Cycling & Health

Les séminaires de l'URePSSS
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Bas de Geus

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Google: Commuter Cycling and Health

Introduction: Epidemiological studies

ORIGINAL INVESTIGATION

All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work

Lars Bo Andersen, PhD, DMSc; Peter Schnohr, MD; Marianne Schroll, PhD, DMSc; Hans Ole Hein, MD

Conclusions: Leisure time physical activity was inversely associated with all-cause mortality in both men and women in all age groups. Benefit was found from moderate leisure time physical activity, with further benefit from sports activity and bicycling as transportation.

Arch Intern Med. 2000;160:1621-1628

ELSEVIER Preventive Medicine 46 (2008) 9–13 www.elsevier.com/locate/ypmed

Review

Active commuting and cardiovascular risk: A meta-analytic review

Mark Hamer*, Yoichi Chida

Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, London WC1E 6BT, UK

Available online 20 March 2007

Conclusions. Active commuting that incorporates walking and cycling was associated with an overall 11% reduction in cardiovascular risk, which was more robust among women. Future studies should investigate the reasons for possible gender effects and also examine the importance of commuting activity intensity.

ORIGINAL INVESTIGATION

Active Commuting and Cardiovascular Disease Risk

The CARDIA Study

Penny Gordon-Larsen, PhD; Janne Boone-Heinonen, PhD; Steve Sidney, MD, MPH; Barbara Sternfeld, PhD; David R. Jacobs Jr, PhD; Cora E. Lewis, MD

Conclusions: Active commuting was positively associated with fitness in men and women and inversely associated with BMI, obesity, triglyceride levels, blood pressure, and insulin level in men. Active commuting should be investigated as a modality for maintaining or improving health.

Arch Intern Med. 2009;169(13):1216-1223

Introduction: Intervention studies

Physiological effects of walking and cycling to work

Oja P, Mänttäri A, Heinomen A, Kukkonen-Harjula K, Laukkanen R, Pasanen M, Vuori I
Scan J Med Sci Sports, 1: 1991: 151-157

Conclusion: These findings indicate that low-intensity walking and cycling to and from work improved cardiorespiratory and metabolic fitness.

Effect of commuter cycling on physical performance of male and female employees

INGRID J. M. HENDRIKSEN, BOB ZUIDERVELD, HAN C. G. KEMPER, and P. DICK BEZEMER

Department of Physiology, Faculty of Medicine, Vrije Universiteit, Amsterdam, THE NETHERLANDS and Institute for Research in Extramural Medicine (EMGO), Faculty of Medicine, Vrije Universiteit, Amsterdam, THE NETHERLANDS

year, but this was counteracted in the second half year. A dose-response relationship was found between two independent variables and the physical performance; the lower the physical performance at the start of the study and the higher the total amount of kilometers cycled, the higher the gain in W_{max}. For subjects with a low initial fitness level, a single trip distance of only 3 km turned out to be enough to improve physical performance. **Conclusion:** Commuter cycling can yield much the same improvement in physical performance as specific training programs. **Key Words:** MAXIMAL EXTERNAL POWER; MAXIMAL OXYGEN UPTAKE; EXERCISE TESTING; CYCLE ERGOMETRY; EXERTION

Introduction: Intervention studies

Scand J Med Sci Sports 2009: 19: 179–187
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DOI: 10.1111/j.1600-0838.2008.00776.x

SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS

Commuter cycling: effect on physical performance in untrained men and women in Flanders: minimum dose to improve indexes of fitness

B. de Geus, J. Joncheere, R. Meeusen

Concluding we can state that, based on the results of this study, cycling to work has the potential to increase physical performance in an untrained study population. The maximal external power and peak oxygen uptake significantly changed over time when the IG and CG were compared. Weak, but significant correlations were found between the peak oxygen uptake and total volume in the first period.

