Urban and transport planning pathways to carbon neutral, liveable and healthy cities

Mark J Nieuwenhuijsen

ISGlobal Barcelona Institute for Global Health

Institució CERCA Centres de Recerca de Catalunya

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CONTEXT

Each year world wide there are:

- **4.2 million deaths due to ambient air pollution**
- **3.2 million deaths due to lack of physical activity**
- **1.2 million deaths due to traffic fatalities**

WHO, GBD

- **Climate crisis**
- **Population growth and ageing**
- **Urbanization (70% live in cities soon)**

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The New Coronavirus: Some Answers and Man Questions

TRANSMISSION REDUCTION MEASURES

Hygiene/hand washing

Physical distancing (1.5 meters)

Self isolation when ill

Light to severe lockdown measures

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IMPACTS

	Barcelona/Catalonia
Reduced physical activity	-40%
Increase in poor mental health	+20%
Domestic violence	+20%
Reduced traffic	70-80%
Reduced air pollution (NO2)	70-90%
Reduced noise	-9Db(a)
Green space visits	-90%

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PREREQUISITES FOR CHANGE

- Crisis
- Knowledge
- Technology
- Partnership
- Vision
- Leadership

Adapted from Lucia Reisch

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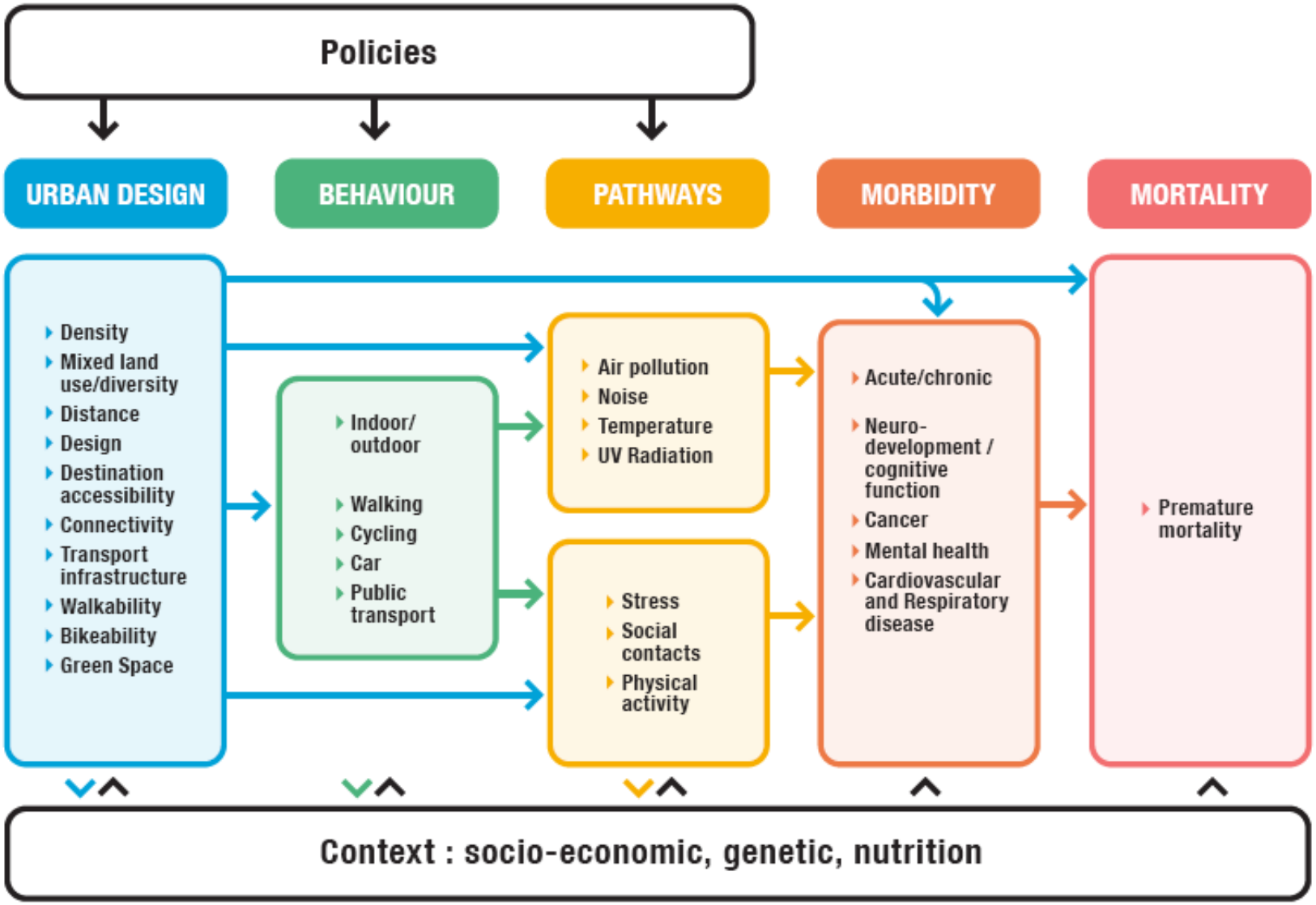

Nieuwenhuijsen 2016 and 2018

2904 premature deaths (20%) annually in Barcelona due to suboptimal urban and transport planning

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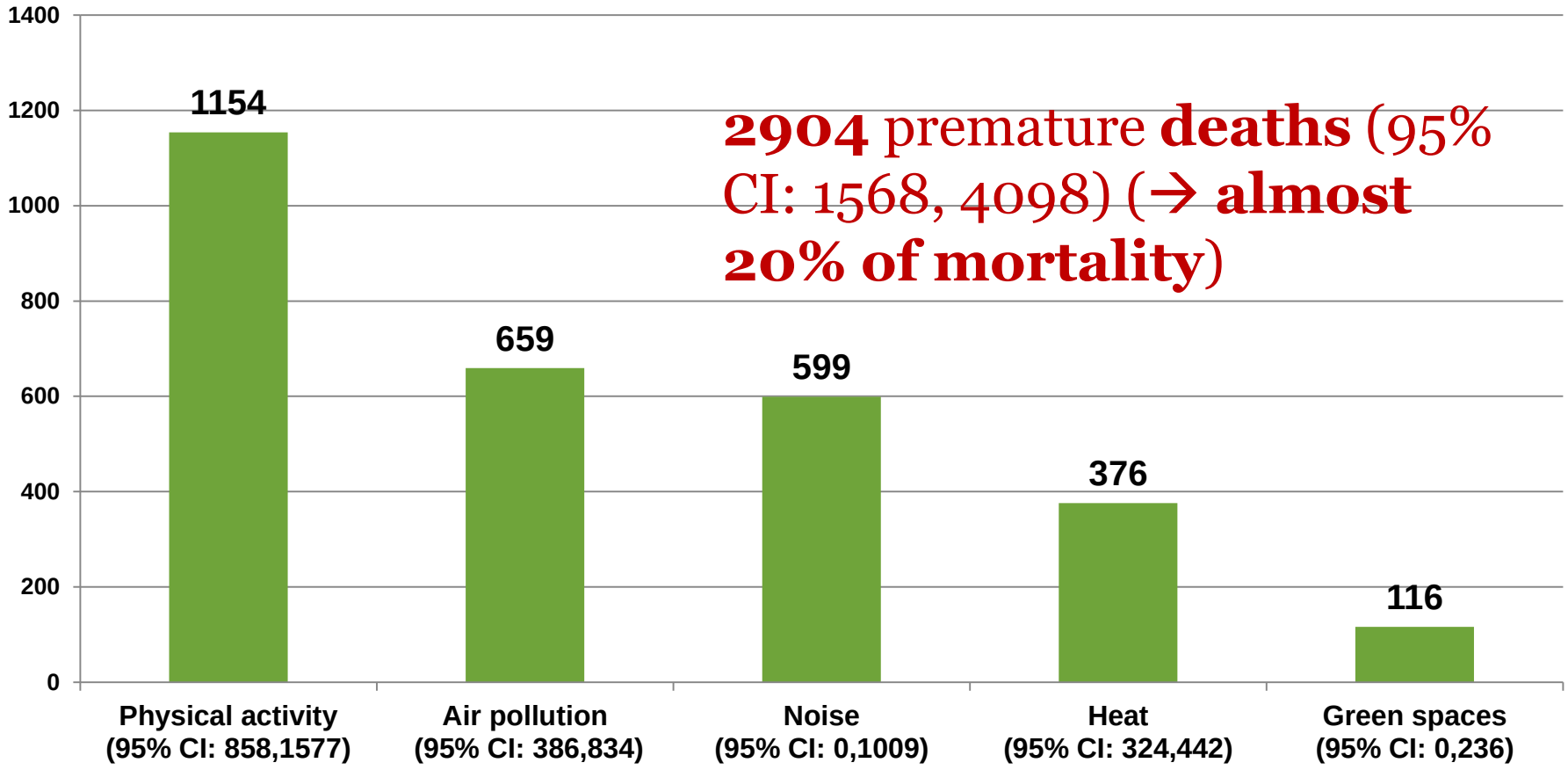
Mueller et al EHP 2017; 125: 89-96

DEATHS DUE TO POOR URBAN AND TRANSPORT PLANNING BARCELONA



2904 premature **deaths** (95% CI: 1568, 4098) (→ **almost 20% of mortality**)

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Traffic injury deaths 30

Mueller et al EHP 2017; 125: 89-96

TRANSPORT SOLUTIONS

1.5 meters distance society

Impact on transport and use of public space

	CR	Public space	health benefits	Environ. impacts
Car	L	H	L	H
Public transport	H	M	M	M
Walking	L	L	H	L
Cycling	L	L	H	L
Others	?	?	?	?

CR=contagion risk

L=low, M=medium, H=high

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36 156

The Guardian view on Covid-19 and transport: walk to the future

Editorial

The need for physical distancing means that space in our towns and cities must be shared in new ways

- Coronavirus – latest updates
- See all our coronavirus coverage

The Rue de Rivoli, a central route in Paris, will be devoted mostly to bike and pedestrian traffic after lockdown is lifted. // Cyril Marcilhacy/Bloomberg

Paris Has a Plan to Keep Cars Out After Lockdown

FEARGUS O'SULLIVAN APRIL 29, 2020

London / Large areas of city to be made car-free as lockdown eased

Live
UK coronavirus: Welsh schools will not open until September; 'stay home' advice remains

London
TfL faces £3bn funding gap despite £1.6bn bailout

Education
Prolonged school closures risk damaging children's education, No 10 warns

Guardian

Milan announces ambitious scheme to reduce car use after lockdown

SOLUTIONS

- **Land use changes**
- **Reduce car dependency**
- **Move towards public and active transportation**
- **Greening cities**

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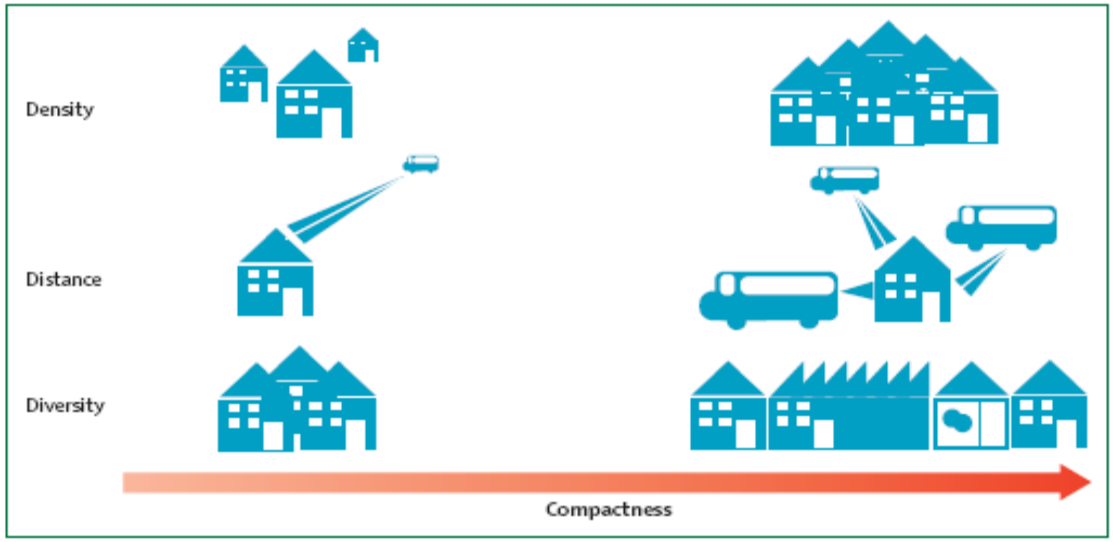

Figure 1: Illustration of the terms density, distance, and diversity as applied in the compact cities model

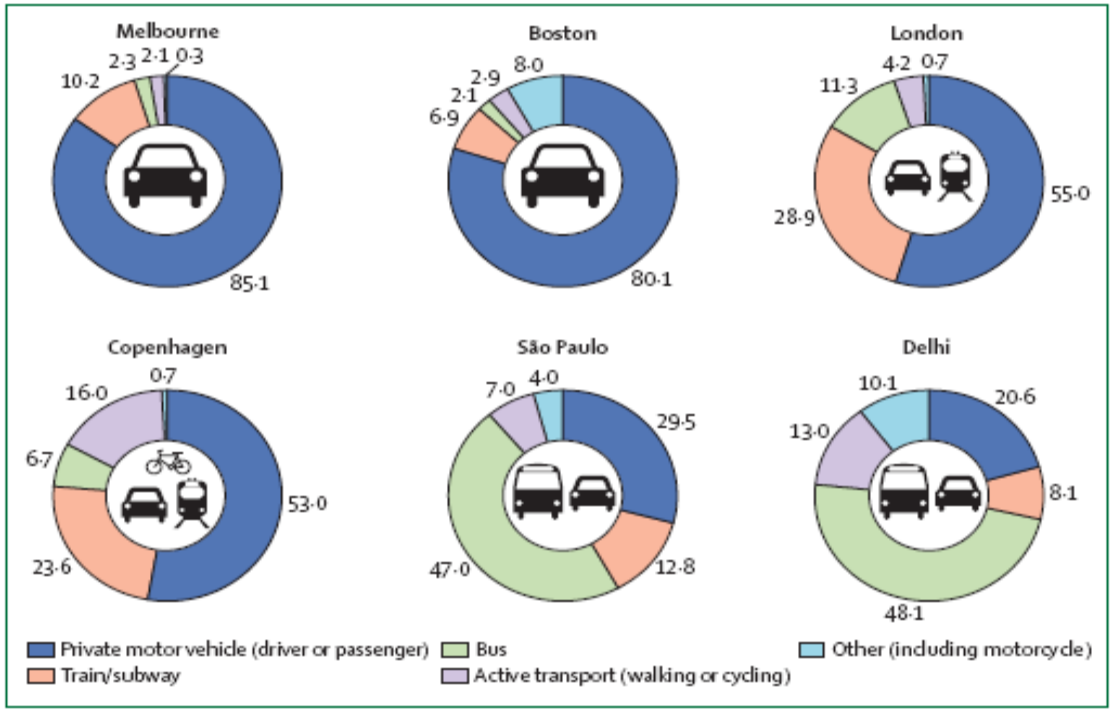

Figure 2: Percentage of vehicle kilometres travelled (VKT) by mode in each city at baseline with dominant transport modes depicted

Using a health impact assessment framework, they estimated the population health effects arising from alternative land-use and transport policy initiatives in six cities.
Land-use changes were modelled to reflect a compact city in which land-use density and diversity were increased and distances to public transport were reduced to produce low motorised mobility, namely a modal shift from private motor vehicles to walking, cycling, and public transport.

