COMMUTER CYCLING & HEALTH

17 janvier 2019

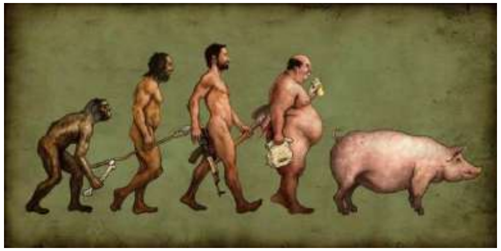
prof dr Bas de Geus

Human Physiology Research Group (MFYS)
Mobility, Logistics and Automotive Technology Research Group (MOBI)
Vrije Universiteit Brussel

Societal Challenges

- Mobility

- Health care



- Air pollution

- Climate change / fossil fuels

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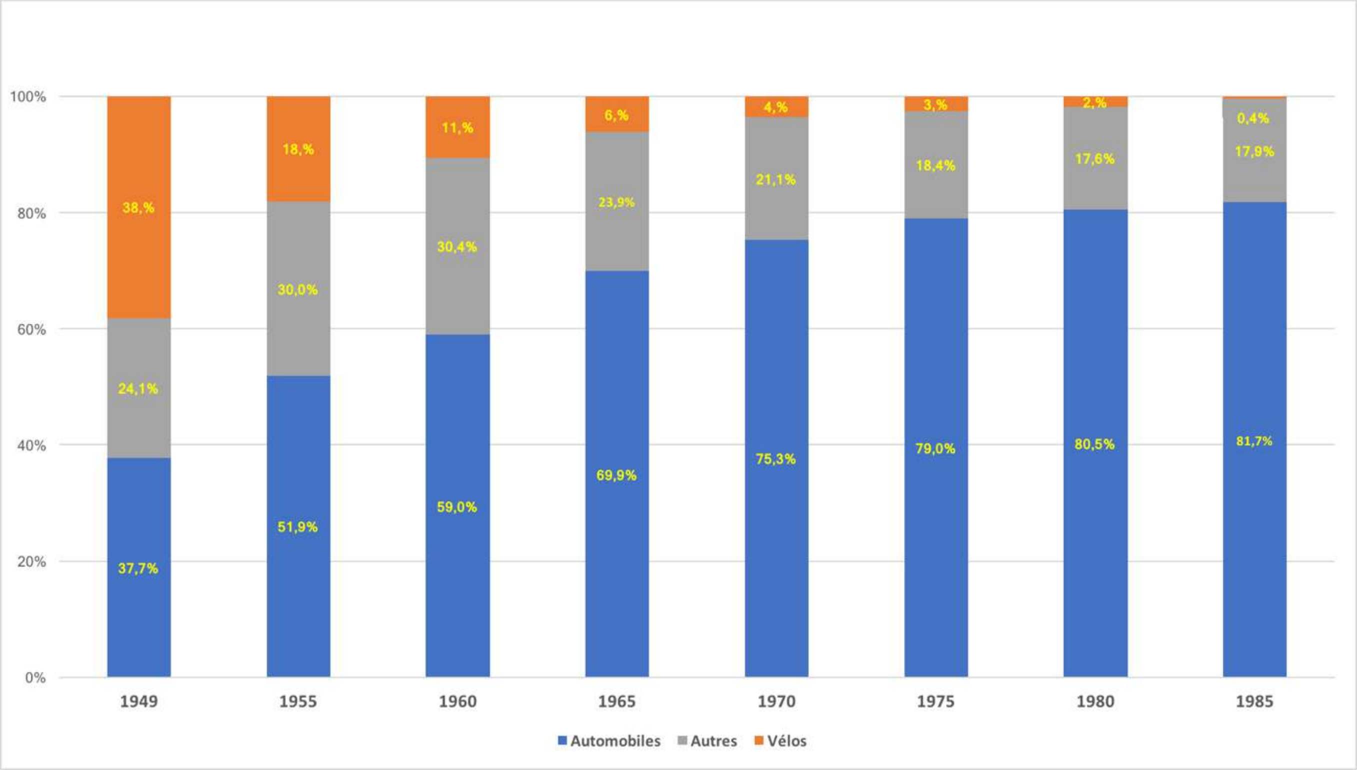
Proportions de véhicules selon des comptages routiers (moyennes pour l'ensemble de la Belgique)