Scand J Med Sci Sports 2008: 18: 498–510
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DOI: 10.1111/j.1600-0838.2007.00729.x

SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS

Cycling to work: influence on indexes of health in untrained men and women in Flanders. Coronary heart disease and quality of life

B. de Geus[1], E. Van Hoof[2,3], I. Aerts[1], R. Meeusen[1]

We conclude that this lifestyle intervention study, where subjects had to cycle to and from work for 1 year, had a positive influence on CHD risk factors and was likely to improve the health-related QOL of previously untrained healthy adults.

Introduction: Systematic Review – Health Benefits

Scand J Med Sci Sports 2011
doi: 10.1111/j.1600-0838.2011.01299.x

SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS

Review

Health benefits of cycling: a systematic review

P. Oja[1], S. Titze[2], A. Bauman[3], B. de Geus[4], P. Krenn[2], B. Reger-Nash[5], T. Kohlberger[2]

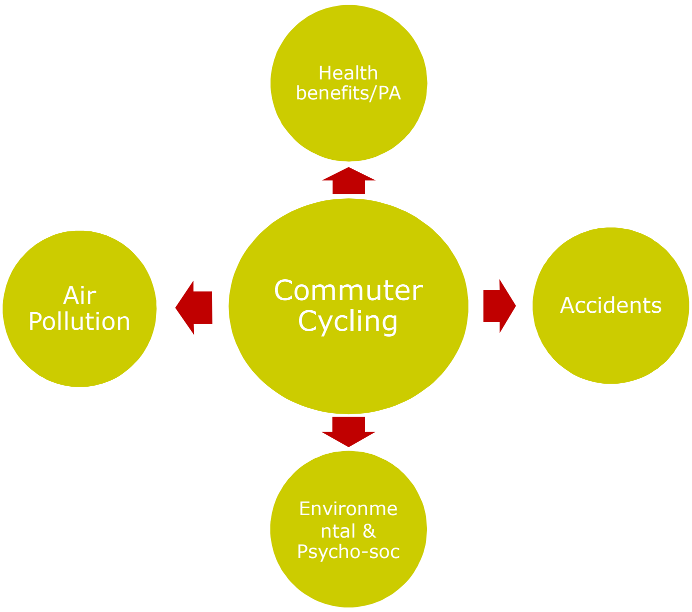
[1]UKK Institute, Tampere, Finland, [2]Institute of Sport Science, University of Graz, Graz, Austria, [3]School of Public Health, University of Sydney, Sydney, Australia, [4]Department of Human Physiology and Sports Medicine, Vrije Universiteit Brussel, Brussels, Belgium, [5]Department of Community Medicine, West Virginia University, Morgantown, West Virginia, USA
Corresponding author: Pekka Oja, F.E.Sillanpään katu 4 A 16, 33230 Tampere, Finland. Tel: +358 50 3394 593, Fax: +358 3 2829 559, E-mail: pekka.oja@uta.fi

Accepted for publication 23 December 2010

The purpose of this study was to update the evidence on the health benefits of cycling. A systematic review of the literature resulted in 16 cycling-specific studies. Cross-sectional and longitudinal studies showed a clear positive relationship between cycling and cardiorespiratory fitness in youths. Prospective observational studies demonstrated a strong inverse relationship between commuter cycling and all-cause mortality, cancer mortality, and cancer morbidity among middle-aged to elderly subjects. Intervention studies among working-age adults indicated consistent improvements in cardiovascular fitness and some improvements in cardiovascular risk factors due to commuting cycling. Six studies showed a consistent positive dose–response gradient between the amount of cycling and the health benefits. Systematic assessment of the quality of the studies showed most of them to be of moderate to high quality. According to standard criteria used primarily for the assessment of clinical studies, the strength of this evidence was strong for fitness benefits, moderate for benefits in cardiovascular risk factors, and inconclusive for all-cause mortality, coronary heart disease morbidity and mortality, cancer risk, and overweight and obesity. While more intervention research is needed to build a solid knowledge base of the health benefits of cycling, the existing evidence reinforces the current efforts to promote cycling as an important contributor for better population health.

So ???

Commuter Cycling positive on Health ??