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Stevenson et al Lancet 2016; 388:2925-2935

DALYS GAINED IN COMPACT CITIES

393 (Copenhagen) to 826 (Boston) DALYs saved per 100.000 people annually

One DALY can be thought of as one lost year of "healthy" life.
DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences:

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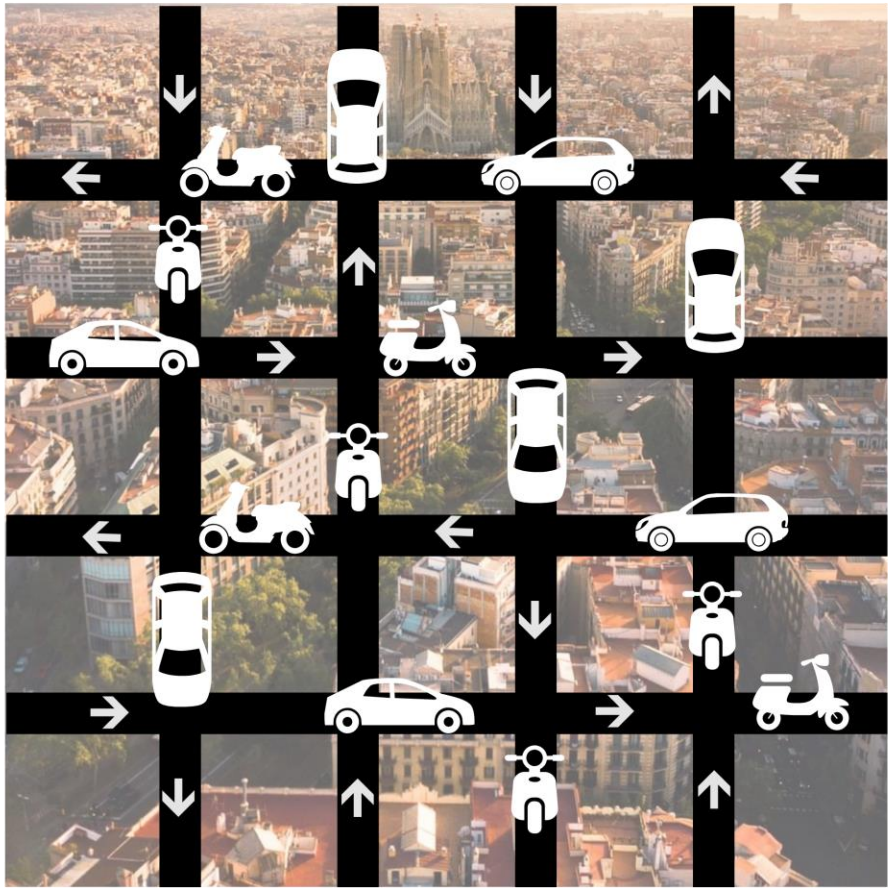
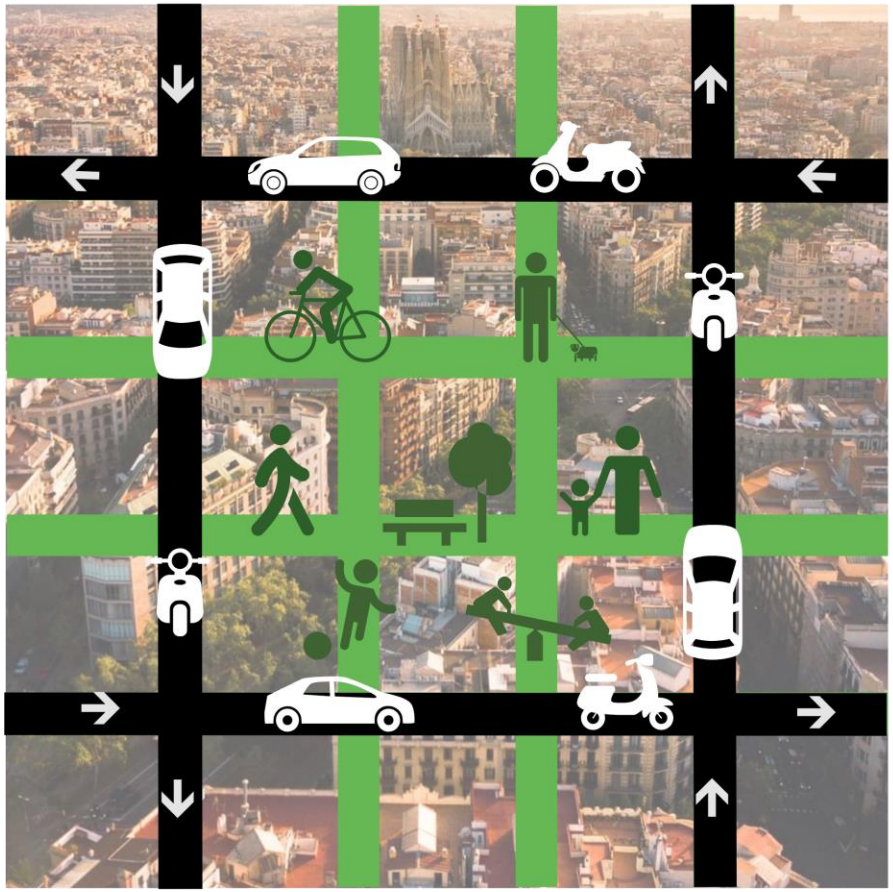
Stevenson et al Lancet 2016; 388:2925-2935


Carrer d'Aribau
Carrer de Còrsega
Carrer del Rosselló
Carrer d'Enric Granados
Carrer de Còrsega
Carrer del Rosselló
Carrer d'Aribau
Carrer del Rosselló
Carrer de Provença
Carrer de Muntaner
Carrer de Provença
Carrer d'Aribau
Carrer de Mallorca



Baseline situation



Superblocks model

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Mueller et al 2019, Env Int

Barcelona Superblock San Antoni

Before

After

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BARCELONA SUPER BLOCKS

- **19.2% car reduction**
- **11.5 ug/m3 (24.3%) NO2 reduction**
- **2.9 dB noise reduction**
- **3 fold increase green space (6.5% to 19.6%)**
- **20% Surface temperature reduction**

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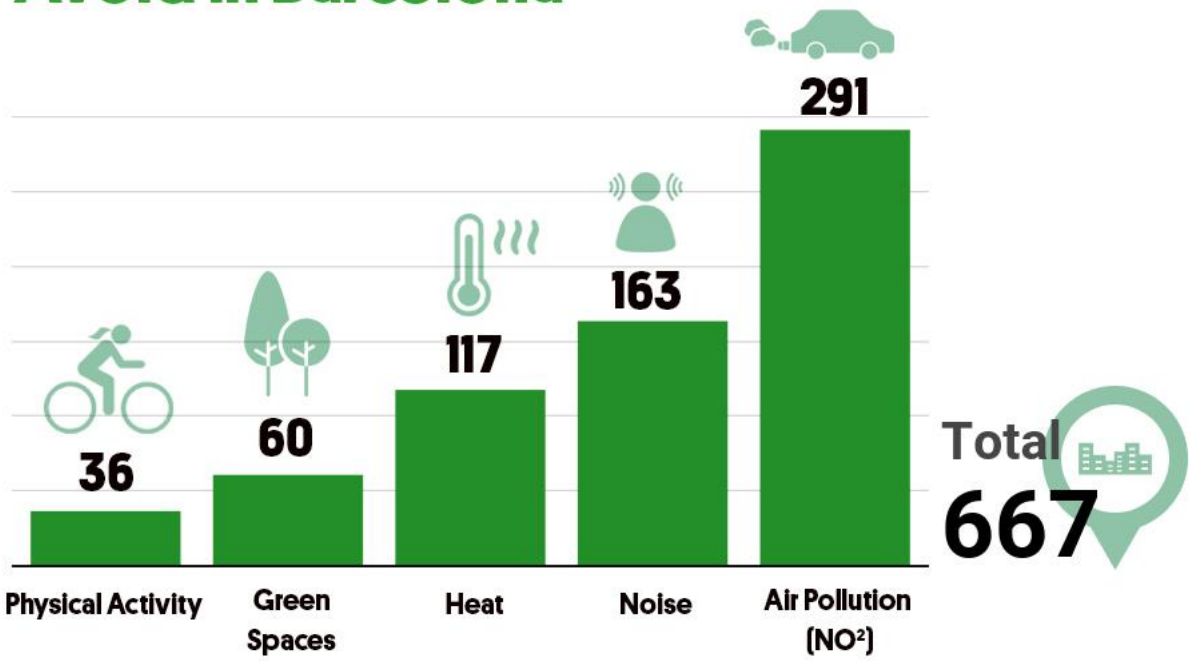
Mueller et al 2019, Env Int

Annual Premature Deaths that the "Superblocks" Model Could Avoid in Barcelona



Source: Mueller et all. Changing the urban design of cities for health: the Superblock model. *Enviroment International.* 2019

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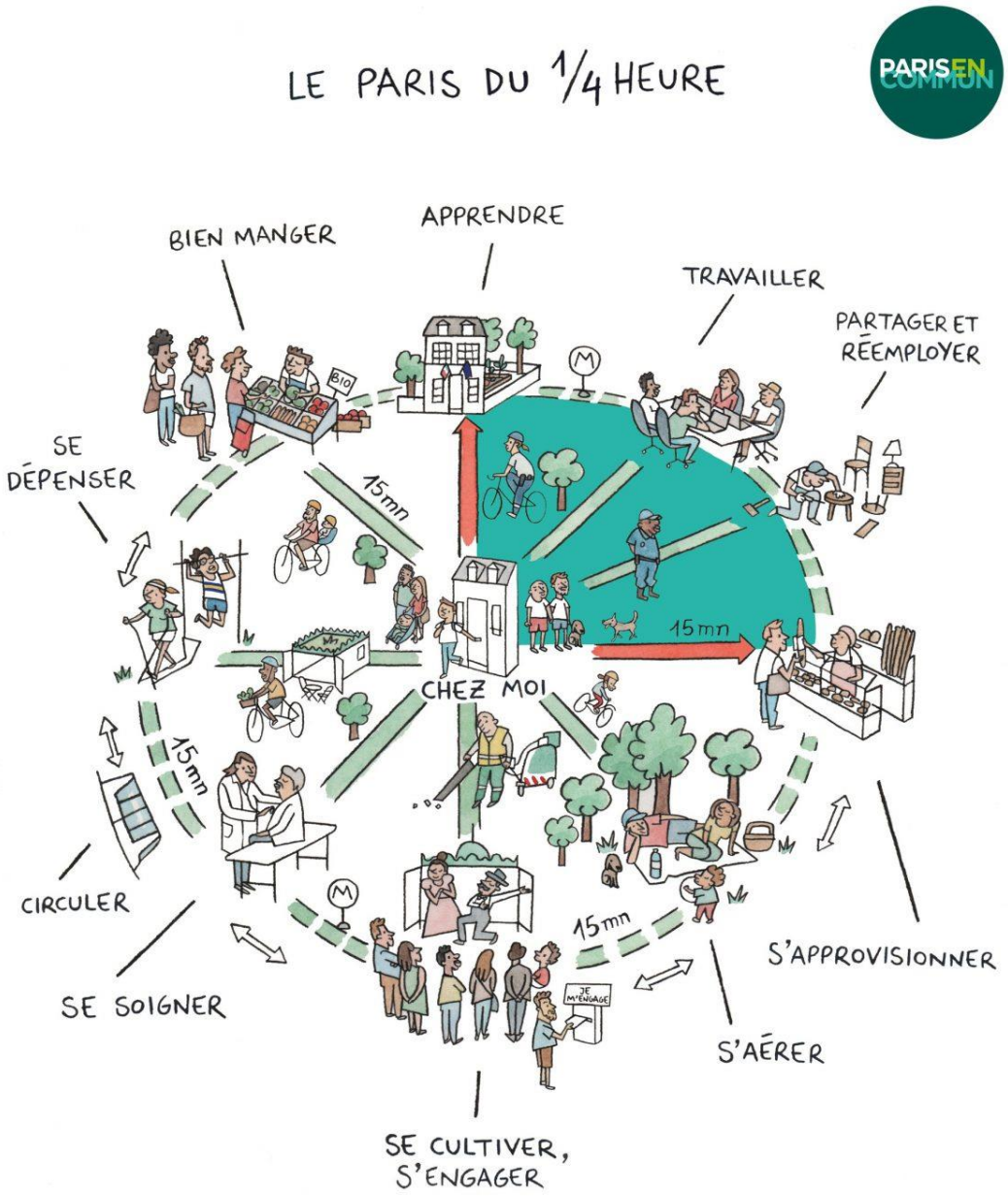
Mueller et al 2019, Env Int

CITYLAB

Paris Mayor: It's Time for a '15-Minute City'

In her re-election campaign, Mayor Anne Hidalgo says that every Paris resident should be able to meet their essential needs within a short walk or bike ride.

