W J H Penninx,<sup>7,8</sup> Martijn Huizman<sup>11</sup>

**Abstract**  
**Purpose** In the Netherlands, a great variety of objectively measured geo-data is available, but these data are scattered and measured at varying spatial and temporal scales. The combination of these geo-data and the linkage of these data to individual-level data from longitudinal cohort studies enables large-scale epidemiological research on the impact of the environment on public health in the Netherlands. In the Geoscience and Health Cohort Consortium (GECCO), six large-scale and ongoing cohort studies have been combined with a variety of existing geo-data. Here, we introduce GECCO by describing (1) the phenotypes of the included cohort studies, (2) the collected geo-data and their sources, (3) the methodology that was used to link the collected geo-data to individual cohort studies, (4) the similarity of commonly used geo-data between our consortium and the nationwide situation in the Netherlands and (5) the distribution of geo-data within our consortium.  
**Participants** GECCO includes participants from six prospective cohort studies (eg, 44 657 respondents (0.6–100 years) in 2002) and it covers all municipalities in the Netherlands. Using postal code information of the participants, geo-data on the address-level, postal code-level as well as neighbourhood-level could be linked to individual-level cohort data.  
**Findings to date** The geo-data could be successfully linked to almost all respondents of all cohort studies with successful data linkage rates ranging from 81.1% to 100.0% between cohort studies. The results show variability in geo-data within and across cohorts. GECCO increases power of analyses, provides opportunities for cross-checking and replication, ensures sufficient geographical variation in environmental exposures and allows for regional analyses on specific subgroups.  
**Future plans** GECCO offers unique opportunities for longitudinal studies on the complex relationships between the environment and health outcomes. For example, GECCO will be used for further research on environmental determinants of (psycho)neurological functioning and lifestyle behaviours.

**INTRODUCTION**  
 The exposure encompasses the life-course environmental exposure from the prenatal period onwards and reaches growing attention in medical research with respect to its relationship with health, behaviours and health outcomes.<sup>1–3</sup> Multidisciplinary and longitudinal research combining individual-level data with environmental-level data is urgently needed to identify and better understand the environmental determinants of behaviours and health and to optimally inform policymakers. In the Netherlands, a great variety of objectively measured geo-data is available (eg, air pollution, traffic noise and area demographics), but these data are currently scattered and measured at varying spatial and temporal scales. The combination of these geo-data and the linkage of these data to individual-level data from longitudinal cohort studies would therefore

**Strengths and limitations of this study**

- The main strengths of the Geoscience and Health Cohort Consortium (GECCO) are the combination of a variety of objectively measured geo-data at the address-level, postal code-level and neighbourhood-level and the linkage of these environmental-level data to individual-level data from six longitudinal cohort studies in the Netherlands.
- The large number of respondents in GECCO are spread out over all municipalities in the Netherlands and, consequently, the variation in environmental exposures is large.
- The geo-data could be successfully linked to almost all respondents of each participating cohort study with successful data linkage rates ranging from 81.1% to 100.0%.
- Although the collaboration between the cohort studies in GECCO increases power of analyses and enables regional analyses on specific subgroups, procedures are required to harmonise variables between cohort studies.