Are cyclists exposed to higher risks due to **air pollution** and **accidents**?

HEALTH

Back-ground air pollution – Long-term

Cardiovascular Mortality and Long-Term Exposure to Particulate Air Pollution

Epidemiological Evidence of General Pathophysiological Pathways of Disease

C. Arden Pope III, PhD; Richard T. Burnett, PhD; George D. Thurston, ScD; Michael J. Thun, MD; Eugenia E. Calle, PhD; Daniel Krewski, PhD; John J. Godleski, MD

Conclusions—Fine particulate air pollution is a risk factor for cause-specific cardiovascular disease mortality via mechanisms that likely include pulmonary and systemic inflammation, accelerated atherosclerosis, and altered cardiac autonomic function. Although smoking is a much larger risk factor for cardiovascular disease mortality, exposure to fine PM imposes additional effects that seem to be at least additive to if not synergistic with smoking. (*Circulation*. **2004; 109:71-77.**)

Back-ground traffic air pollution – Long-term

Long-Term Effects of Traffic-Related Air Pollution on Mortality in a Dutch Cohort (NLCS-AIR Study)

Rob Beelen,[1] Gerard Hoek,[1] Piet A. van den Brandt,[2] R. Alexandra Goldbohm,[3] Paul Fischer,[4] Leo J. Schouten,[2] Michael Jerrett,[5] Edward Hughes,[6] Ben Armstrong,[7] and Bert Brunekreef[1,8]

CONCLUSIONS: Traffic-related air pollution and several traffic exposure variables were associated with mortality in the full cohort. Relative risks were generally small. Associations between natural-cause and respiratory mortality were statistically significant for NO_2 and BS. These results add to the evidence that long-term exposure to ambient air pollution is associated with increased mortality.

Micro-environment traffic air pollution – Short-term

ELSEVIER

The Science of the Total Environment 279 (2001) 131–136

the Science of the Total Environment

www.elsevier.com/locate/scitotenv

Differences in cyclists and car drivers exposure to air pollution from traffic in the city of Copenhagen

Jette Rank[a,*], Jens Folke[b], Per Homann Jespersen[a]

5. Conclusion

On the basis of this study, we can conclude that cyclists in the city of Copenhagen are exposed to lower concentrations of traffic related pollutants than car drivers. Furthermore, we conclude that car drivers experience 3–4 times higher BTEX concentrations and approximately two times higher exposure of particles than bikers. The study also indicates that the air children breathe may be better on the back of a bicycle than inside a car.

What do we forget?

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Physical effort (VE) of cycling >> car driving

➔ Inhaled # particles: cyclist >> driver ??

Project: SHAPES

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Literature: ventilation – exposure

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Study	**Measurment - Estimation**	**Bicycle/car ventilation ratio**
Van Wijnen (1995) (Vrijkotte (unpublished))	Measurment	2.3
den Breejen (2006)	Van Wijnen (1995)	2.3
Rank (2001)	Van Wijnen (1995)	2.3
O'Donoghue (2007)	Estimation - HR	2.6
Zuurbier (2009)	Estimation - HR	2.1

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Micro-environment traffic air pollution – Short-term

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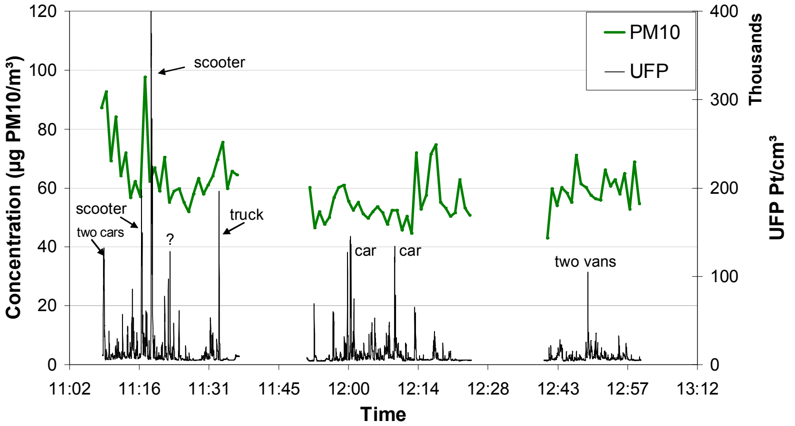