By Feargus O'Sullivan
18 de febrero de 2020 14:40 CET



15 minute City Paris

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Environment International 94 (2016) 251–262

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Review article

Car free cities: Pathway to healthy urban living

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ABSTRACT

Background: Many cities across the world are beginning to shift their mobility solution away from the private cars and towards more environmentally friendly and citizen-focused means. Hamburg, Oslo, Helsinki, and Madrid have recently announced their plans to become (partly) private car free cities. Other cities like Paris, Milan, Chengdu, Masdar, Dublin, Brussels, Copenhagen, Bogota, and Hyderabad have measures that aim at reducing mo-


Vauban, Freiburg

ELECTRIC CARS

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50% of car trips < 5 km

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7 WAYS THAT BICYCLES CAN MAKE CITIES *Healthier*

1 LESS RISK OF PREMATURE MORTALITY

REGULAR CYCLING IMPROVES CARDIOVASCULAR HEALTH AND DECREASES THE RISK FOR PREMATURE MORTALITY BY 10%

1. SOURCE: KELLY ET AL. 2014. INT J BEHAV NUTR PHYS ACT .11:1

2 CYCLING COMBINES TRANSPORT WITH THE GYM

ON AVERAGE CYCLISTS WEIGH **2 KG LESS** THAN CAR DRIVERS

2. SOURCE: PASTA PROJECT

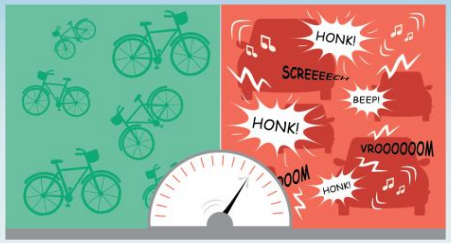
3 LESS AIR POLLUTION

A 40% SHIFT FROM CAR TRIPS TO CYCLING IN BARCELONA'S METROPOLITAN AREA

COULD AVOID AT LEAST 28 PREMATURE DEATHS A YEAR DUE TO REDUCED AIR POLLUTION

3. SOURCE: ROJAS-RUEDA ET AL. 2012. ENVIRON. INT. 49:100-109

4 LESS NOISE POLLUTION



ON CAR FREE DAYS NOISE LEVELS CAN BE REDUCED BY UP TO 10 DECIBELS

4. SOURCE: NIEUWENHUISEN & KHREIS 2016

5 ZERO EMISSIONS TRANSPORT MODE

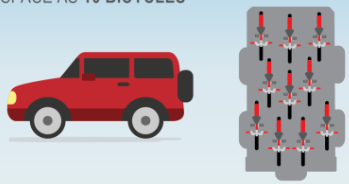
CYCLING DOES NOT DEPEND ON FOSSIL FUELS AND CAN HELP STOP GLOBAL WARMING

A 40% SHIFT FROM CAR TRIPS TO CYCLING CAN REDUCE 200,000 TONS OF CO_2 EMISSIONS ANNUALLY IN BARCELONA'S METROPOLITAN AREA

5. SOURCE: ROJAS-RUEDA ET AL. 2012. ENVIRON. INT. 49:100-109

6 MORE PUBLIC SPACE

ONE CAR OCCUPIES THE SAME PARKING SPACE AS **10 BICYCLES**



BICYCLES ARE A DOOR-TO- DOOR TRANSPORT THAT CAN HELP AVOID TRAFFIC JAMS AND CONGESTION IN CITIES

7 MORE HAPPINESS!!

ACTIVE TRANSPORT IS ASSOCIATED WITH BETTER MENTAL AND PHYSICAL WELL-BEING, LESS STRESS AND MORE HAPPINESS!

Be healthy, be happy, cycle!!!

FOR MORE INFORMATION, VISIT
WWW.ISGLOBAL.ORG/EN/URBAN-PLANNING

GRAPHIC DESIGN: RACHEL JILL PAPERNICK

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Benefits of physical activity well outweight the risks of air pollution and accidents for cyclists

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SUBWAY
赛百味

ELECTRIC BIKE

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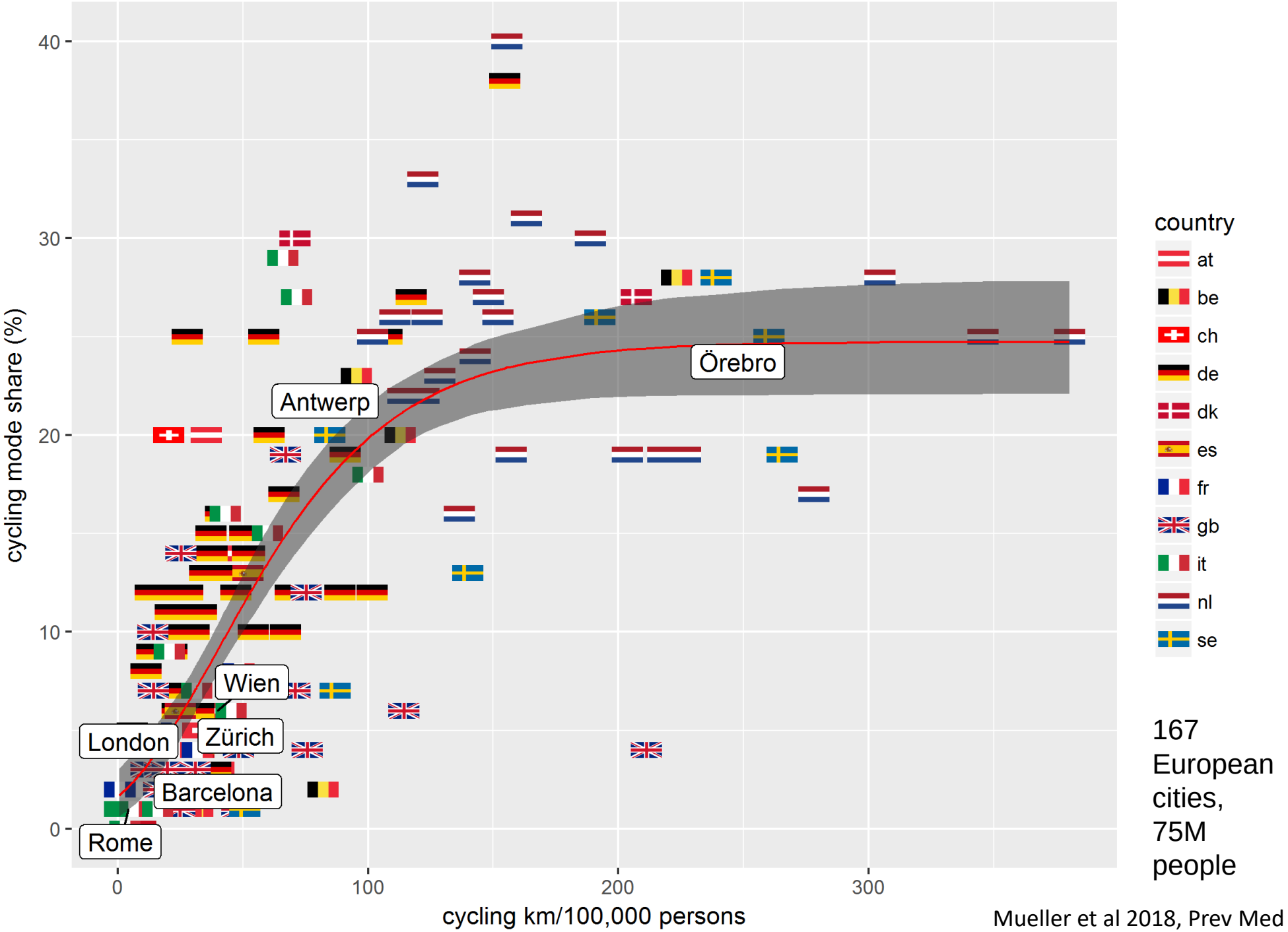
Utrecht, NL


cycling mode share (%)
40
30
20
10
0
0
100
200
300
cycling km/100,000 persons
Antwerp
Örebro
Wien
Zürich
London
Barcelona
Rome
country
at
be
ch
de
dk
es
fr
gb
it
nl
se
167 European cities, 75M people
Mueller et al 2018, Prev Med

PREMATURE DEATHS PREVENTED

- **10,091 premature deaths prevented annually in 167 European cities (75M people) if the mode share of cycling went up to 24.7%**

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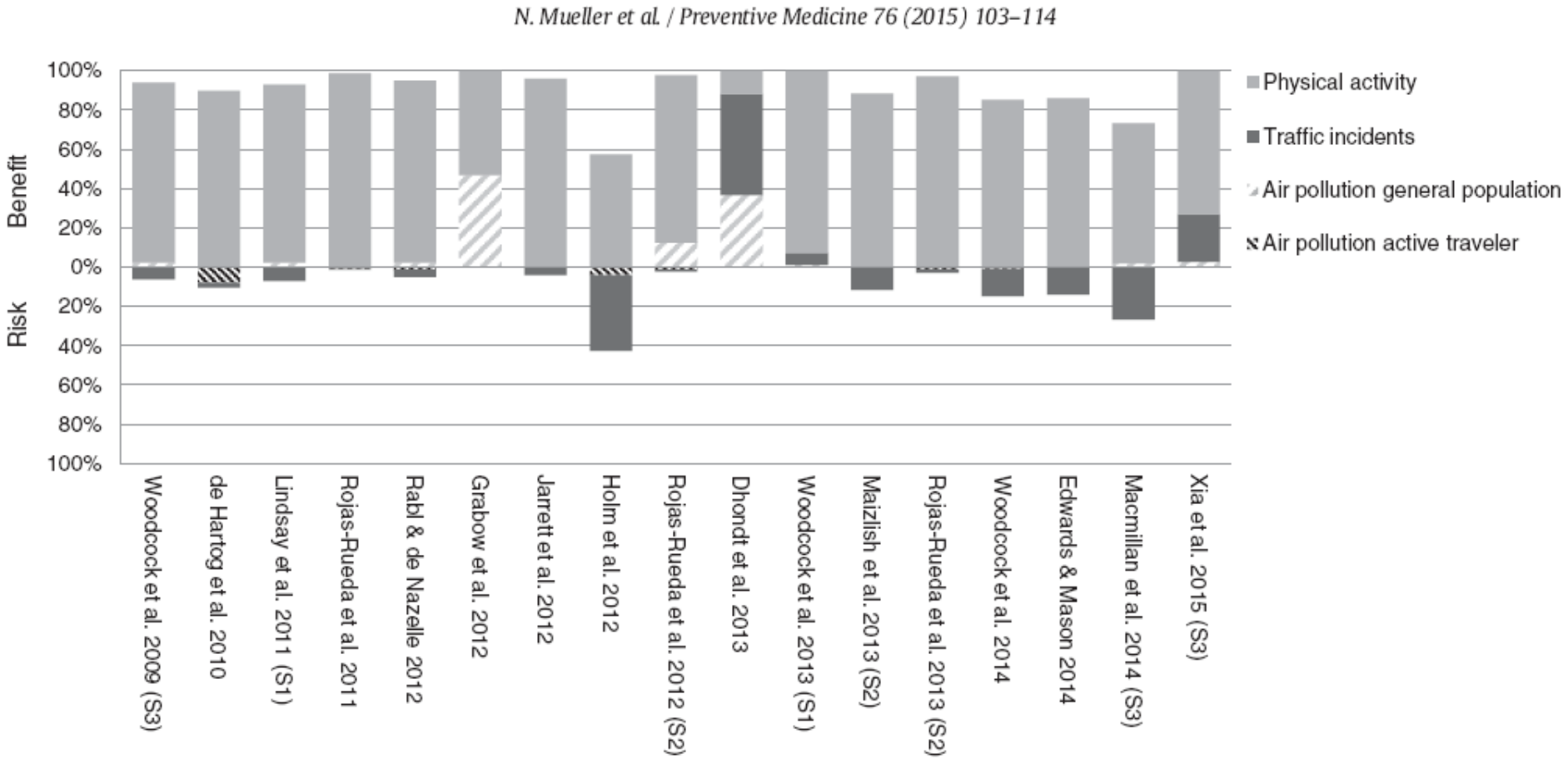
Mueller et al 2018, Prev Med

HIAs of ACTIVE TRANSPORTATION



Mueller et al 2015

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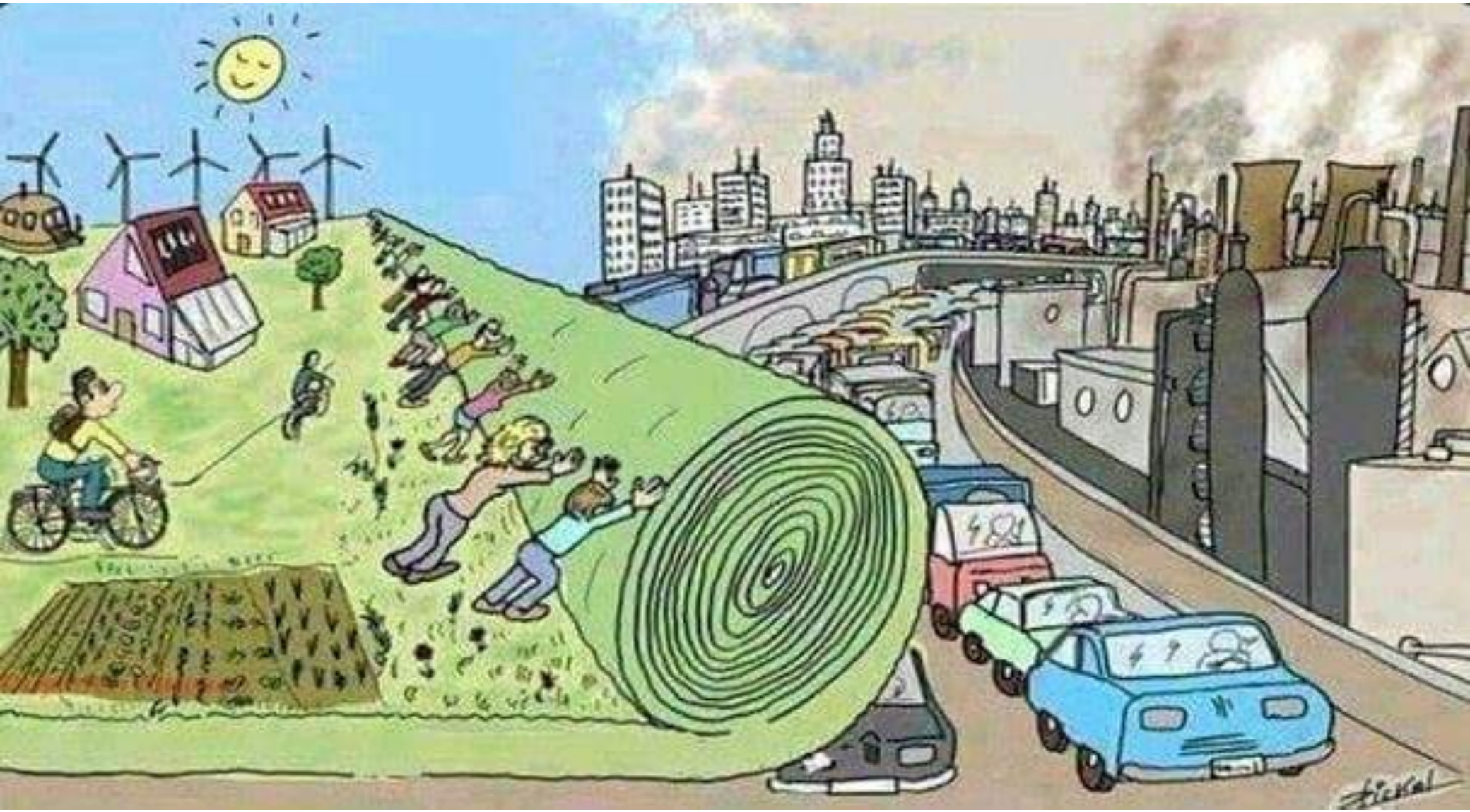

GREEN AND LIVEABLE

- Greening cities has many health benefits including longer life expectancy, fewer mental health problems, better cognitive function, better mood and healthier babies
- It mitigates air pollution, heat and noise levels.
- CO2 sequestration
- Replacing roads and parking with green environments can be one way forward to change an environment from detrimental to beneficial.