Source : Annuaires Statistiques de la Belgique, Archives de l'Etat

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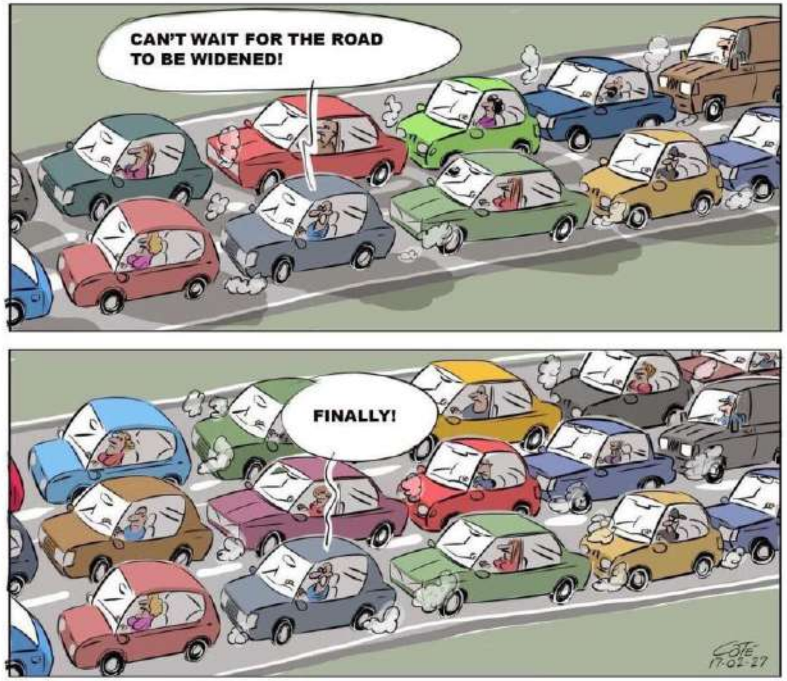
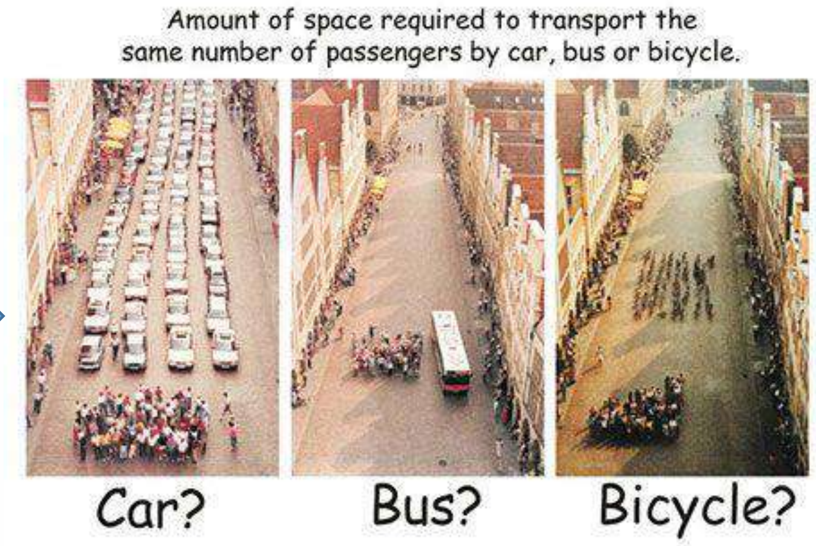
Societal Challenges - Sustainability