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Materials & Methods

- N = 55 healthy adults
- Field tests: Cycling + Car passenger (cross-over experiment)
  - Breath-by-breath ergospirometry (MetaMax 3B) ➔ **Minute Ventilation**
  - Particle Number Conc (UFP) + Particulate Matter (PM10, PM2.5)

➔ Exposure = ventilation per distance x concentration x distance

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Materials & Methods

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Materials & Methods

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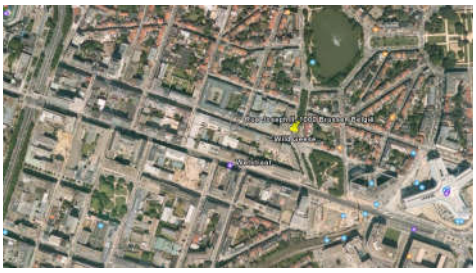
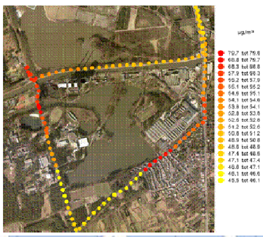
- 3 ≠ locations:
  - flat – hilly
  - polluted – non-polluted





Results – Air pollution

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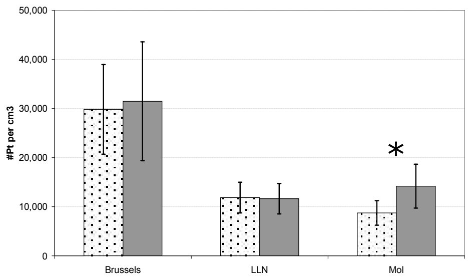
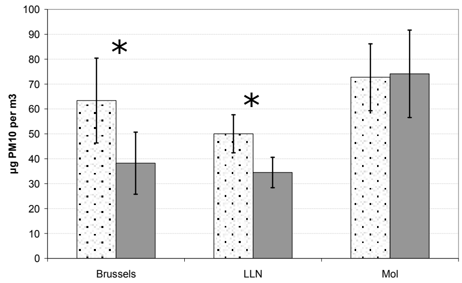
UFP (PNC/cm³)



PM10 (µg/m³)



Values are mean (SD)

* Sign diff car vs bicycle

cycling

car

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Results: Minute Ventilation (VE): Bike/car ratio

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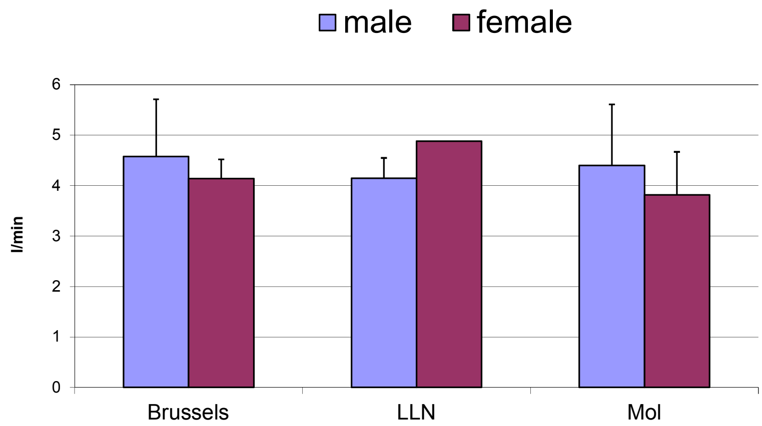

Values are mean (SD)