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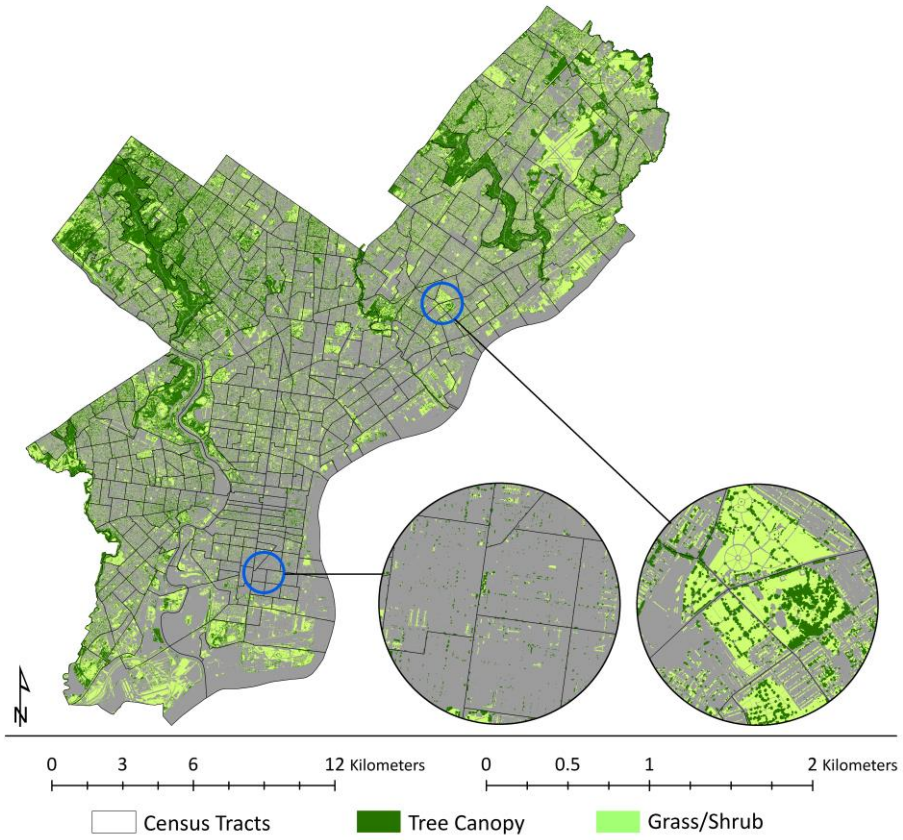
Nieuwenhuijsen et al 2017, Epidemiology

HEALTH IMPACT ASSESSMENT OF PHILADELPHIA'S 2025 TREE CANOPY COVER GOALS (30%)



Land cover analysis in 2008 showed that tree canopy covered 20% of land area

Of the 155 neighborhoods, 19 already met or exceeded the 30% tree canopy goal, and 102 neighborhoods could meet the goal by planting and establishing trees in areas currently covered with grass and/or shrub. The remaining 34 neighborhoods would require removal of impervious surface to meet the 30% cover goal

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Greenworks Philadelphia plan

Kondo et al 2019

DEATHS PREVENTED IN PHILADEPHIA BY INCREASING TREE COVER

	Preventable premature adult deaths		Value (millions, US$ 2015 [95% interval])*
	n (95% interval)	% (95% interval)	
Ambitious increase scenario§			
City-wide	403 (298–618)	2·9% (2·1–4·5)	3865 (2865–5933)
Lower socioeconomic status census tracts	244 (180–373)	3·6% (2·6–5·5)	2339 (1735–3586)
Higher socioeconomic status census tracts	159 (11–244)	2·4% (1·7–3·6)	1526 (1130–2346)
Tree canopy cover (%)			
Quantile 1 (<10%)	196 (144–301)	5·9% (4·3–9·1)	1877 (1389–2890)
Quantile 2 (12–15%)	129 (95–197)	4·0% (2·9–6·1)	1235 (916–1891)
Quantile 3 (16–26%)	75 (55–113)	1·9% (1·4–2·9)	716 (532–1092)
Quantile 4 (>27%)	3 (2–4)	0·1% (0·0–0·1)	28 (2–43)

*Based on value of a statistical life year for 2015 generated by the US Department of Transportation; values are per million (2015 $US). †Five percentage point increase in tree canopy coverage. ‡Ten percentage point increase in tree canopy coverage. §30% total tree canopy cover.

Table 3: Annual preventable premature adult deaths (2014–2025) and economic effects

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Kondo et al 2020

Multisectorial approach

Multi sectorial and systemic approaches are needed to address current problems and find solutions

ISUH International Society for Urban Health

Global Barcelona Institute for Global Health

Courtesy of Jo Ivey Boufford

SYSTEMIC APPROACHES

- It is important that we have a more systemic approach to our cities,

Tackling

- COVID19
- Air pollution
- Noise
- Heat islands
- Lack of green space
- Lack of physical activity

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HOLISTIC APPROACHES

- It is important that we have a more holistic to our cities,

Addressing

- Health
- Livability
- Sustainability
- Climate change
- Equity

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FINANCING

- a large financial stimulus package – European green deal

- The money can only be spent once, and we therefore might as well do it in the way that will save more lives in the long term, and create also a more just, sustainable and liveable society

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Seoul

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ALDERHEY HOSPITAL LIVERPOOL BEFORE AND AFTER

ISGlobal Barcelona Institute for Global Health

(Photo: Marcia Taylor)

Hamburg Plans to Become Car-Free By 2034

But should there really be zero cars?

By Rachel Nuwer
SMITHSONIANMAG.COM
FEBRUARY 17, 2014

Hamburg, Germany, recently announced plans to convert 40 percent of the city into car-free pedestrian zones within the next two decades. According to Inhabitat, existing green spaces


Vauban, Freiburg

Mark Nieuwenhuijsen
Haneen Khreis *Editors*

Integrating Human Health into Urban and Transport Planning

A Framework

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Urban and transport planning pathways to carbon neutral, liveable and healthy cities; A review of the current evidence

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Green cities, healthy people

Active cities, healthy people,

Clean cities, healthy people

Social cities, healthy people

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Mark Nieuwenhuijsen · Haneen Khreis *Editors*

Integrating Human Health into Urban and Transport Planning

A Framework

This volume brings together the world's leading experts on urban and transport planning, environmental exposures, physical activity, health and health impact assessment to discuss challenges and solutions in cities. The book provides a conceptual framework and work program for actions and outlines future research needs. It presents the current evidence-base, the benefits of and numerous case studies on integrating health and the environment into urban development and transport planning.

Within cities there is a considerable variation in the levels of environmental exposures such as ambient air pollution, noise, and temperature, green space availability and physical activity. Many of these exposures, and their adverse health impacts, are related to and are being exacerbated by urban and transport planning and policy. Emerging research suggests that urban and transport planning indicators such as road network, distance to major roads, traffic density, household density, industry, and natural and green space can explain a large proportion of the variability in environmental exposures and therefore represent important and highly modifiable factors.

The urban environment is a complex interlinked system. Decision-makers need not only better data on the complexity of factors in environmental and developmental processes affecting human health, but also an enhanced understanding of the linkages between these factors and health effects to determine at which level to target their actions most effectively. In recent years, there also has been a shift from trying to change at the national level to more comprehensive and ambitious actions being developed and implemented at the regional and local levels. Cities have come to the forefront of providing solutions for environmental issues such as climate change, which has co-benefits for health, but yet need better knowledge for wider health-centric action. This book provides the latest and most up-to-date information and studies for academics and practitioners alike.

Environment

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Nieuwenhuijsen · Khreis *Eds.*

Integrating Human Health into Urban and Transport Planning

Mark Nieuwenhuijsen
Haneen Khreis *Editors*

Integrating Human Health into Urban and Transport Planning

A Framework

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URBAN TRANSITIONS 2020

Integrating Urban and Transport Planning,
Environment and Health for Healthier Urban Living

10–12 November 2020
Sitges, Barcelona, Spain

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Green spaces and mortality: a systematic review and meta-analysis of cohort studies

David Rojas-Rueda, Mark J Nieuwenhuijsen, Mireia Gascon, Daniela Perez-Leon, Pierpaolo Mudu

Summary

Background Green spaces have been proposed to be a health determinant, improving health and wellbeing through different mechanisms. We aimed to systematically review the epidemiological evidence from longitudinal studies that have investigated green spaces and their association with all-cause mortality. We aimed to evaluate this evidence with a meta-analysis, to determine exposure-response functions for future quantitative health impact assessments.

Methods We did a systematic review and meta-analysis of cohort studies on green spaces and all-cause mortality. We searched for studies published and indexed in MEDLINE before Aug 20, 2019, which we complemented with an additional search of cited literature. We included studies if their design was longitudinal; the exposure of interest was measured green space; the endpoint of interest was all-cause mortality; they provided a risk estimate (ie, a hazard ratio [HR]) and the corresponding 95% CI for the association between green space exposure and all-cause mortality; and they used normalised difference vegetation index (NDVI) as their green space exposure definition. Two investigators (DR-R and DP-L) independently screened the full-text articles for inclusion. We used a random-effects model to obtain pooled HRs. This study is registered with PROSPERO, CRD42018090315.

Findings We identified 9298 studies in MEDLINE and 13 studies that were reported in the literature but not indexed in MEDLINE, of which 9234 (99%) studies were excluded after screening the titles and abstracts and 68 (88%) of 77 remaining studies were excluded after assessment of the full texts. We included nine (12%) studies in our quantitative evaluation, which comprised 8 324 652 individuals from seven countries. Seven (78%) of the nine studies found a significant inverse relationship between an increase in surrounding greenness per 0·1 NDVI in a buffer zone of 500 m or less and the risk of all-cause mortality, but two studies found no association. The pooled HR for all-cause mortality per increment of 0·1 NDVI within a buffer of 500 m or less of a participant's residence was 0·96 (95% CI 0·94–0·97; I^2, 95%).

Lancet Planet Health 2019; 3: 469–77

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ANNUAL PREVENTABLE PREMATURE DEATHS AND AVERTED COSTS IN PHILADELPHIA

646 premature deaths (4.7% of total) prevented annually

Averted cost $6,2 billion annually

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Kondo et al 2019

Figure 1. Visualisations for a typical urban terraced street. The four figures are taken from the visualisations used in the Visions 2030 Walking and Cycling Project http://www.visions2030.org.uk/. Each vision represents four different possibilities for urban transport in 2030 in the UK. These visualisations are of a 'typical' Victorian terraced street. Visualisations created by the School of Computing at the University of East Anglia.
doi:10.1371/journal.pone.0051462.g001

Woodcock et al 2013, PLoS ONE

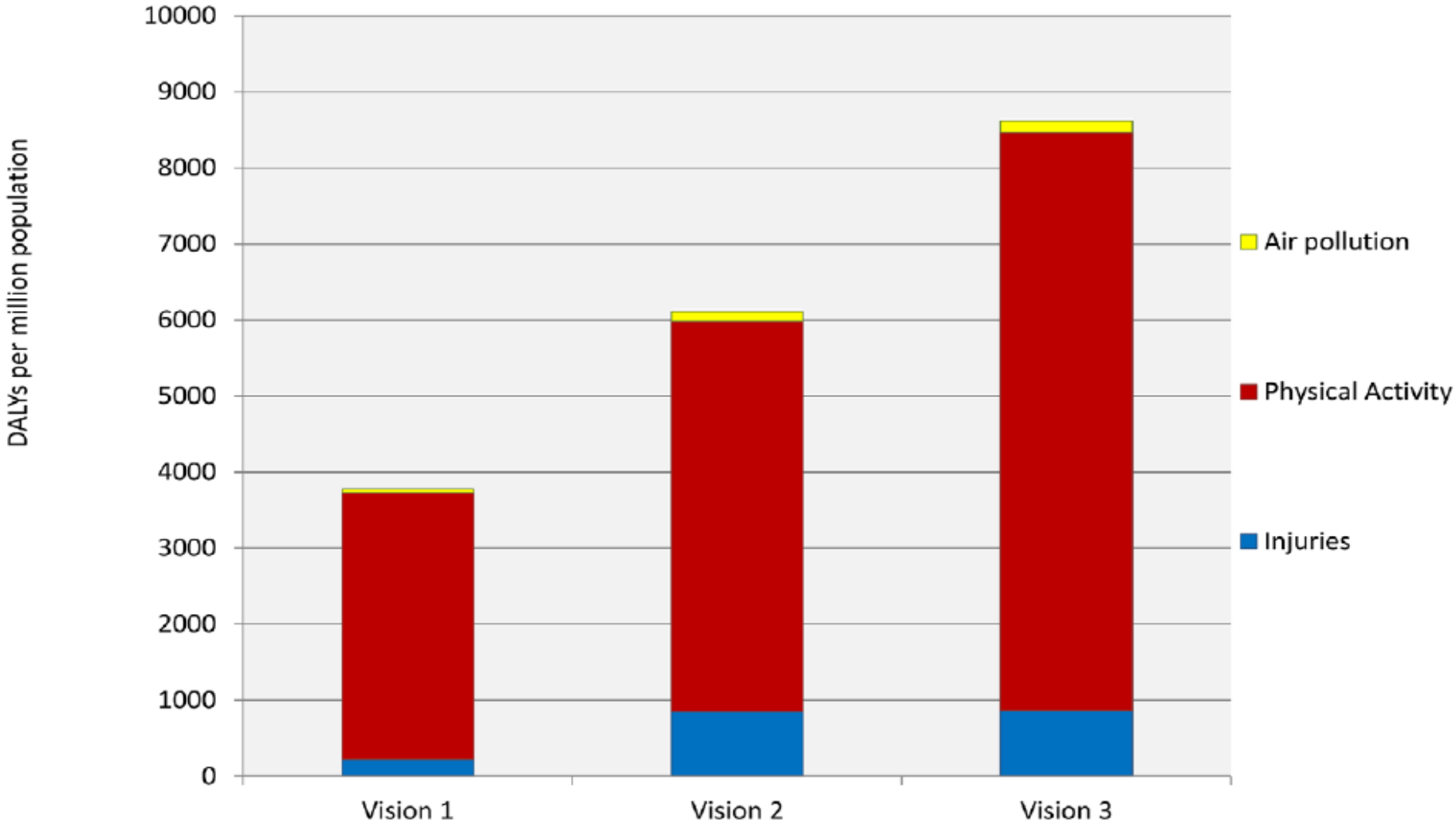

Figure 3. Health gains by Vision and risk factor. Disability Adjusted Life Years gained per million population under each of the three visions, broken down into the proportions attributable to improvements from air quality, increased physical activity and decreased road injuries. See Table 7 for full results.
doi:10.1371/journal.pone.0051462.g003

Woodcock et al 2013, PLoS ONE

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VIDEOS

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(Photo: Marcia Taylor)

Hamburg Plans to Become Car-Free By 2034

But should there really be zero cars?

