EFFECTS OF URBAN PLANNING ON HEALTH

Mark J Nieuwenhuijzen
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)
Paris, France
Policies

URBAN DESIGN
- Density
- Mixed land use/diversity
- Distance
- Design
- Destination accessibility
- Connectivity
- Transport infrastructure
- Walkability
- Bikeability
- Green Space

BEHAVIOUR
- Indoor/outdoor
- Walking
- Cycling
- Car
- Public transport

PATHWAYS
- Air pollution
- Noise
- Temperature
- UV Radiation

MORBIDITY
- Acute/chronic
- Neurodevelopment/cognitive function
- Cancer
- Mental health
- Cardiovascular and Respiratory disease

MORTALITY
- Premature mortality

Context: socio-economic, genetic, nutrition

Nieuwenhuijsen 2016 and 2018
• Land use changes
• Reduce car dependency
• Move towards public and active transportation
• Green cities
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.
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:

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

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

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.
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
Premature mortality impacts

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

- 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)
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
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
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)

Mueller et al 2018
PREMATURE DEATHS PREVENTED

- 10,091 premature deaths prevented annually in 167 European cities if the mode share of cycling went up to 24.7%

Mueller et al 2018
CITIZENS PARTICIPATION

• Engage with communities to make a changes/community led studies
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.
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.
The Ringland project is a 6 billion euro investment which proposes a large-scale sustainable urban development focusing 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.
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
De luchtkwaliteit in mei 2016 op 2.000 locaties in Antwerpen

WWW.CURIEUZENEUZEN.ORG
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 et 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]).

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

doi:10.1371/journal.pone.0154052.t002
Before

After

Seoul
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...
Car free cities: Pathway to healthy urban living

Mark J. Nieuwenhuijsen a,b,c,*, Haneen Khreis d

a ISGlobal, Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain
b Universitat Pompeu Fabra (UPF), Spain
c CIBER Epidemiología y Salud Pública (CIBERESP), Spain
d Institute for Transport Studies (ITS), University of Leeds, Leeds, United Kingdom

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-
Multisectorial approach

Multi sectorial and systemic approaches are needed to address current problems and find solutions.
### 3. Density
- Is a medium to high dwelling density provided in the area? 
  - 100–499 dwellings/ha (range: 50–100 dwellings/ha)
- Is a low to mid-rise building form provided? 
  - ≥ 75% stories 1 to 4 stories
- Is a human scale with sky visibility within normal sight lines ensured? 
  - ≤ 52° 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? 
  - Optimum 30 m²/capita

### 4. Traffic Calming
- Is space for circulating and parked private motorized transport minimized? 
  - ≤ 25% of total surface for roads, ways, and parking
- Are road lanes kept at a functional minimum? 
  - ≤ 3 lane width on road lane
- Are traffic calming and speed reductions features incorporated? 
  - Number of traffic calming and speed reduction features (e.g., speed humps, curb extensions, vertical deflections such as street medians, or roundabouts, etc.)
- Is on-road parking space minimized? 
  - On-road parking

### 5. Walking
- Is segregated, non-shared pedestrian infrastructure provided? 
  - ≥ 75% total space accessible to pedestrians
- Is sidewalk width consistent with its use? 
  - ≥ 1.5 m sidewalk width
- Are different pedestrian needs and abilities considered? 
  - Share-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., multimodality)? 
  - Yes
### 6. CYCLING
- Is segregated, non-shared cycling infrastructure provided?  
  - Yes
  - No
- Is a homogeneous, continuous and intuitive cycling network provided?  
  - Yes
  - No
- Are conflicts with other transport modes at intersections and street form changes avoided?  
  - Yes
  - No
- Are changes in street side and over- and underpasses avoided?  
  - Yes
  - No
- Is the cycling infrastructure located on the curbside of the road instead of in the center?  
  - Yes
  - No
- Is a cycling network created that interconnects with other active and public transport modes (i.e., multi-modality)?  
  - Yes
  - No
- Does the cycling infrastructure contain continuous greenery?  
  - Yes
  - No

### 7. PUBLIC TRANSPORT
- Is universal access (100% of population) to public transport provided?  
  - Yes
  - No
- Are conflicts with other transport modes at intersections and street form changes avoided?  
  - Yes
  - No
- Are highly-connected public transport networks within and between municipalities developed?  
  - Yes
  - No
- Is a public transport network created that interconnects with other active and public transport modes (i.e., multi-modality)?  
  - Yes
  - No

### 8. MULTI-MODALITY
- Are pedestrian, cycling and public transport infrastructures well connected?  
  - Yes
  - No
- Are multi-modality nodes that prioritize the switch between walking, cycling and public transport established and well distributed across the city?  
  - Yes
  - No
- 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
  - No

### 9. PUBLIC OPEN/ GREEN SPACE
- Is universal access (100% of population) to public open/green space provided?  
  - Yes
  - No
- Is there sufficient public open/green space?  
  - Yes
  - No
- Is a major local green space provided?  
  - Yes
  - No
- Is a district green space provided?  
  - Yes
  - No
- Is a regional green space provided?  
  - Yes
  - No
- Is continuous surrounding greenness provided? (e.g., green corridors, street trees, green patches, pocket parks, etc.)  
  - Yes
  - No
- Are walking and cycling infrastructures integrated into the local green space system?  
  - Yes
  - No

### 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
  - No

### NOTES
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 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 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.
Green cities, healthy people

Active cities, healthy people,

Clean cities, healthy people

Social cities, healthy people