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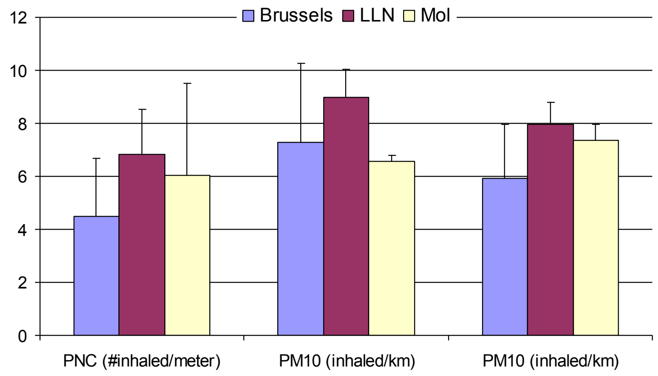
Results: Inhaled quantities: bicycle/car ratio



Values are mean (SD)

Results - Conclusions

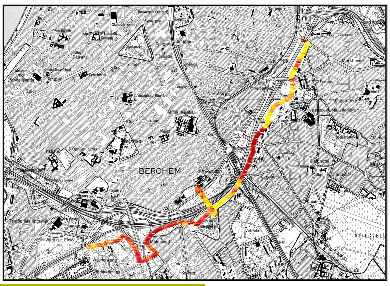
- bike/car PNC, PM ratio = ≈ 1
- bike/car VE ratio = 4.3

- inhaled particles by cyclists 400 - 900% higher compared to car passengers on the same trajectory

PM²TEN – Effect of cycling on Health outcomes

- Cross-over experiment: examine the acute effect of exercise on **plasma BDNF, Exhaled nitric oxide (NO), plasma interleukin-6 (IL-6), platelet function, Clara cell protein in serum and blood cell counts** when cycling in Polluted Environment (Antwerp ring) + Clean Room and examine the potential effect-modification by exposure to traffic-related air pollution.

Antwerp ring



Clean room

Results – PM10, PM2.5, UFP

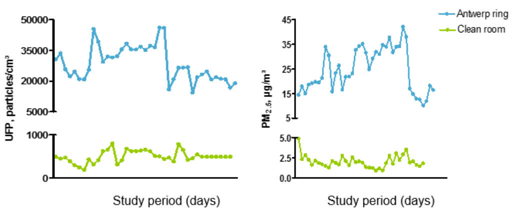


Figure 2: Concentration of UFP (PNC; particles/cm³) and PM2.5 (µg/m³) during the study period (days) in both locations.

Table 2 Exposure measurements during the road test and in the clean room

Endpoint	Road test	Clean room	p-value*
Average PM_{10}, µg/m³	62.8 (23.6)	7.6 (3.3)	<0.001
Average $PM_{2.5}$, µg/m³	24.2 (8.7)	2.0 (0.78)	<0.001
Average UFP, particles/cm³	28,867 (8479)	496 (138)	<0.001
Duration of cycling, min	20.8 (1.6)	20.2 (1.9)	0.20
Temperature,°C	15.2 (1.6)	21.6 (1.0)	<0.001
Relative humidity,%	57.0 (9.5)	45.7 (6.6)	<0.001
Heart rate, beats/min	131 (15.0)	131 (14.6)	0.90
% of maximal heart rate	74.0% (8.6)	74.1% (8.8)	0.90

Values are Mean (SD).
*Paired t-test.