By Rachel Nuwer
SMITHSONIANMAG.COM
FEBRUARY 17, 2014

Hamburg, Germany, recently announced plans to convert 40 percent of the city into car-free pedestrian zones within the next two decades. According to Inhabitat, existing green spaces

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Review article

Car free cities: Pathway to healthy urban living

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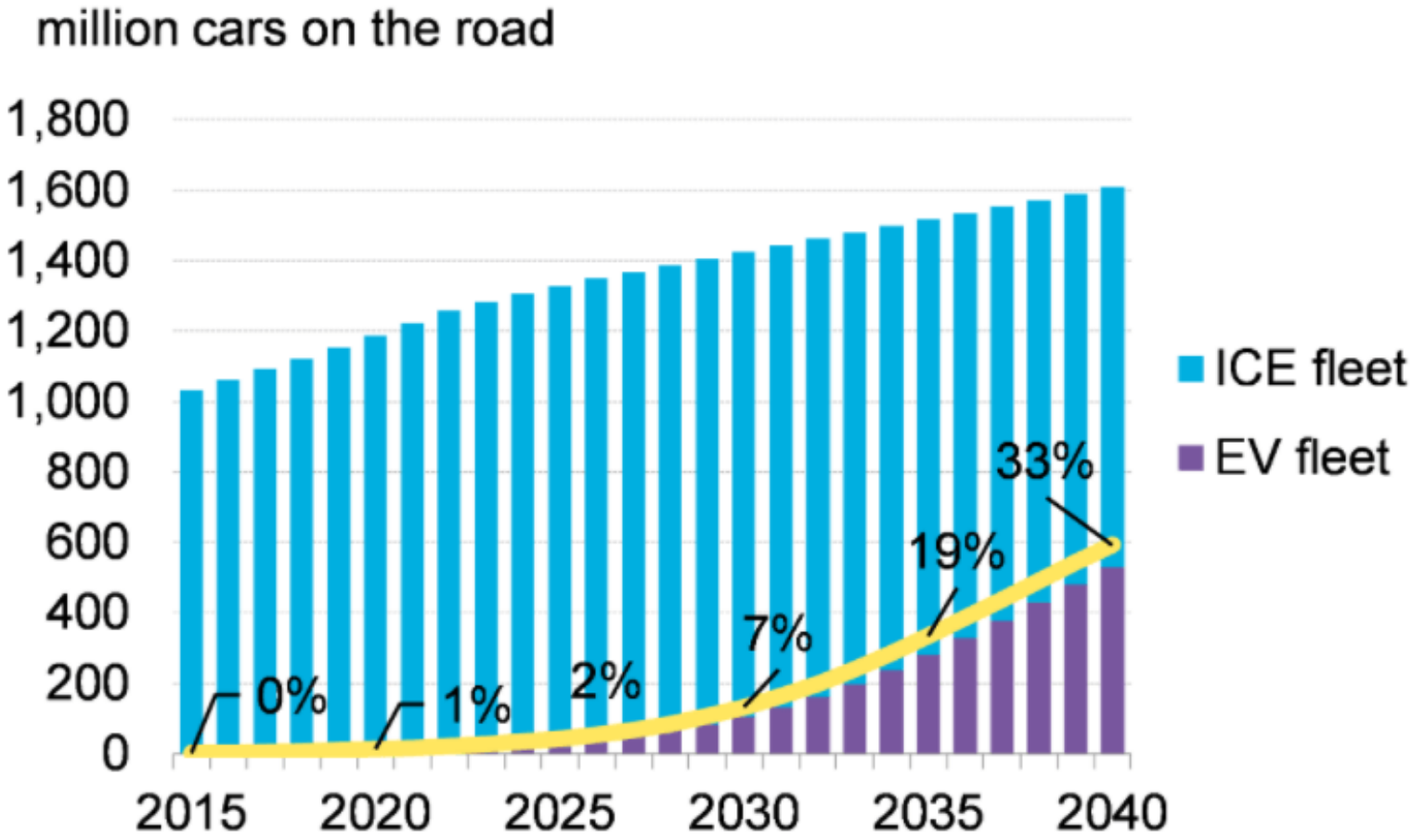
ABSTRACT

Background: Many cities across the world are beginning to shift their mobility solution away from the private cars and towards more environmentally friendly and citizen-focused means. Hamburg, Oslo, Helsinki, and Madrid have recently announced their plans to become (partly) private car free cities. Other cities like Paris, Milan, Chengdu, Masdar, Dublin, Brussels, Copenhagen, Bogota, and Hyderabad have measures that aim at reducing mo-

PREDICTIONS FOR CARS



Bloomberg New Energy Finance (BNEF)

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AUTONOMOUS VEHICLES

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Urban Planning, Environment and Health Initiative

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More information:
www.isglobal.org/urban-planning

The Urban Planning, Environment and Health Initiative transfers scientific evidence and tools to promote healthy and sustainable urban development.

Indicator checklist for **healthy urban and transport planning**

PLANNING PRINCIPLE	☑	INDICATOR
1. LAND USE MIX		
Is there sufficient public open/green space?	☐	≥ 25% of total surface
Is the allocation of the built environment appropriate?	☐	≤ 75% of total surface
• Is the proportion of the built environment allocated to roadways appropriate?	☐	≤ 25 % of total surface for roadways
• Is the proportion of built environment allocated to buildings appropriate?	☐	≤ 50% of total surface for buildings
• Is there a balance between residential and non-residential building function?	☐	75% of buildings with residential function 25% of buildings with non-residential function
Are there diverse destinations in direct proximity? Note: 'Walkable' destinations are those within a ≤ 300 m street network distance 'Cyclable' destinations are those within a ≤ 5 km street network distance	☐	↑ Number and diversity of local destinations (food, retail, general services, healthcare, community services, eating and drinking, recreation, entertainment, etc.) ≤ 300 m street network distance ≤ 5 km street network distance
2. STREET CONNECTIVITY		
Are streets well-connected and provide direct and short routes to destinations?	☐	↑ Number of street junctions
• Is active and public transport prioritized in providing short and direct routes to destinations?	☐	Yes
• Is private motorized transport diverted and re-directed to discourage use?	☐	Yes
Are over-and underpasses and other physical barriers that force pedestrians/ cyclists to change levels avoided?	☐	↓ Number of pedestrian/ cyclist over- and underpasses and other physical barriers
Are block sizes kept relatively small?	☐	≤ 120 m (i.e. Eixample blocks)
Are cul-de-sacs avoided?	☐	↓ Number of cul-de-sacs

NOTES

	☑	
3. DENSITY		
Is a medium to high dwelling density provided in the area?	☐	100 dwellings/ ha (Range: 50-150 dwellings/ ha)
Is a low to mid-rise building form provided?	☐	≤ 5-6 storey buildings that can be 'walked-up'
Is a human scale with sky visibility within normal sight lines retained?	☐	50° above horizontal is normal angle of sight
Is horizontal sprawl (i.e. low density development) avoided?	☐	↓ Low density development
Is vertical sprawl (i.e. high-rise building development) avoided?	☐	↓ High-rise building development
Is the housing surface/ capita appropriate?	☐	Optimum 30 m²/ capita
4. TRAFFIC CALMING		
Is space for circulating and parked private motorized transport minimized?	☐	≤ 25 % of total surface for roadways and parking
Are the number of road lanes kept at a functional minimum?	☐	↓ Number of road lanes
Are road lane widths kept to functional minimum?	☐	≤ 3 m width each road lane
Are traffic calming and speed reductions features incorporated?	☐	↑ Number of traffic calming and speed reduction features (e.g. speed bumps, curb extensions, vertical deflections such as raised intersections or crossings, etc.)
Is on-road parking space minimized?	☐	↓ On-road parking Optimum ≥ 90% of parking is off-road parking
5. WALKING		
Is segregated, non-shared pedestrian infrastructure provided?	☐	≥ 75 % of total space accessible to pedestrians
Is sidewalk width consistent with its use?	☐	≥ 1.5 m sidewalk width
Are different pedestrian needs and abilities considered?	☐	↑ Barrier-free pedestrian infrastructure
Are street side changes and over- and underpasses avoided?	☐	Yes
Are conflicts with other transport modes at intersections and street form changes avoided?	☐	Yes
Does the walking infrastructure contain continuous greenery?	☐	Yes
Is a pedestrian network created that interconnects with other active and public transport modes (i.e. multi-modality)?	☐	Yes

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6. CYCLING

Is segregated, non-shared cycling infrastructure provided?	☐	≤ 400 m street network distance from residences
Is a homogenous, continuous and intuitive cycling network provided?	☐	Yes
Are conflicts with other transport modes at intersections and street form changes avoided?	☐	Yes
Are changes in street side and over- and underpasses avoided?	☐	Yes
Is the cycling infrastructure located on the curbside of the road instead of in the center?	☐	Yes
Is a cycling network created that interconnects with other active and public transport modes (i.e. multi-modality)?	☐	Yes
Does the cycling infrastructure contain continuous greenery?	☐	Yes

7. PUBLIC TRANSPORT

Is universal access (i.e. 100% of population) to public transport provided?	☐	≤ 300 m street network distance to bus stop ≤ 600 m street network distance to metro/ tram stop ≤ 800 m street network distance to train stop
Are conflicts with other transport modes at intersections and street form changes avoided?	☐	Yes
Are highly-connected public transport networks within and between municipalities developed?	☐	Yes
Is a public transport network created that interconnects with other active and public transport modes (i.e. multi-modality)?	☐	Yes

8. MULTI-MODALITY

Are pedestrian, cycling and public transport infrastructures well connected?	☐	Yes
Are multi-modality nodes that prioritize the switch between walking, cycling and public transport established and well distributed across the city?	☐	Yes
Is there space allocated for the necessary multi-modal infrastructures (e.g. park-and-ride parking, car-sharing spaces, bike and pedestrian infrastructures near public transport stops, etc.)?	☐	Yes

9. PUBLIC OPEN/ GREEN SPACE

Is universal access (100% of population) to public open/ green space provided?	☐	≤ 300 m street network distance
Is there sufficient public open/ green space?	☐	≥ 20 m²/ capita of public open space of which ≥ 10 m²/ capita should be green space
Is a major local green space provided?	☐	≥ 0.5 ha, best if within ≤ 300 m street network distance
Is a district green space provided?	☐	≥ 5 ha, best if within ≤ 2 km street network distance
Is a regional green space provided?	☐	≥ 20 ha, best if within cities catchment area
Is continuous surrounding greenness provided? (e.g. green corridors, street trees, green patches, pocket parks, etc.)	☐	100% of streets with vegetation ≥ 10 trees/ city block
Are walking and cycling infrastructures integrated into the local green space system?	☐	Yes

10. INTEGRATION OF ALL PLANNING PRINCIPLES

Are the land use mix, connectivity, density, traffic calming, walking, cycling, public transport, multi-modality and public open/ green space objectives developed simultaneously and integrated?	☐	Yes

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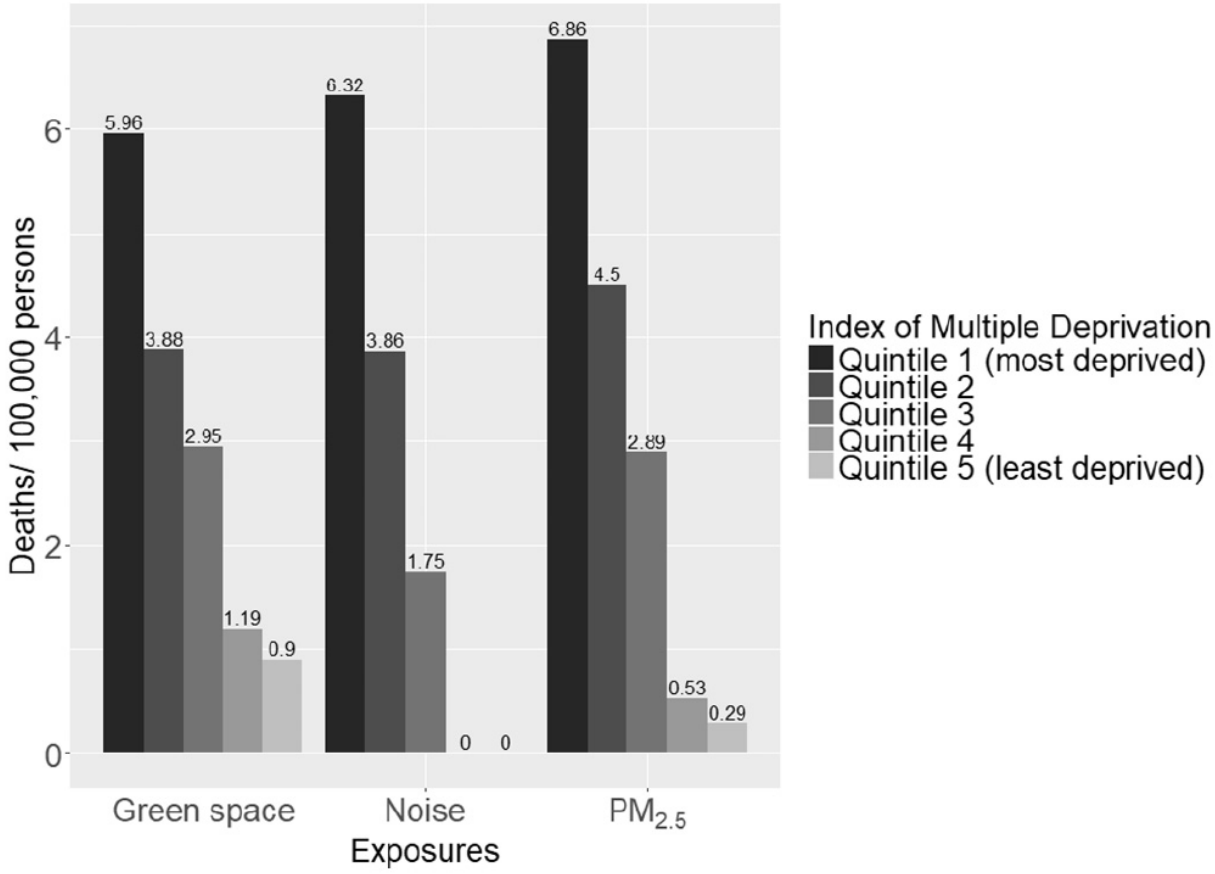
PREMATURE MORTALITY BY DEPRIVATION IN BRADFORD, UK



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Mueller et al 2018

CYCLING LANES

- When there are more cycling lanes, do people cycle more?
- Can cycling more prevent premature deaths?
- Health impact assessment study in 167 European cities (75M people)

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Mueller et al 2018

Fifty Shades of Green

Pathway to Healthy Urban Living

Mark J. Nieuwenhuijsen,[a,b,c] *Haneen Khreis,*[d] *Margarita Triguero-Mas,*[a,b,c] *Mireia Gascon,*[a,b,c] *and Payam Dadvand*[a,b,c]

Abstract: Currently half the world population lives in cities, and this proportion is expected to increase rapidly to 70% over the next years. Over the years, we have created large, mostly grey cities with many high-rise buildings and little green space. Disease rates tend to be higher in urban areas than in rural areas. More green space in cities could reduce these rates. Here, we describe the importance of green space for health, and make recommendations for further research. Green space has been associated with many beneficial health effects, including reduced all-cause and cardiovascular mortality and improved mental health, possibly through mediators, such as reduced air pollution, temperature and stress, and increased physical activity, social contacts, and restoration. Additional studies are needed to strengthen the evidence base and provide further guidelines to transport planners, urban planners, and landscape architects. We need more longitudinal studies and intervention studies, further understanding of the contribution of various mechanisms toward health, and more information on susceptible populations and on where, when, how much, and what type of green space is needed. Also needed are standardized methods for green space quality assessments and evaluations of effectiveness of green prescriptions in clinical practice. Many questions are ideally suited for environmental epidemiologists, who should work with other stakeholders to address the right questions and translate knowledge into action. In conclusion, a growing evidence base supports the hypothesis that greener cities are healthier cities.