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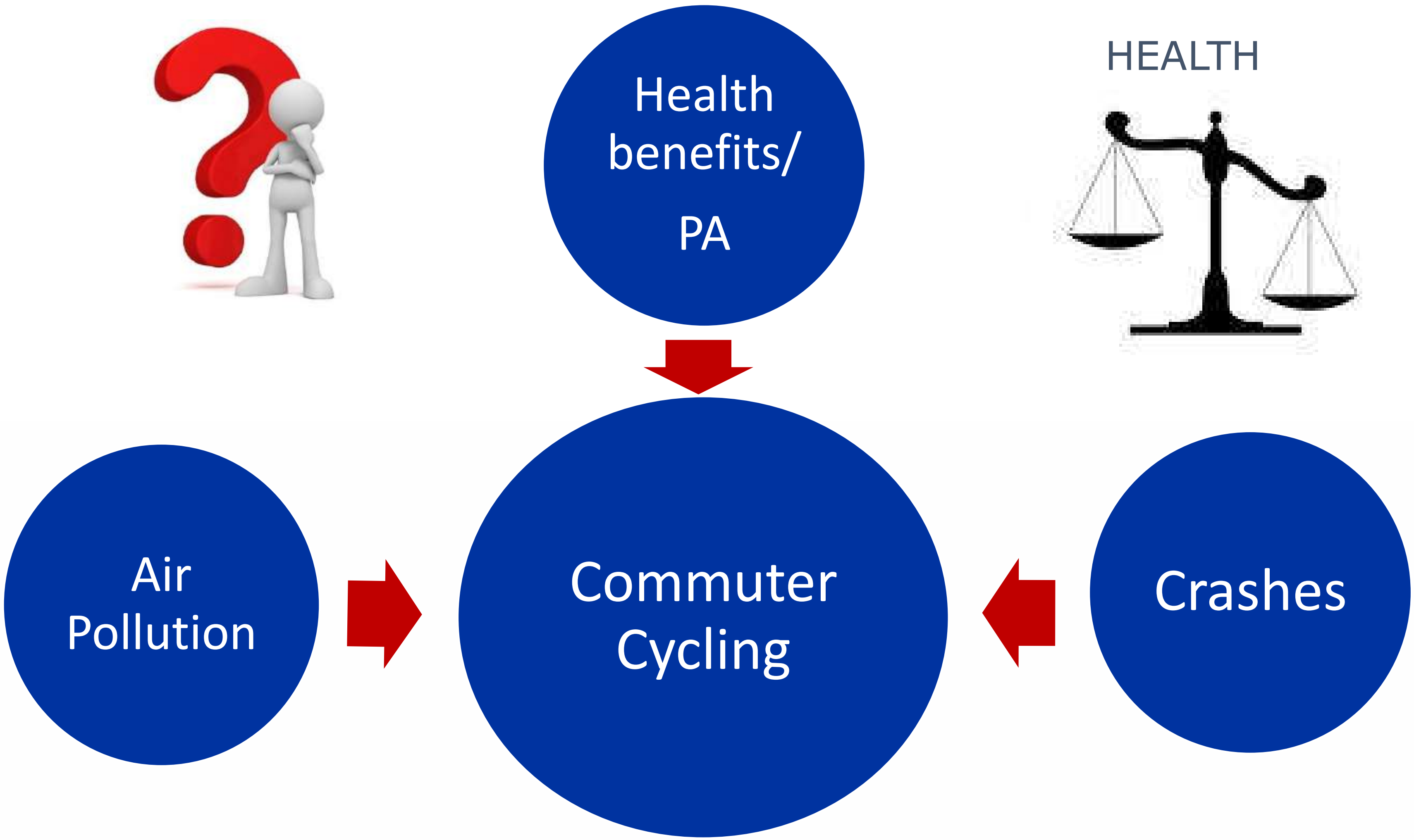
Introduction

Google: Commuter Cycling and Health

Google: Commuter Cycling and Health

Hazards of cycling


HEALTH
Health benefits/ PA
Air Pollution
Commuter Cycling
Crashes

Is Cycling (for commuting) good for Health?

Cycling for leisure/sport

Cycling for commuting

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Health benefits of cycling

Epidemiological studies – All-cause mortality

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

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Cycling & Type 2 diabetes

PLOS | MEDICINE

RESEARCH ARTICLE

Associations between Recreational and Commuter Cycling, Changes in Cycling, and Type 2 Diabetes Risk: A Cohort Study of Danish Men and Women

Martin G. Rasmussen[1]*, Anders Grøntved[1], Kim Blond[1], Kim Overvad[2,3], Anne Tjønneland[4], Majken K. Jensen[5,6], Lars Østergaard[1]*

Conclusions

Commuter and recreational cycling was consistently associated with lower risk of T2D in Danish adults. Our results also provide evidence that late-in-life initiation of or continued engagement in cycling lowers risk of T2D.