Results - BDNF

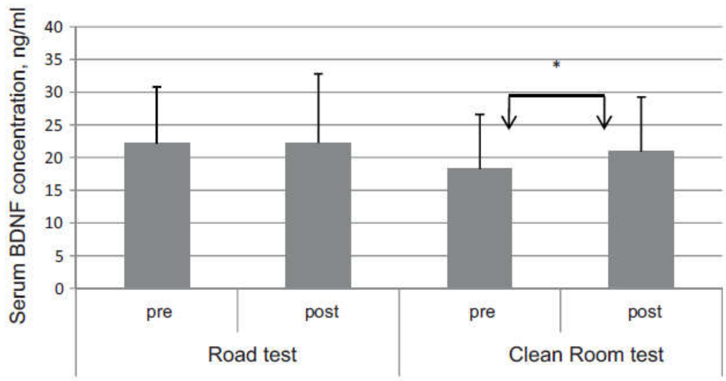


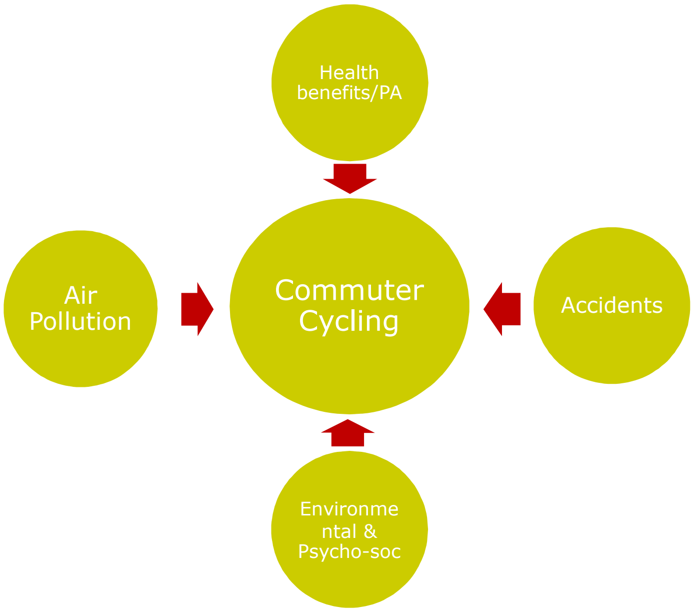
Fig. 3. Serum BDNF concentrations (ng/mL) before and after cycling in the road test and the clean room test (mean ± SD). Serum BDNF concentrations were significantly different ($p = 0.04$). BDNF concentrations increased significantly after cycling in the clean room ($^*p = 0.02$; $n = 35$).

Results - Exhaled nitric oxide (NO), blood parameters

Table 4 Percent change (pre/post-cycling) in endpoints per exposure scenario (road test or clean room)

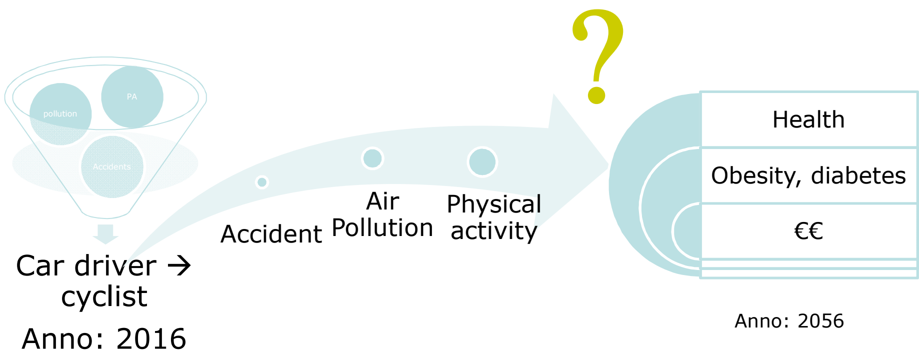
Endpoint	Road test		Clean room		p-value for interaction		
	Percent change (95%CI)	p-value	Percent change (95%CI)	p-value	Exposure scenario*	UFP†	$PM_{2.5}$‡
Exhaled NO,	**-4.4% (-8.3% to -0.37%)**	**0.04**	-1.3% (-6.5% to 4.1%)	0.63	0.38	0.63	0.50
PFA closure time	6.5% (-1.0% to 14.5%)	0.10	5.1% (-1.0% to 11.6%)	0.11	0.76	0.60	0.59
Plasma IL-6	17.4% (-6.7% to 47.9%)	0.18	-2.9% (-19.0% to 16.4%)	0.75	0.21	0.38	0.40
Clara cell protein	1.6% (-10.8% to 15.8%)	0.82	-0.27% (-11.7% to 12.7%)	0.97	0.90	0.91	0.80
Blood leukocyte counts	1.3% (-2.0% to 4.6%)	0.44	2.5% (-1.1% to 6.0%)	0.19	0.75	0.97	0.71
Blood neutrophil counts	**4.6% (0.48% to 8.7%)**	**0.04**	2.4% (-2.3% to 7.2%)	0.32	0.36	0.35	0.20
Percentage blood neutrophils	**3.9% (1.5% to 6.2%)**	**0.003**	0.22% (-1.8% to 2.2%)	0.83	**0.004**	**0.02**	**0.01**