(*Epidemiology* 2017;28: 63–71)

It is remarkable that when you talk to people about green space they tend to have positive experiences to tell. They remember their childhood climbing a tree, a long hike in the forest, a barbeque with friends in the garden, or some time spent with their beloved in a park (Figure 1). Perhaps this is not so surprising as for tens of thousands of years humans have lived in forests and savannahs surrounded by nature, and only during the past few thousand years they have moved into cities, where nature is often less available. Our bodies and minds may be best adapted to living with nature, a concept Wilson[1] described with the term biophilia: people's innate affinity for the natural world.

Currently half the world's population live in cities, and this proportion is expected to increase rapidly to 70% during the next 20 to 30 years.[2] This rapid increase is particularly happening in low- and medium-income countries; 80% to 90% of people already live in cities in high-income countries.

Cities have long been known to be society's predominant engine of innovation and wealth creation, yet they are also its main source of crime, pollution, and disease.[3] Over the years, we have created large, mostly grey cities with many high-rise buildings and little green space. (Shenzhen, China; Beirut, Lebanon; Buenos Aires, Argentina; Kuwait City, Kuwait; and Athens, Greece are a few examples.) It is therefore not surprising that only 23% of the residents of Athens are very or rather satisfied

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How Urban Environment Impacts our Health

Head
- stroke, cerebrovascular diseases
- mental health
- neurodegenerative diseases
- autism, child behaviour problems
- cognitive impairment

Heart
- myocardial infarction
- arrhythmia
- cardiovascular diseases

Arteries
- hypertension

General
- sleep disturbance and annoyance
- labour and traffic incidents with injury
- obesity
- diabetes
- thrombosis
- systemic inflammation
- increase in mortality

Respiratory tract
- lung cancer
- asthma
- respiratory diseases

Breast
- breast cancer

Reproductive system and fetus
- low birth weight
- preterm birth
- lower sperm quality

Digestive system
- colon cancer

Health conditions associated with air pollution, noise, temperature
and a lack of physical activity, natural spaces

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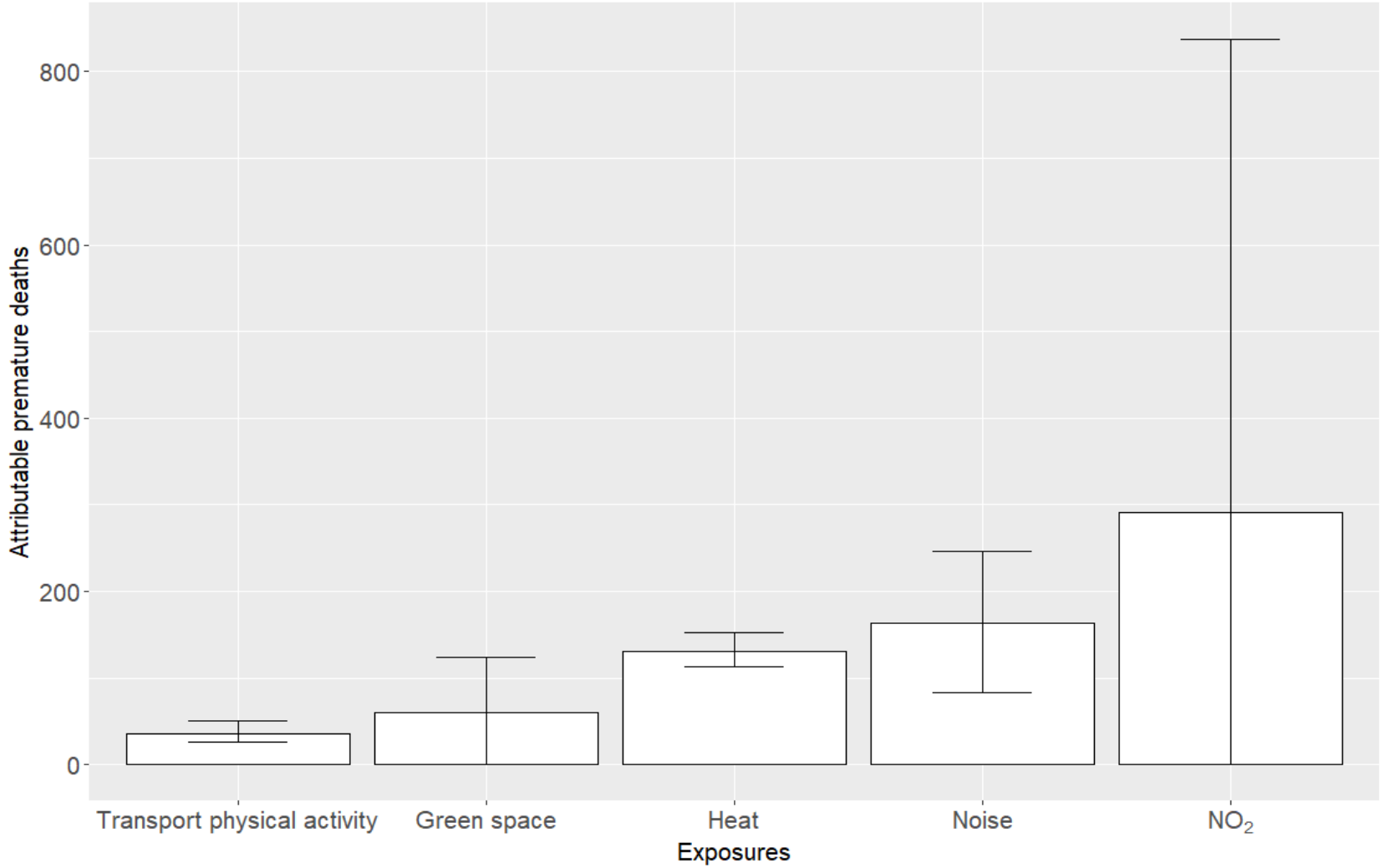
Premature mortality impacts

681 premature deaths preventable (95% CI: 245-1,113)

Transport physical activity	Green space	Heat	Noise	NO_2
36 deaths 95% CI: 26-50	61 deaths 95% CI: 0-123	131 deaths 95% CI: 114-153	163 deaths 95% CI: 83-246	291 deaths 95% CI: 0-838



a for ealth

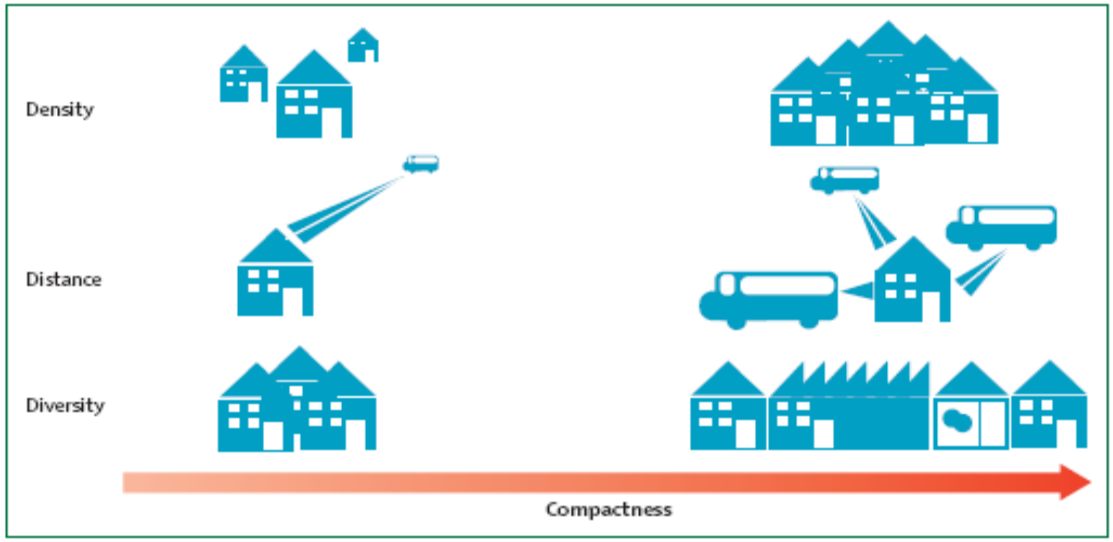


Figure 1: Illustration of the terms density, distance, and diversity as applied in the compact cities model

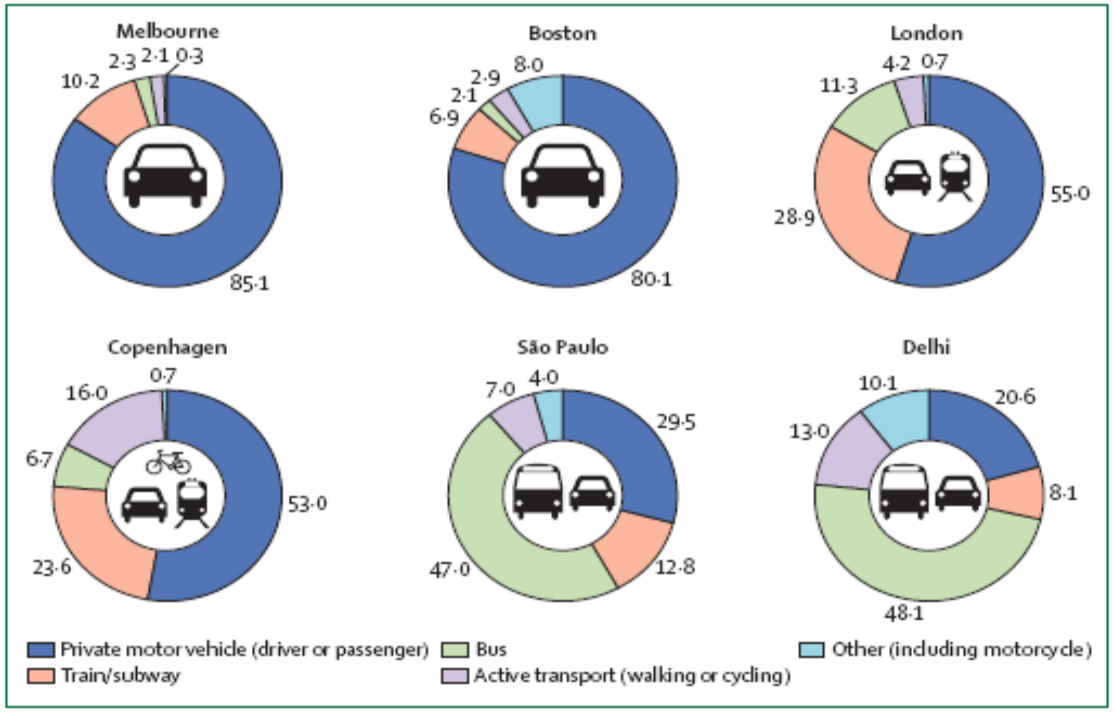


Figure 2: Percentage of vehicle kilometres travelled (VKT) by mode in each city at baseline with dominant transport modes depicted

Using a health impact assessment framework, they estimated the population health effects arising from alternative land-use and transport policy initiatives in six cities.
Land-use changes were modelled to reflect a compact city in which land-use density and diversity were increased and distances to public transport were reduced to produce low motorised mobility, namely a modal shift from private motor vehicles to walking, cycling, and public transport.

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Stevenson et al Lancet 2016; 388:2925-2935

DALYS GAINED IN COMPACT CITIES

393 (Copenhagen) to 826 (Boston) DALYs saved per 100.000 people annually

One DALY can be thought of as one lost year of "healthy" life.
DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences:

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Stevenson et al Lancet 2016; 388:2925-2935

Green cities, healthy people

Active cities, healthy people,

Clean cities, healthy people

Social cities, healthy people

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How Urban Environment Impacts our Health

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- colon cancer

Health conditions associated with air pollution, noise, temperature
and a lack of physical activity, natural spaces

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5 Key Ways to Create Healthy Urban Environments

1. Air Pollution:

Reducing motorised vehicles

2. Physical Activity:

Increasing active transport

3. Noise:

Reducing motorised vehicles

4. Green and Blue Spaces:

Increasing the availability of and access to nature

5. Temperature:

Reducing infrastructure for motorised vehicles and increasing green spaces

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CITIES

´´Cities have long been known to be society's predominant engine of innovation and wealth creation, yet they are also its main source of crime, pollution, and disease´´

Bettencourt et al 2007

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Tehran, Iran, 15 November 2016. Habib Kashani, a member of Tehran's municipal council, said on Tuesday that pollution in Tehran had led to the death of 412 citizens in the past 23 days, according to the state news agency, Irna. City authorities announced that all schools would be closed on Wednesday. The concentration of ultra-fine airborne particles (known as PM2.5) reached more than 150 this week, setting a new record. These particles of less than 2.5 micrometres in diameter can penetrate the lungs and pass into the bloodstream and have been linked to increased rates of chronic bronchitis, lung cancer and heart disease. (Guardian newspaper)

CITIZENS PARTICIPATION

- Engage with communities to make a changes/community led studies

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RINGLAND

- Currently a highway system (300,000 vehicles/day) currently runs through densely populated areas within the city (~500,000 inhabitants), which has a major impact on pollution, living conditions and health.
- Moreover, the city of Antwerp has an urgent need for additional green areas (e.g. to combat the heat island effect) as well as housing development opportunities as the city expects a population increase of 70,000 inhabitants by 2050.