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Epidemiological studies – (Over)Weight

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Preventive Medicine 46 (2008) 29 – 32

Preventive Medicine

www.elsevier.com/locate/ypmed

Inverse associations between cycling to work, public transport, and overweight and obesity: Findings from a population based study in Australia

Li Ming Wen *, Chris Rissel

Results. Men who cycled to work were significantly less likely to be overweight and obese (39.8%) compared with those driving to work (60.8%), with an adjusted odds ratio of 0.49 (95% CI: 0.31–0.76) and much less likely to be obese (5.4%) with an adjusted odds ratio 0.34 (95% CI: 0.13–0.87). Men who used public transport to work were also significantly less likely to be overweight and obese (44.6%) with an adjusted odds ratio of 0.65 (95% CI: 0.53–0.81). However, these inverse relationships were not found in women.

Cycling - Mental Health

Contents lists available at ScienceDirect

Preventive Medicine

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

ELSEVIER

Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey

Adam Martin [a,b,*], Yevgeniy Goryakin [a,b], Marc Suhrcke [a,b,c]

Results. After accounting for changes in individual-level socioeconomic characteristics and potential confounding variables relating to work, residence and health, significant associations were observed between overall psychological wellbeing (on a 36-point Likert scale) and (i.) active travel (0.185, 95% CI: 0.048 to 0.321) and public transport (0.195, 95% CI: 0.035 to 0.355) when compared to car travel, (ii.) time spent (per 10 minute change) walking (0.083, 95% CI: 0.003 to 0.163) and driving (−0.033, 95% CI: −0.064 to −0.001), and (iii.) switching from car travel to active travel (0.479, 95% CI: 0.199 to 0.758). Active travel was also associated with reductions in the odds of experiencing two specific psychological symptoms when compared to car travel.

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Cycling - Sickness absence

Preventive Medicine 51 (2010) 132–135

Contents lists available at ScienceDirect

Preventive Medicine

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

The association between commuter cycling and sickness absence

Ingrid J.M. Hendriksen [a,b,*], Monique Simons [a,b,c], Francisca Galindo Garre [a], Vincent H. Hildebrandt [a,b]

Conclusion. Cycling to work is associated with less sickness absence. The more often people cycle to work and the longer the distance travelled, the less they report sick.

Intervention studies - Fitness

Scand J Med Sci Sports 2009: 19: 179–187
Printed in Singapore. All rights reserved
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.

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de Geus et al., 2009

Intervention studies – CVD risk factors - QOL - Vitality

Scand J Med Sci Sports 2008: 18: 498–510
Printed in Singapore . All rights reserved
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.

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de Geus et al., 2008

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.