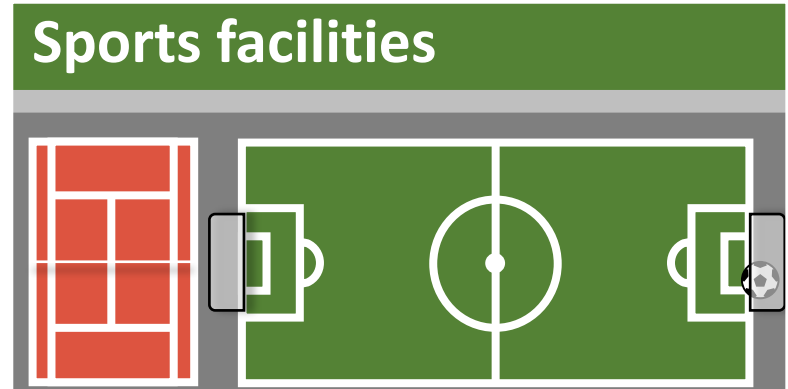
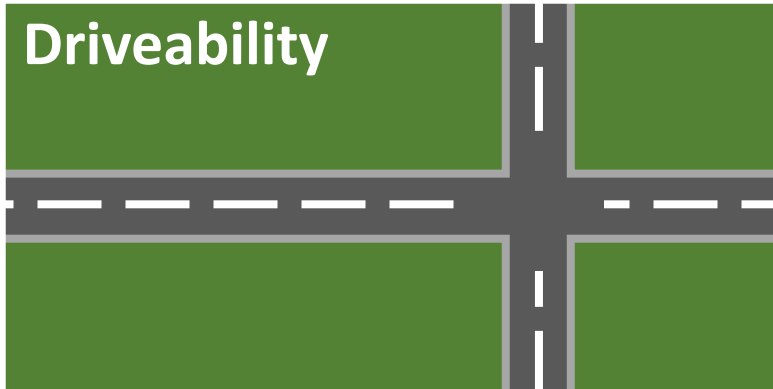
**Check for updates**

For more information on this article, please see the end of this article.

Correspondence to: Erik J Timmermans, e.j.timmermans@uu.nl

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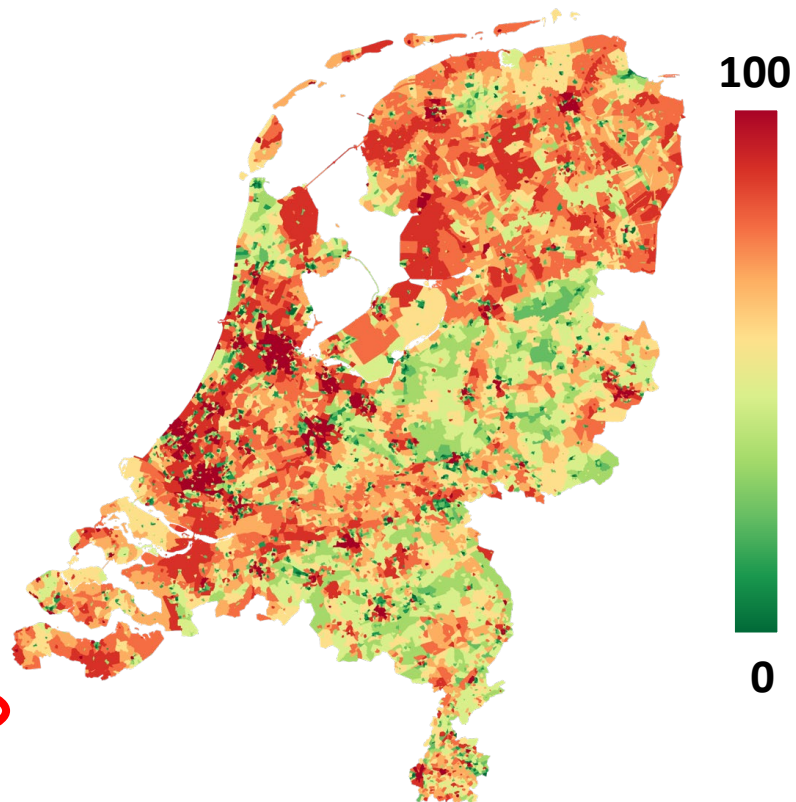
# Obesogenic Built environmental Characteristics (OBCT) index



# OBCT index and health outcomes

10% increase in OBCT index is associated with higher BMI, higher systolic blood pressure, higher prevalence of overweight/obesity and higher prevalence of hypertension.