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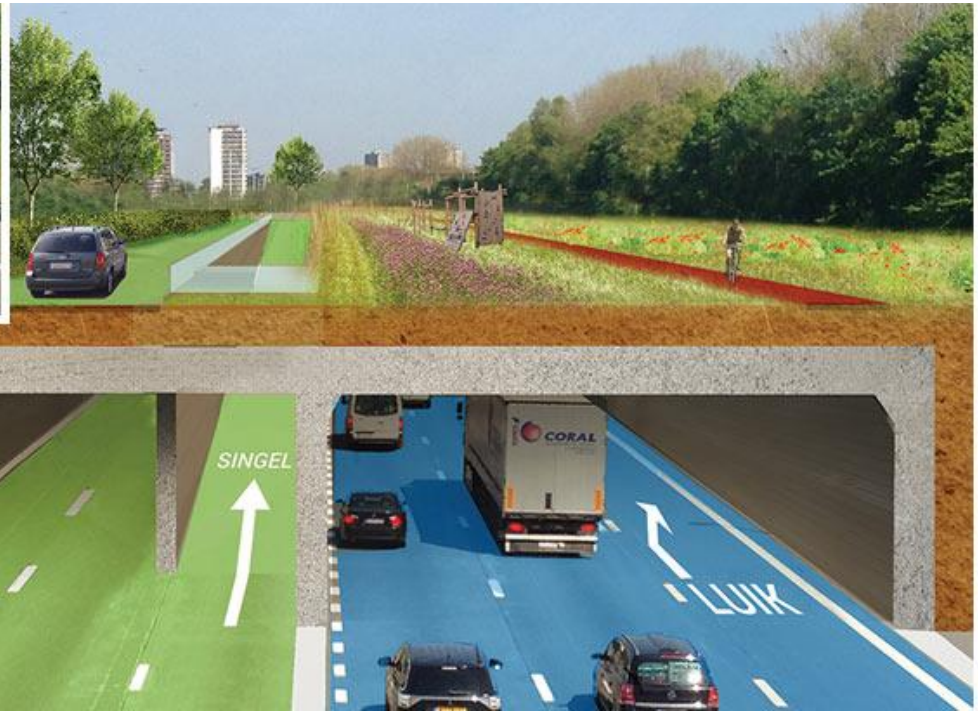
RINGLAND



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RINGLAND

Fig 1. Overview and visual representation of the 'Ringland' project (www.ringland.be). Reprinted from 'Ringland' under a CC BY license, with permission from Peter Vermeulen, original copyright 2015.

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RINGLAND

- The Ringland project is a 6 billion euro investment which proposes a large-scale sustainable urban development focussing on a complete redesign of the highway system in the city of Antwerp.
- Extraordinarily, the research underlying this complex infrastructure project has been entirely organized by local citizens in bottom-up fashion.
- Detailed research studies, executed by external academics, are financed through crowdfunding and subsequently presented to the government.
- The Ringland project hence pioneers a new kind of societal interaction between citizens, scientists and policy makers.

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RINGLAND CITIZENS SCIENCE

- The 200,000 euros that was collected through crowdfunding was used to fund four research projects, in which four external partners participated. These research teams investigated four different topics:
- Infrastructural planning and technical feasibility
- Mobility impact assessment
- Environmental impact assessment
- Financial feasibility and real estate development

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Table 2. Differences in all-cause mortality, life expectancy, number of myocardial infarctions and lung cancer deaths in the exposed population—predicted by the 'filtered tunneled ring road' scenario ('Ringland project') as compared to the 'open air ring road'. (dose response functions based on the *extended follow-up of the Harvard Six Cities Study by Laden et al. 2006* for the calculation of the changes in mortality [32]; *Pope at al. 2009* for the calculation of life expectancy [36]; *a meta-analysis by Nawrot et al. 2014* for the calculation of myocardial infarctions [41]; and a meta-analysis by *Hamra et al. 2014* for the calculation of lung cancer deaths [40]).

	500m radius of ring road	1500m radius of ring road
Population exposed	108,225	351,556
Annual number of deaths avoided	12.5 (95% CI 4.2–24.9)	21.1 (95% CI 7–41)
Annual number of deaths avoided per 100,000 inhabitants	11.5 (95% CI 3.9–23)	6 (95% CI 2–12)
Annual total number of life years gained	1009.7 (+- 336.6)	1710.4 (+-570.1)
Annual number of myocardial infarctions avoided	0.3 (95% CI 0–0.7)	0.5 (95% CI 0–1.13)
Annual number of lung cancer deaths avoided	0.05 (95% CI 0.02–0.07)	0.1 (95% CI 0.04–0.12)

doi:10.1371/journal.pone.0154052.t002

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Van Brusselen et al 2016

Seoul

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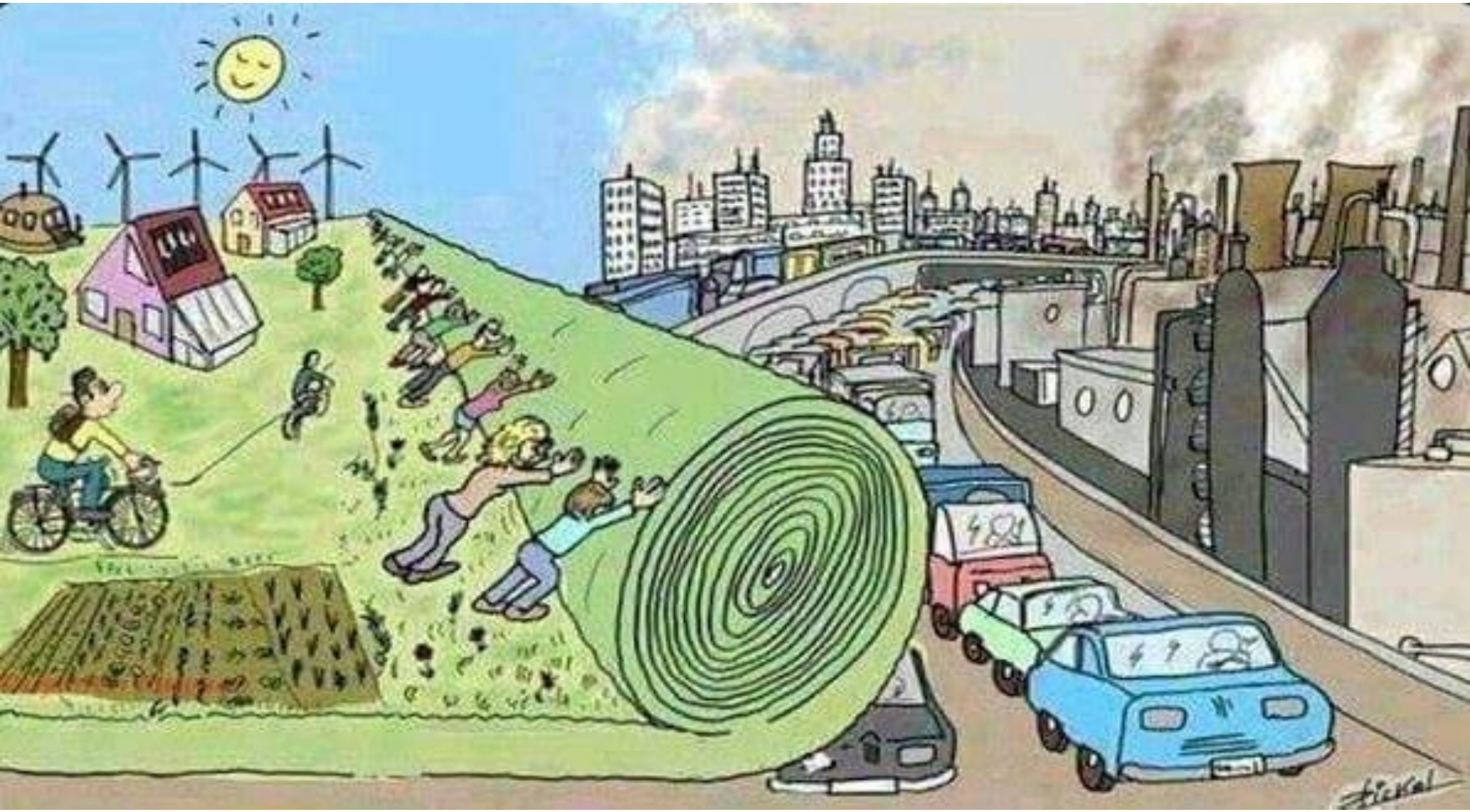
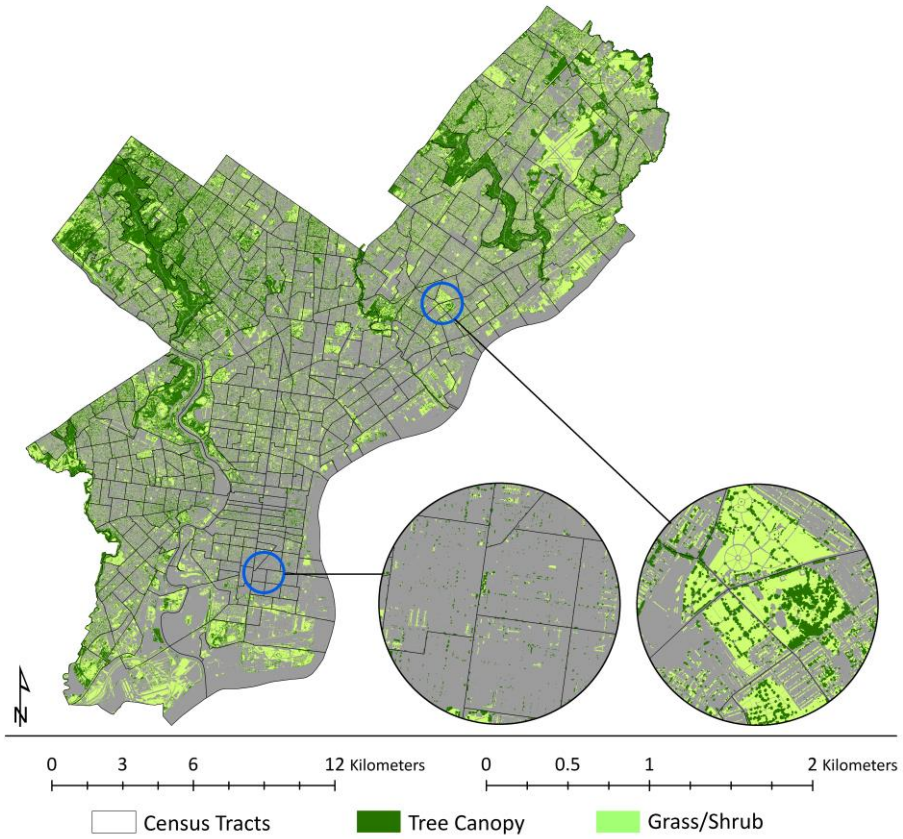


HEALTH IMPACT ASSESSMENT OF PHILADELPHIA'S 2025 TREE CANOPY COVER GOALS (30%)



Land cover analysis in 2008 showed that tree canopy covered 20% of land area

Of the 155 neighborhoods, 19 already met or exceeded the 30% tree canopy goal, and 102 neighborhoods could meet the goal by planting and establishing trees in areas currently covered with grass and/or shrub. The remaining 34 neighborhoods would require removal of impervious surface to meet the 30% cover goal

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Kondo et al 2019

ANNUAL PREVENTABLE PREMATURE DEATHS BY COUNT AND PERCENT, AND AVERTED COSTS

	Preventable Premature Deaths					Averted cost	
	Count	95% CI	Percent	95% CI		Value	95% CI
SCENARIO 10% increase tree coverage							
Total Mortality							
City-wide	-11.4	(-19.0, -7.0)	-0.09%	(-0.14%, -0.05%)		-$121	(-$178, -$66)
Lower SES areas	-6.4	(-9.8, -3.6)	-0.09%	(-0.14%, -0.05%)		-$62	(-$92, -$34)
Upper SES areas	-5.0	(-9.2, -3.4)	-0.09%	(-0.13%, -0.05%)		-$59	(-86, -32)
SCENARIO (30% tree coverage)							
Total Mortality							
City-wide	-1,050	(-1,683, -595)	-8.0%	(-12.1%, -4.3%)		-$10,490	(-$15,824, -$5,591)
Lower SES areas	-606	(-964, -340)	-9.1%	(-13.7%, -4.8%)		-$6,002	(-$9,061, -$3,197)
Upper SES areas	-444	(-720, -255)	-7.0%	(-10.5%, -3.6%)		-$4,487	(-$6,763, -$2,394)

[1] based on value of a statistical life year for 2014 generated by the United States Department of Transportation.
[2] values are per million (2014 $US).

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CITIES

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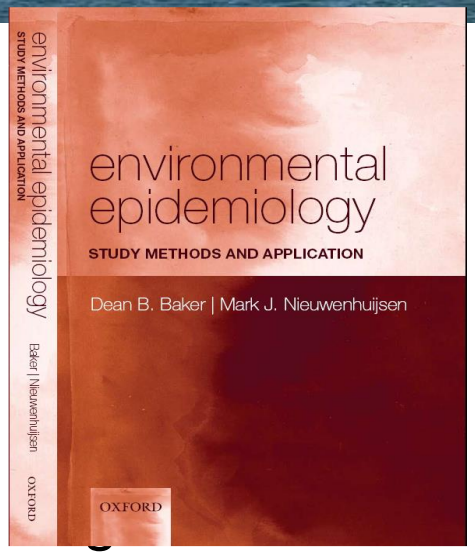

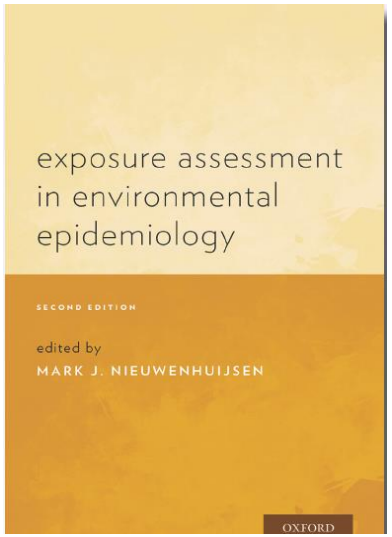

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EL PAÍS

Materia

ENTREVISTA | CARLOS DORA

“Toda la planificación urbana del mundo es para los coches; la gente no importa”

