Active mobility and health:
Insights from the PASTA project

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on behalf of the PASTA consortium

This project has received funding from the European Union’s Seventh Framework Programme for research; technological development and demonstration under grant agreement no 602624-2.
7 Case-study Cities
Cycling Networks are Associated with Cycling Mode Shares

Mueller N. Et al. forthcoming
How does Active Travel affect Health?

**Individual perspective**

How healthy or unhealthy (risky) is AT?

- Compared to driving, wellbeing was higher when using active travel or public transport.

**Public health perspective**

What is it worth to society?

Relative risk for all-cause mortality for 11.25 MET hours/week of walking.
Towards a Comprehensive Conceptual Framework of Active Travel Behavior: a Review and Synthesis of Published Frameworks

Thomas Götschi¹ • Audrey de Nazelle² • Christian Brand³ • Regine Gerike⁴
on behalf of the PASTA Consortium
Review of Reviews: Measures to Promote Active Mobility


Evidence based health policy

- How do policy makers know what works?
- Health recommendations often derived from cross-sectional / observational studies
  - Causality issues
  - Risk of false/reverse associations
  - Observed Effects Biased towards null because of exposure misclassification
  - Risk of ineffective policies & wasted tax money

=> Need for
- Longitudinal studies
- Experimental studies
- Accountability studies

(What effect does a change in exposure* have on health?
=> Need for accurate (personal) exposure measurement)

* Physical activity / Air Pollution 7
Study design

Open Access

BMJ Open Physical Activity through Sustainable Transport Approaches (PASTA): a study protocol for a multicentre project

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Protocol

Physical Activity through Sustainable Transport Approaches (PASTA): protocol for a multi-centre, longitudinal study

Evi Dons¹,², Thomas Götschi², Mark Nieuwenhuijsen⁴,⁵,⁶, Audrey de Nazelle³, Esther Anaya³, Ione Avila-Palencia⁴,⁵,⁶, Christian Brand⁶, Tom Cole-Hunter⁴,⁵,⁶, Malin Gaupp-Berghausen⁹, Sonja Kahlmeier³, Michelle Laeremans³,¹³ Natalie Mueller⁴,⁵,⁶, Juan Pablo Orjuela⁷, Elisabeth Rasenberger,¹⁴ David Rojas-Rueda⁴,⁵,⁶, Arnout Standaert¹, Erik Stigell¹¹, Tina Uhlmann⁹, Regine Gerike⁹,¹² and Luc Int Panis⁵,¹⁰*
Recruitment for the online Survey

12,825 registrations
Sample description

54% 46%

Participants by city

- Antwerp: 12%
- Barcelona: 12%
- London: 16%
- Oerebro: 17%
- Rome: 14%
- Vienna: 14%
- Zurich: 15%

Age distribution:

- 16-20: 2%
- 20-30: 25%
- 30-40: 27%
- 40-50: 21%
- 50-60: 17%
- 60-70: 6%
- 70-80: 2%
- 80+: 0.1%

Education distribution:

- No degree: 0.3%
- Primary education: 1.2%
- Secondary education / Further education: 26.0%
- Higher education / University education: 72.5%
Online Survey

Welcome to the PASTA survey!

Completing this questionnaire will take about a minute. You will be entered in a prize draw.

With many thanks and best wishes from the PASTA team.
Longitudinal Online Survey

- Before/after, trend evaluation
- Active travel and physical activity vary in time
- Lots of questions to ask

Baseline Q

- Socio-d.
- Commute route
- Health status
- GPAQ
- Mobility scale
- Travel D
- Psychology
- Top measure

Crash Q (only in case of crash or near-miss)

FU short Mobility –scale PA single item Crash-q

FU short

FU long GPAQ Travel-D Crash-q

FU short

FU short
10’000+ Participants, 87’000 Questionnaires
Concern over health effects of air pollution

![Map of NO2 and PM2.5 levels across Europe with percentage concerns for each city.](https://www.pastaproject.eu)

- **Not worried at all**
- **Not worried**
- **Neither worried nor not worried**
- **Worried**
- **Extremely worried**

<table>
<thead>
<tr>
<th>City</th>
<th>Antwerp</th>
<th>Barcelona</th>
<th>London</th>
<th>Oerebro</th>
<th>Rome</th>
<th>Vienna</th>
<th>Zurich</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO2</td>
<td>29%</td>
<td>16%</td>
<td>15%</td>
<td>11%</td>
<td>21%</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>PM2.5</td>
<td>48%</td>
<td>65%</td>
<td>49%</td>
<td>32%</td>
<td>51%</td>
<td>26%</td>
<td>23%</td>
</tr>
</tbody>
</table>
Concern over health effects of air pollution

Being male, having children in the household, being more physically active, and higher NO₂ at the home address \( \rightarrow \) higher concern over health effects of air pollution.
Current epi studies largely ignore:
- Concentration heterogeneity
- Movement of people
- Indoor/Outdoor
- Inhalation rate

=> Small wearable sensors can potentially solve all of these problems
PEOPLE DON’T SPENT THEIR DAYS ON THEIR DOORSTEP…
NEED FOR PERSONAL EXPOSURE ASSESSMENT

- Need for portable sensors
- Large temporal/spatial differences in concentrations (esp. BC)
- Large differences in inhalation rate

(Dons et al., ATMOS ENVIRON, 2011)
LOWER CONCENTRATION BUT HIGHER DOSES FOR CYCLISTS

Source: PhD by Evi Dons
Dons et al 2011
https://www.researchgate.net/publication/232070900_Personal_exposure_to_Black_Carbon_in_transport_microenvironments
The PASTA experiment

Our experiment:
- 122 participants
- 3 repeated measures/participant
- In different seasons
- 3 cities
- Integrates multiple biomarkers

One week
What physiological signals did we measure?