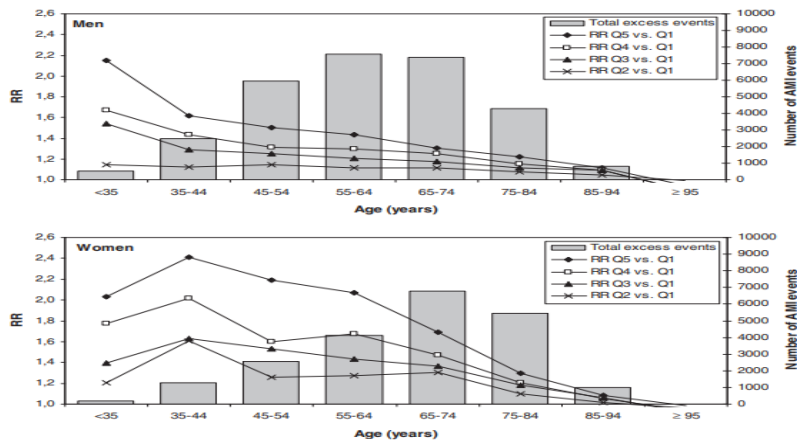
Meijer et al. *Submitted*.



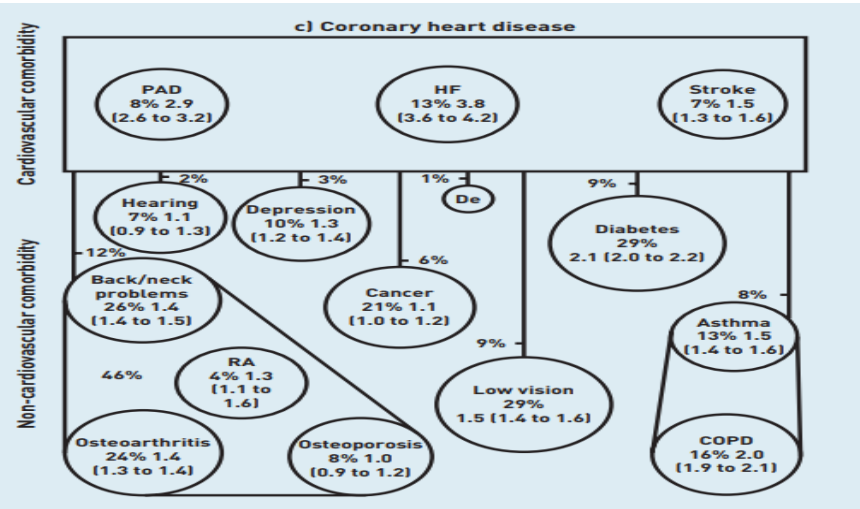
A word cloud featuring various terms in different colors and sizes. The most prominent words are 'ecosyndemics' (green), 'resilience' (dark red), 'science' (green), 'healthcare' (blue), 'citizens' (green), and 'lifestyle' (purple). Other visible words include 'policy', 'systems', 'catastroph', 'information', 'pollution', 'greenness', 'association', 'activity', 'physical', 'noise', 'models', 'environment', 'smoking', 'mining', 'decision', 'rule', 'diet', 'food', 'geographical', 'air', 'participatory', 'action', 'text', 'research', 'mobility', 'forest', 'random', and 'exercise'.

policy systems  
catastroph information  
pollution  
greenness association activity  
**ecosyndemics**  
physical noise models  
environment smoking mining decision  
rule  
**resilience**  
diet food geographical air  
participatory action text  
**science** **healthcare**  
research  
**citizens** mobility  
forest  
random  
exercise  
**lifestyle**