Analysis adjusted for temperature, relative humidity and heart rate.
*p-value for the interaction between pre/post-cycling measurements and exposure scenario (road test or clean room).
†p-value for the interaction between pre/post-cycling measurements and UFP concentrations.
‡p-value for the interaction between pre/post-cycling measurements and $PM_{2.5}$ concentrations.



Cost-benefit analysis
/
Health Impact Assessment

Predictive models – population level



Net health benefit: 7 months

→ 500,000 car drivers make a transition from car to bicycle for short trips (7.5-15 km) on a daily basis in the Netherlands

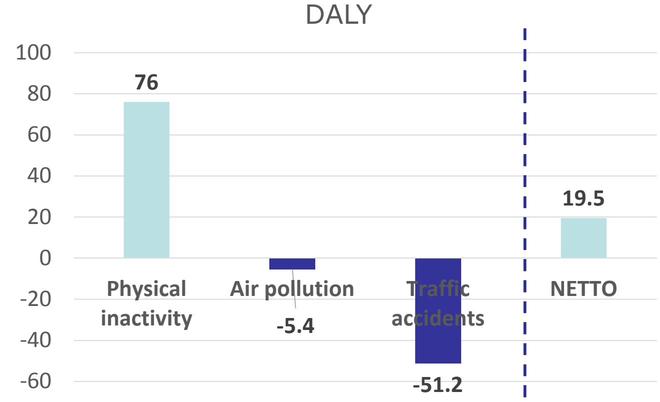
Stressor	Relative risk	Gain in life years[a]	Gain in life days/ months per person[a]
Air pollution	1.001 to 1.053	−1,106 to −55,163 (−28,135)	−0.8 to −40 days (−21 days)
Traffic accidents	0.996 to 1.010[b] 0.993 to 1.020[b]	−6,422 to −12,856 (−9,639)	−5 to −9 days (−7 days)
Physical activity	0.500 to 0.900	564,764 to 111,027 (337,896)	14 to 3 months (8 months)

CONCLUSIONS: On average, the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting their mode of transport.

de Hartog et al. (2010)

Net DALY: 19.5 annually

Now: 33% trips in Copenhagen by bicycle
→ 50% car trips 2-10 km & 33% car trips 10-15 km to cycling ➔ cyclists to 42%



Holm et al. (2012)

Economic cost: health

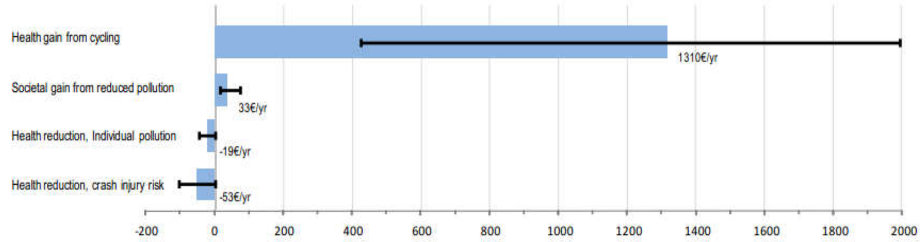
- Shift car → bicycling, by evaluating 4 effects:
  - health benefit by PA
  - public health benefit due to reduced pollution
  - individual exposure to ambient air pollution
  - individual risk of accidents

→ Health ➔ €€

Rabl & de Nazelle (2012)

Economic cost: health

- Estimated mortality costs and benefits per individual switching from car to bicycle for work trips* in large European cities



* 2x5km daily roundtrip, 5 days per week, 46 weeks per year

Error bars represent upper and lower (%% confidence intervals.