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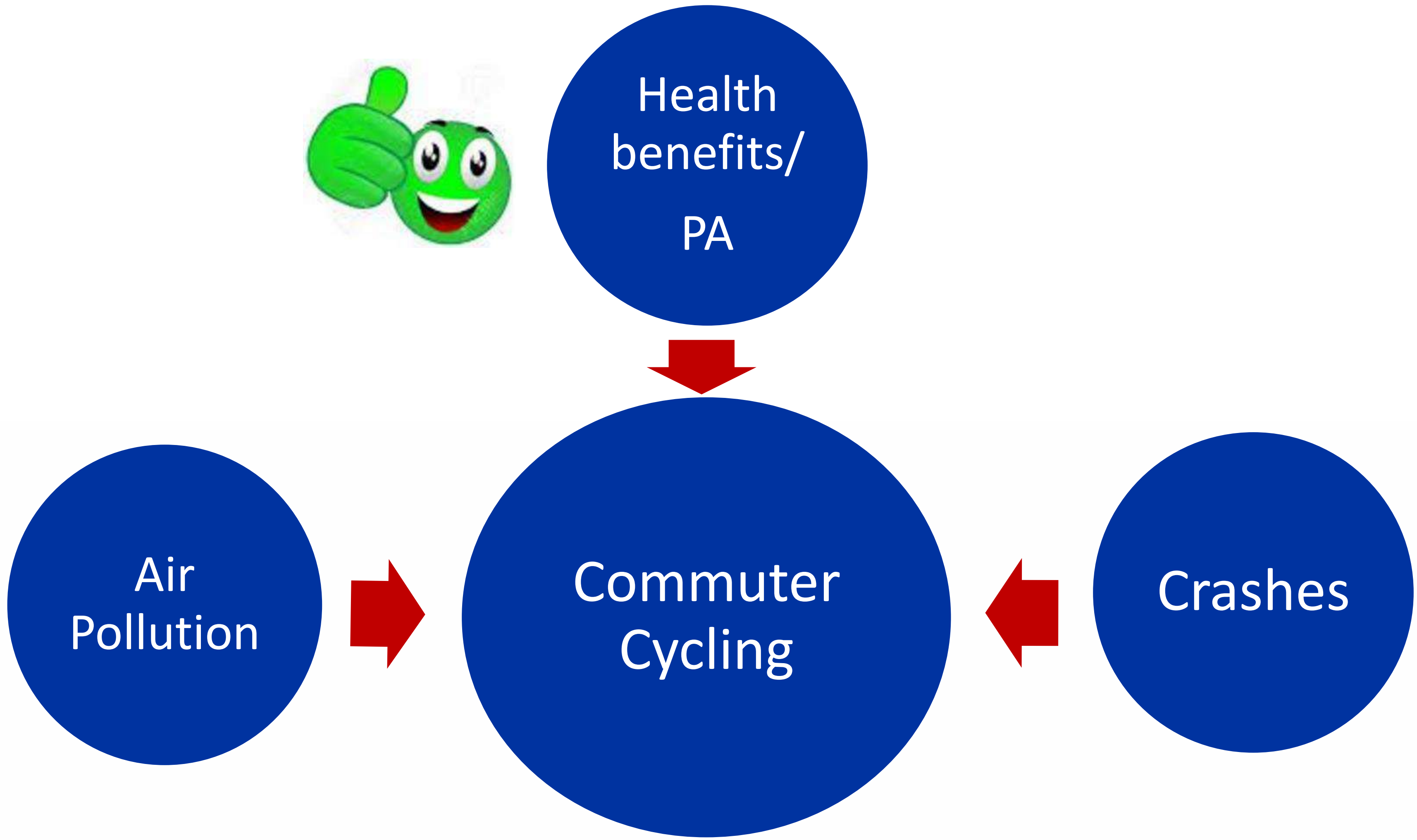
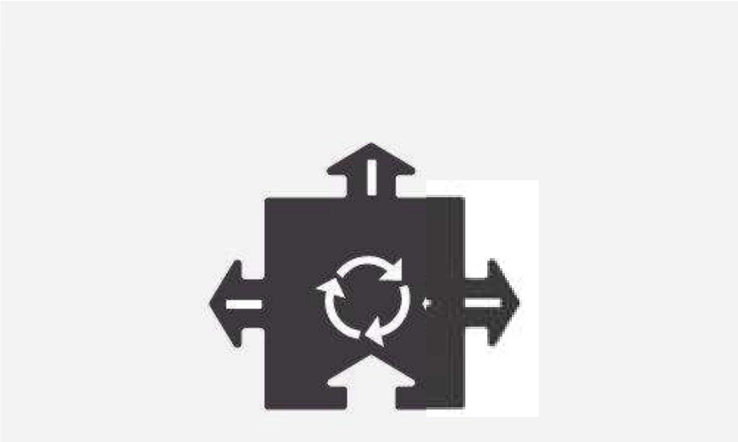

Health benefits/ PA
Air Pollution
Commuter Cycling
Crashes

Bicycle crashes

Bicycle crashes - Exposure

- Bicycle crashes:
  - Incidence (# crashes)
  - Incidence rate (# crashes / exposure) = risk

Incidence: 10 crashes / year
Exposure: 1000 trips / year
Incidence rate: 0.01 crashes / year