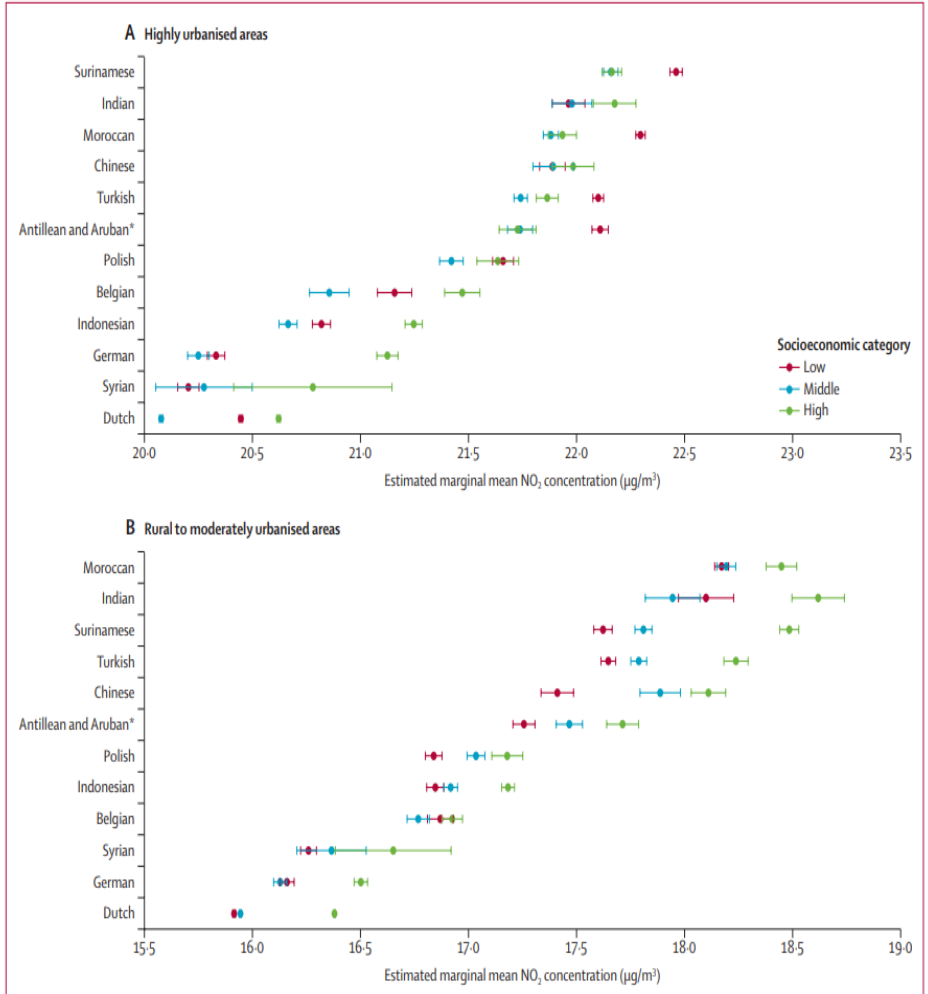




Koopman et al. BMC Public Health 2012, 12:617



Buddeke et al. BJGP(2019),2398



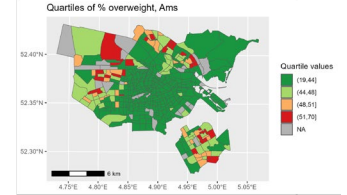
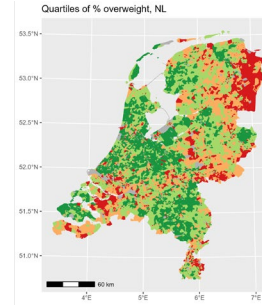
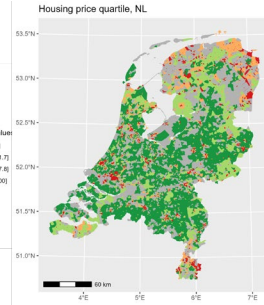
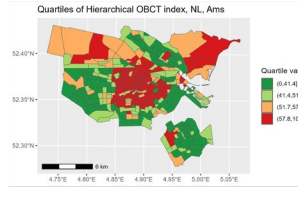
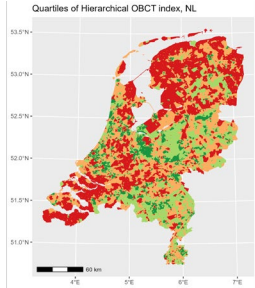
Van den Brekel et al. Lancet Planetary Health(2024) 8, 18–29

## Definition ecosyndemic:

The ecosyndemic model is an **extension** of the syndemic theory that focuses on how the physical environment interacts with health conditions as well as shape the context for enhanced interaction between health conditions.