- Heart rate variability
- Blood pressure
- Retinal pictures
- Exhaled NO
- Lung function (spirometry)
Physical activity (PA) and black carbon (BC) levels by city. Points represent average levels per individual.

Black carbon levels by activity types and by city.
Key questions in PASTA

Does an increase in walking and cycling translate into more physical activity?

YES: active mobility helps to increase physical activity levels
Is self-reported PA reliable?

Vigorous-intensity PA: YES
Moderate-intensity PA: underestimated
Sedentary time: inaccurate
The beneficial effect of physical activity decreases with increasing black carbon concentrations.
Long term: physical activity benefit on the respiratory system decreases with air pollution levels

Lung function ~ FEV*$_1$

Lung function ~ FEV$_1$

FEV$_1$ = Forced Expiratory Volume in the 1st second
The benefit of additional hour of physical activity per week on FEV1 tends to zero, in black carbon concentrations of 1.5 µg/m³.
In case of all-cause mortality, most studies report that physical activity benefits outweigh the risks. However, the *respiratory system* might need some additional attention.
BMI analysis

What happens when you start cycling?

Key gaps addressed:
- Cross-sectional analysis vs. longitudinal analysis
- Taking into account important covariates like leisure-time PA
- Many participants using many different modes
- Multicentre study

Baseline questionnaire (t₀)
- height
- weight
- transport mode
- etc.

Final questionnaire (t₁)
- height
- weight
- transport mode
- etc.

N=8,579

<< 476 days >>

N=3,292
BMI analysis

Results from the cross-sectional analysis

![Graph showing BMI difference per additional day per month for different modes of transport: Bike, Walk, Public transport, Motorcycle, E-bike, Car. The BMI difference ranges from -0.035 to 0.035 kg/m² per day per month. Non-cyclists, occasional cyclists, and frequent cyclists are also depicted, with BMI differences ranging from -0.5 to 0.5 kg/m².]
BMI analysis

- Translate BMI in kilograms.
- Reverse causality.
Antwerp Cycling Highway

Cost-benefit ratios indicate that the benefits of the 25 km cycling highway Antwerp-Mechelen (Belgium) are 2 to 14 times higher than the initial investment.

<table>
<thead>
<tr>
<th>Impact factor</th>
<th>euro</th>
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<tbody>
<tr>
<td>Physical activity (reduced mortality)</td>
<td>$1.2 \times 10^7$</td>
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<tr>
<td>Physical activity (reduced morbidity)</td>
<td>$2.3 \times 10^6$</td>
</tr>
<tr>
<td>Reduced air pollution society (mortality)</td>
<td>$7.4 \times 10^4$</td>
</tr>
<tr>
<td>Air pollution active mobility</td>
<td>$-8.9 \times 10^5$</td>
</tr>
<tr>
<td>Crash risk</td>
<td>$-1.4 \times 10^6$</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$+1.2 \times 10^7$</strong></td>
</tr>
<tr>
<td>Infrastructure construction costs</td>
<td>$-6.0 \times 10^6$</td>
</tr>
<tr>
<td><strong>Benefit:cost ratio</strong></td>
<td><strong>2.0</strong></td>
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</table>
Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways

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ARTICLE INFO

Article history:
Received 2 June 2015
Received in revised form
18 August 2015
Accepted 21 August 2015

Keywords:
Health impact assessment
Cycling
Walking
Crashes
Monetary evaluation
Bicycle highway

ABSTRACT

In Flanders, a European hot spot for air pollution, alternatives to car transport are put in place to increase the daily level of physical activity (PA) among the population and reduce air pollution and global warming. To evaluate the economic impact of increased PA (cycling and walking), a health impact model was developed for a given volume of PA, relative to car use, within a defined population in Flanders. Flanders is an interesting region because of the combination of high air pollution, high cycling volumes and good data availability e.g on crashes and PA. The model uses two health indicators: external costs and DALYs. Considered impacts in the model are: mortality and morbidity related to increased PA, air pollution exposure for society and active individuals and crash risks. In addition to health, external costs for CO2 emission, congestion and noise exposure can be considered. The model was applied to the new bicycle highways Antwerp–Mechelen and Leuven–Brussels, which were built near important traffic axes to provide the densely populated region with an alternative to car use. Different sensitivity analyses with a variable number of cyclists and travelled distances were elaborated to check the robustness of the results. Overall, the conclusion was that increased PA outweighed other impacts. The benefit:cost ratio...
Take-home message

Keep on promoting active mobility & use the PASTA study to highlight the need for better (urban) air quality
Health economic assessment tools (HEAT) for walking and for cycling

Methodology and user guide

ECONOMIC ASSESSMENT OF TRANSPORT INFRASTRUCTURE AND POLICIES
Thanks to all PASTA Collaborators

B. Alasya, E. Anaya, I. Avila-Palencia,

Advisory Board: K. Dziekan, A. Ahrens, M. Jerrett, A. Davis