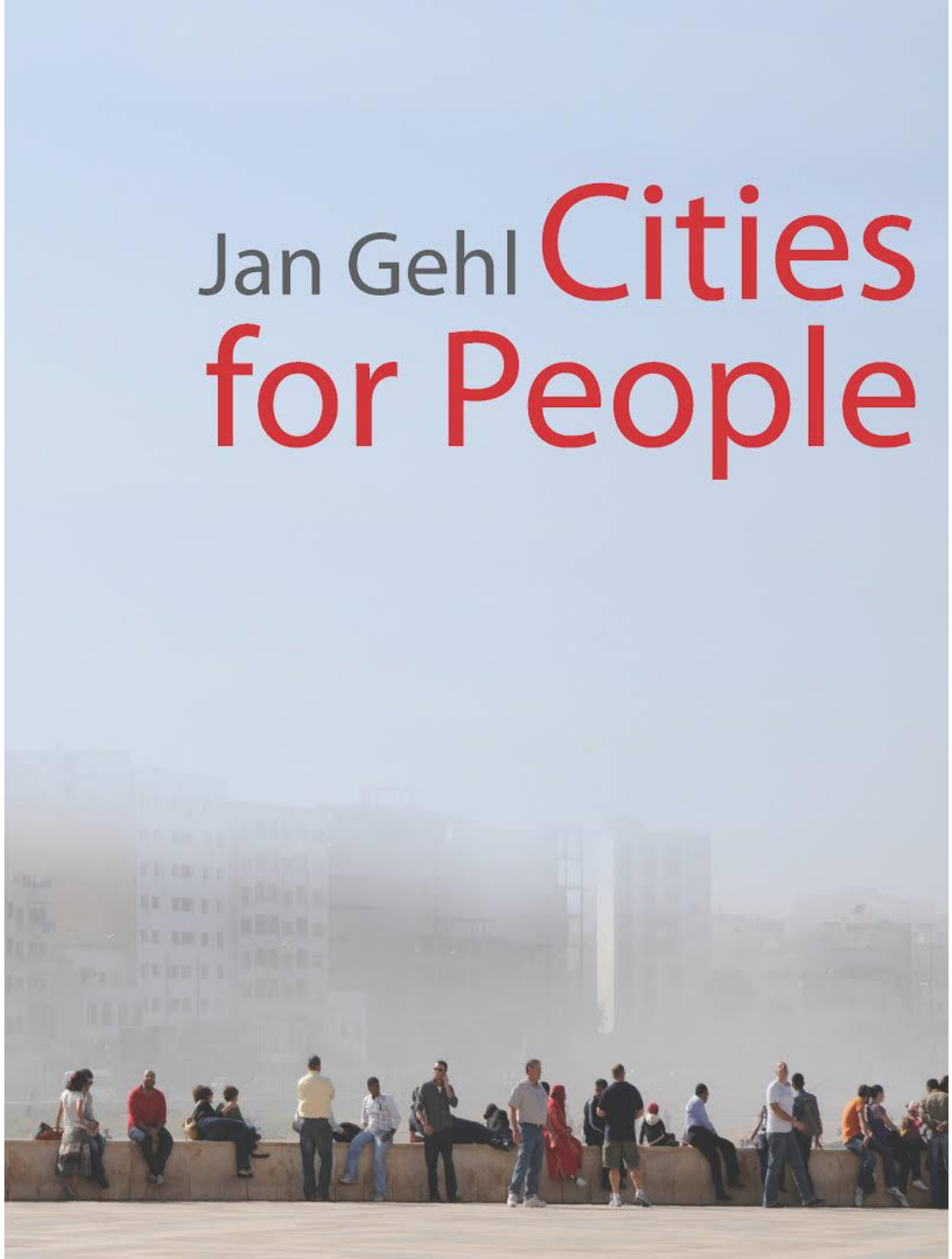
El coordinador de Salud Pública y Medioambiente de la OMS apuesta por desarrollar modelos sostenibles de ciudades para mejorar la salud

JESSICA MOUZO QUINTÁNS

Barcelona - 30 JUN 2017 - 09:40 CEST

Carlos Dora, coordinador de Salud Publica y Medio Ambiente de la Organizacion Mundial de la Salud (OMS), el miércoles en Barcelona. ALBERT GARCIA

"All the urban planning in the world is for cars; People do not matter "



Jan Gehl: “Life happens on foot. Man was created to walk, and all of life’s events large and small develop when we walk among other people. There is so much more to walking than walking. There is direct contact between people and the surrounding community, fresh air, time outdoors

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HOLISTIC APPROACHES

- It is important that we have a more holistic to our cities,

Addressing

- Health
- Livability
- Sustainability
- Climate change
- Equity

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SYSTEMIC APPROACHES

- It is important that we have a more systemic approach to our cities,

Tackling

- Air pollution
- Noise
- Heat islands
- Lack of green space
- Lack of physical activity

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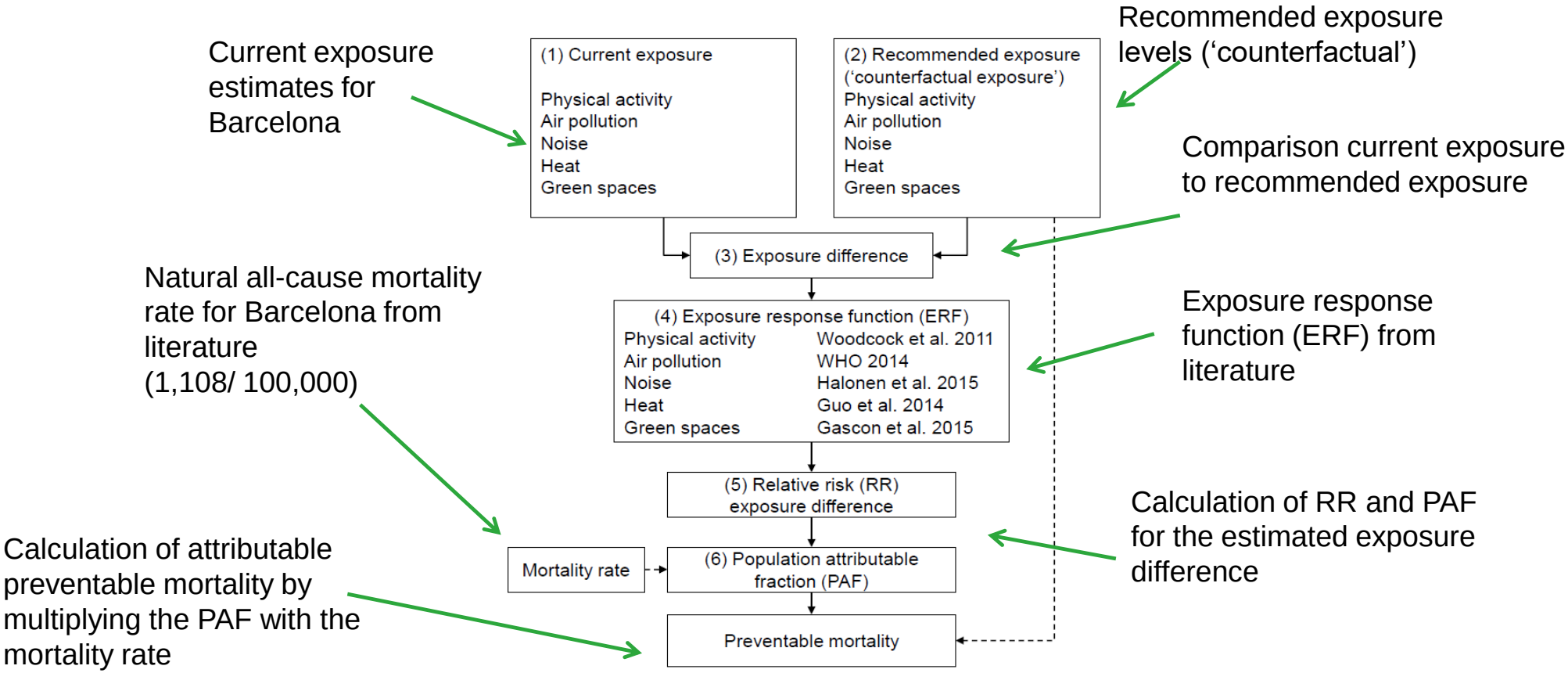
Carrer de Còrsega
Carrer del Rosselló
Carrer d'Enric Granados
Carrer de Còrsega
Carrer del Rosselló
Carrer d'Aribau
Carrer del Rosselló
Carrer de Provença
Carrer de Muntaner
Carrer de Provença
Carrer d'Aribau
Carrer de Mallorca

Urban and TranspOrt Planning Health Impact Assessment tool (UTOPHIA)



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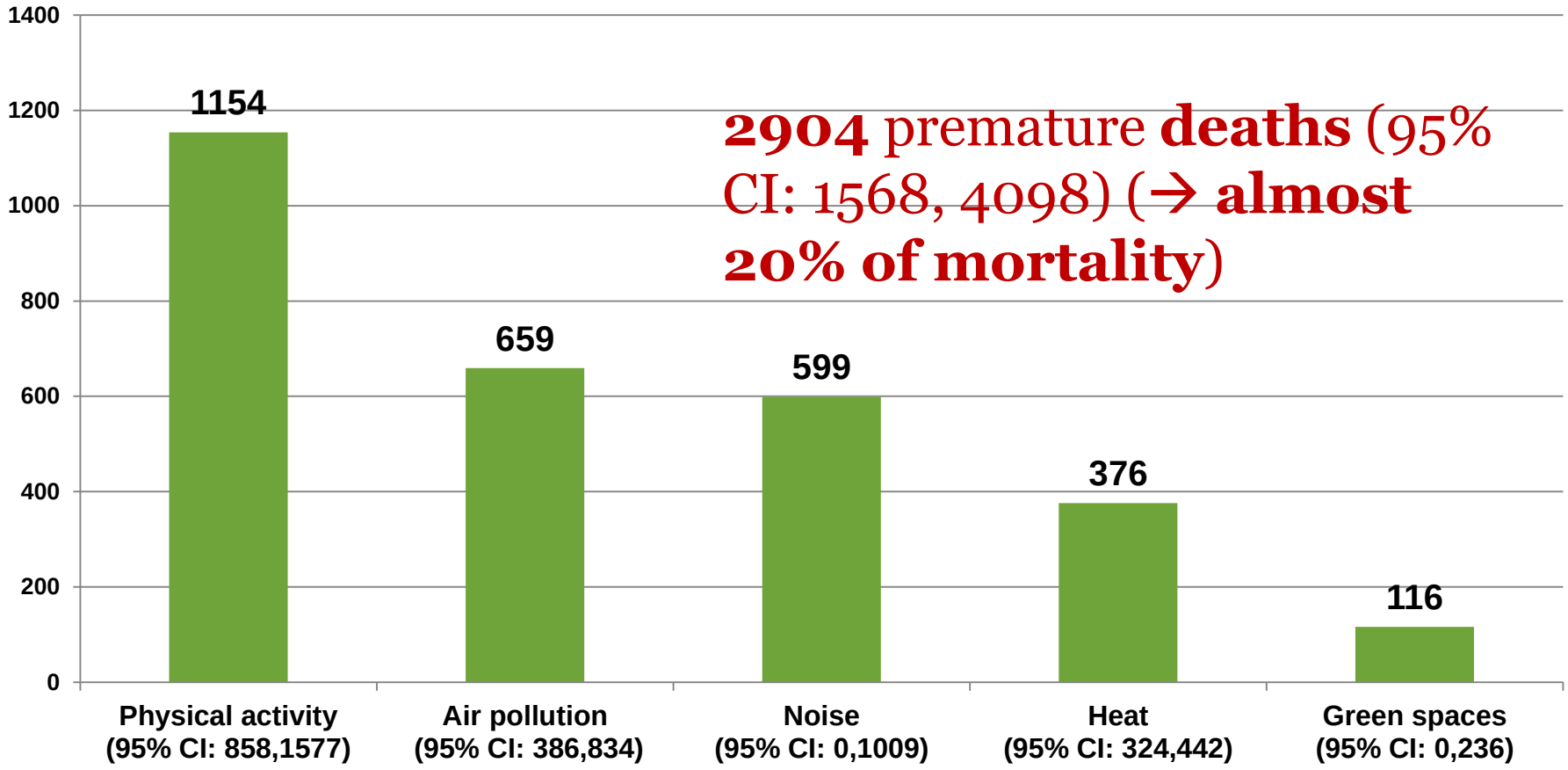
Mueller et al EHP 2017; 125: 89-96

DEATHS DUE TO POOR URBAN AND TRANSPORT PLANNING BARCELONA



2904 premature **deaths** (95% CI: 1568, 4098) (→ **almost 20% of mortality**)

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Traffic injury deaths 30

Mueller et al EHP 2017; 125: 89-96

DALYS GAINED IN COMPACT CITIES

	Melbourne	São Paulo	Delhi	London	Boston	Copenhagen
Cardiovascular disease (ICD-AM I00–I99)	622 (312 to 1071)	363 (14 to 915)	565 (169 to 1117)	582 (244 to 1053)	765 (355 to 1386)	337 (4 to 832)
Type 2 diabetes (ICD-AM E10–E14)	86 (40 to 159)	55 (−9 to 155)	28 (−10 to 91)	27 (7 to 61)	94 (41 to 189)	53 (−4 to 146)
Respiratory disease (ICD-AM J30–J98)	2 (1 to 4)	3 (1 to 5)	22 (8 to 42)	8 (4 to 14)	3 (−1 to 5)	2 (1 to 4)
Road trauma (ICD-AM V00–V89)	−34 (−64 to −7)	−4 (−71 to 62)	2 (−48 to 51)	−41 (−64 to −19)	−34 (−66 to −1)	−1 (−22 to 20)
Total	679 (330 to 1181)	420 (12 to 1029)	620 (167 to 1233)	581 (216 to 1084)	826 (352 to 1553)	393 (5 to 967)

Data are 50th percentile estimates (95% CI). Aggregated individual estimates may not equal the total due to rounding and Monte Carlo estimation. ICD-AM=International Classification of Diseases, Australian modification.

***Table 4*: Disability-adjusted life-years (DALYs) gained per 100 000 population under the compact cities model**

One DALY can be thought of as one lost year of "healthy" life.
DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences:

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Stevenson et al Lancet 2016; 388:2925-2935

ANNUAL PREVENTABLE PREMATURE DEATHS BY COUNT AND PERCENT, AND AVERTED COSTS

	Preventable Premature Deaths					Averted cost	
	Count	95% CI	Percent	95% CI		Value	95% CI
SCENARIO 10% increase tree coverage							
Total Mortality							
City-wide	-11.4	(-19.0, -7.0)	-0.09%	(-0.14%, -0.05%)		-$121	(-$178, -$66)
Lower SES areas	-6.4	(-9.8, -3.6)	-0.09%	(-0.14%, -0.05%)		-$62	(-$92, -$34)
Upper SES areas	-5.0	(-9.2, -3.4)	-0.09%	(-0.13%, -0.05%)		-$59	(-86, -32)
SCENARIO (30% tree coverage)							
Total Mortality							
City-wide	-1,050	(-1,683, -595)	-8.0%	(-12.1%, -4.3%)		-$10,490	(-$15,824, -$5,591)
Lower SES areas	-606	(-964, -340)	-9.1%	(-13.7%, -4.8%)		-$6,002	(-$9,061, -$3,197)
Upper SES areas	-444	(-720, -255)	-7.0%	(-10.5%, -3.6%)		-$4,487	(-$6,763, -$2,394)

[1] based on value of a statistical life year for 2014 generated by the United States Department of Transportation.
[2] values are per million (2014 $US).

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Kondo et al 2019