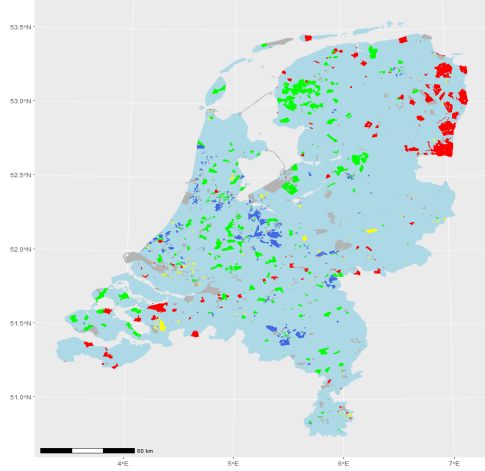
## Four ecosyndemic rules:

1. Disease clustering
2. Disease interaction
3. Harmful social conditions drive interactions
4. **The physical environment is actively interacting with health conditions on an individual and population level.**

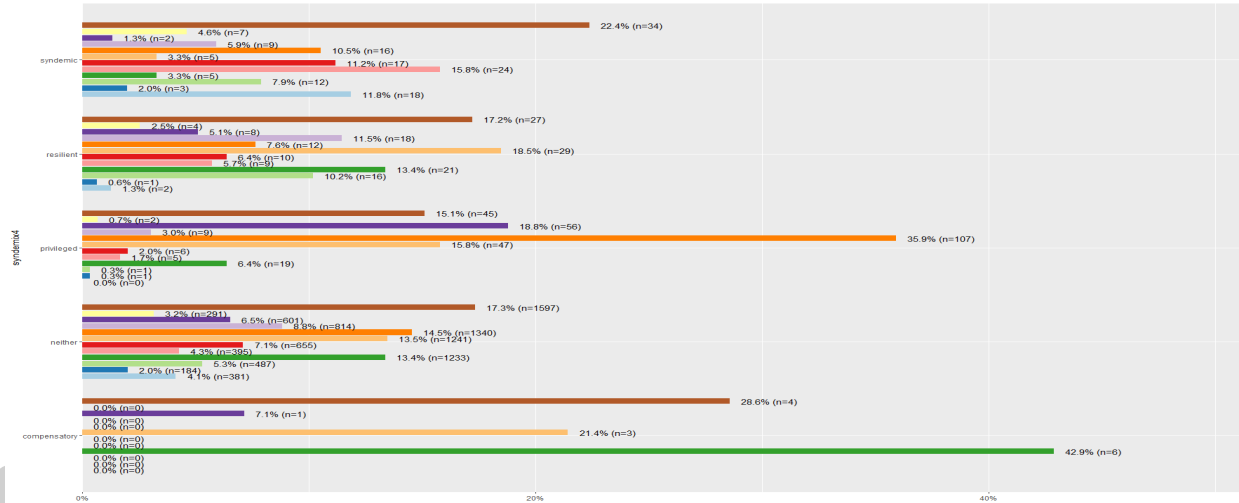
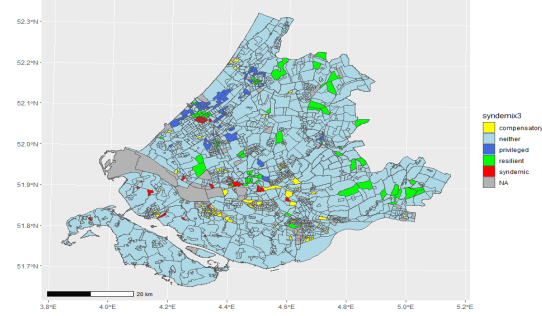


	Environmental High risk		Environmental low risk	
OBCT	Hi		Lo	
SES	Low		Hi	
Overweight	Hi	Lo	Hi	Lo
Categories	Syndemic	Resilient	sensitive	Privileged
n	341	635	194	481

NBH categories, NL



NBH categories, ZH



Provincienaam



# TAKE HOME MESSAGES

- **Climate change will burden CVD patients**
- **Abundance of evidence available showing the harm of environmental exposures on CVD-> clinicians also should take a role in dealing with this problem.**
- **Effect size on individual level might seem small but the entire population is exposed-> large public health consequences**
- **Big steps have been made but there is further room for improvement in this research field (e.g combining exposures)**
- **Prevention is challenging though ecosyndemic way of thinking might open up new avenues**



## Acknowledgement

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Erik Timmermans



[www.exposome.nl](http://www.exposome.nl)

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