Rabl & de Nazelle (2012)

Economic cost: ‘other’ impacts

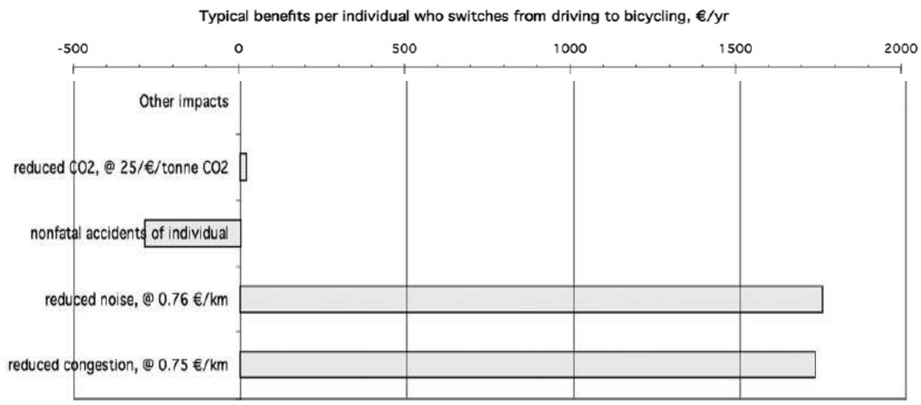


Fig. 3. Comparison of mortality costs and benefits with other impacts, for our bicycling scenario.

Rabl & de Nazelle (2012)

Total Economic benefit: 177 M€/yr

- Vélib Program in Paris:
  - total cost of the program is 64 M€/yr (2011)

Upper bound of benefits of Vélib bike sharing program in Paris.

Item	Amount, M€/yr
Health gain from bicycling	52.4
Public gain from reduced pollution	1.3
Pollution exposure of individual	−0.7
Fatal accidents	−4.2
Nonfatal accidents	−11.5
Reduced CO_2 emissions	0.6
Congestion	69.0
Noise	69.9
Total benefit	**176.9**

Rabl & de Nazelle (2012)

Economic cost: infrastructure

- transport infrastructure or policy + walking and/or cycling and health effects
- variation in values attributed to 1 new active walker/cyclist: €127 - €1290/year

Cavill et al. (2008)

Economic cost: infrastructure

- By 2040, investments M$138 to M$605 result:
  - health care cost savings: M$388 to M$594
  - fuel savings: M$143 to M$218
  - savings in value of statistical lives: $7 to $12 billion

  - BCR for health care and fuel savings: **3.8:1 - 1.2:1**
  - order of magnitude larger when value of statistical lives is used

Gotchi (2011)

Health impact assessment of active transportation: A systematic review

Contents lists available at ScienceDirect

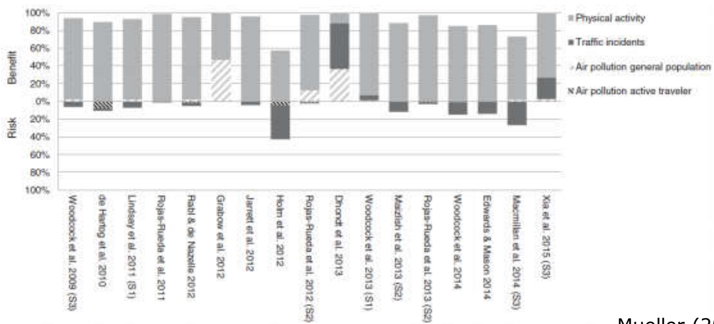
Preventive Medicine

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

Review

Health impact assessment of active transportation: A systematic review

Natalie Mueller, David Rojas-Rueda, Tom Cole-Hunter, Audrey de Nazelle, Evi Dons, Regine Gerike, Thomas Götschi, Luc Int Panis, Sonja Kahlmeier, Mark Nieuwenhuijsen



Mueller (2015)

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THANK YOU FOR YOUR ATTENTION

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