Incidence: 10 crashes / year
Exposure: 10000 trips / year
Incidence rate: 0.001 crashes / year

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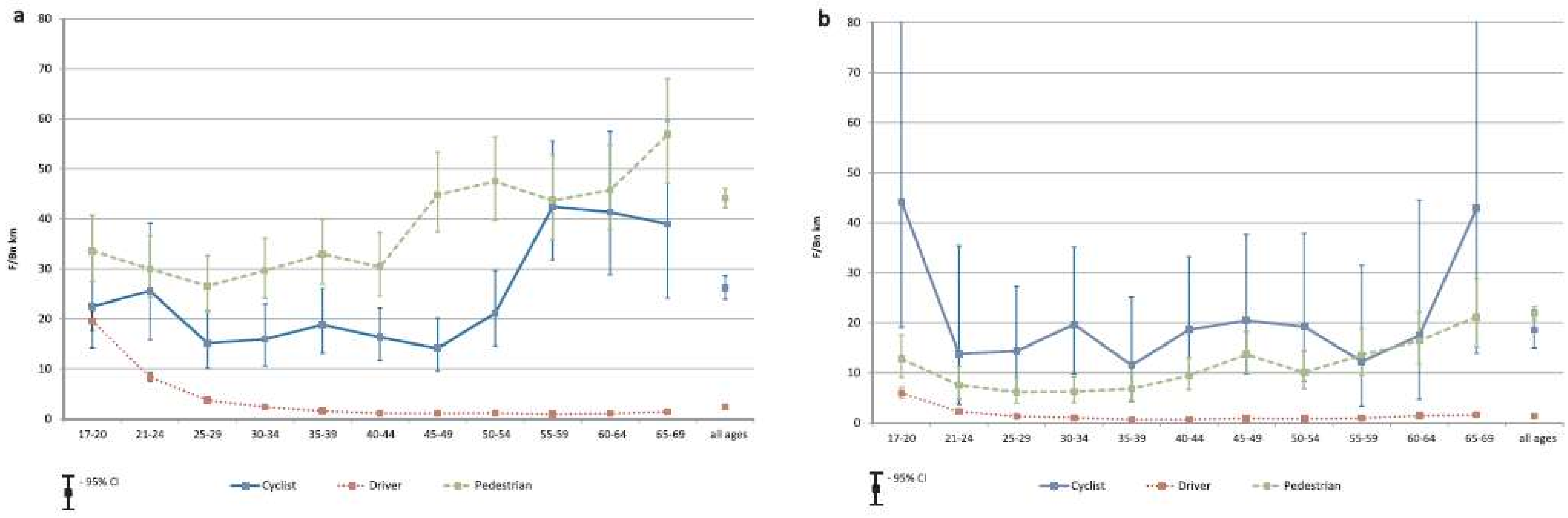
Fatality rates - Exposure

Comparative fatality risk for different travel modes by age, sex, and deprivation

Robel Feleke[a], Shaun Scholes[b], Malcolm Wardlaw[c], Jennifer S. Mindell[b,*]



Fatality rates by mode by distance travelled, 2007–12. a) Males < 70, b) females < 70,

Risques grave (MAIS3+) et mortel par type d'usager de la route en Belgique selon la distance et selon le temps.

	Risque d'être grièvement blessé ou tué		*Risque d'être tué*	
	Par million km	*Par million min*	*Par million km*	*Par million min*
Piéton	*0,13*	*0,01*	*0,032*	*0,003*
Cycliste	*0,37*	*0,10*	*0,027*	*0,007*
Motocycliste / cyclomotoriste	*0,91*	*0,57*	*0,169*	*0,105*
Automobiliste	*0,02*	*0,01*	*0,006*	*0,005*
Passager de voiture	*0,02*	*0,01*	*0,005*	*0,004*
Passager de bus ou de train	*0,01*	*0,00*	*0,000*	*0,000*
Tous les usagers	*0,04*	*0,02*	*0,008*	*0,005*

Source : Vandemeulebroek, Focant, et Lequeux, 2017, d'après **Martensen 2004**

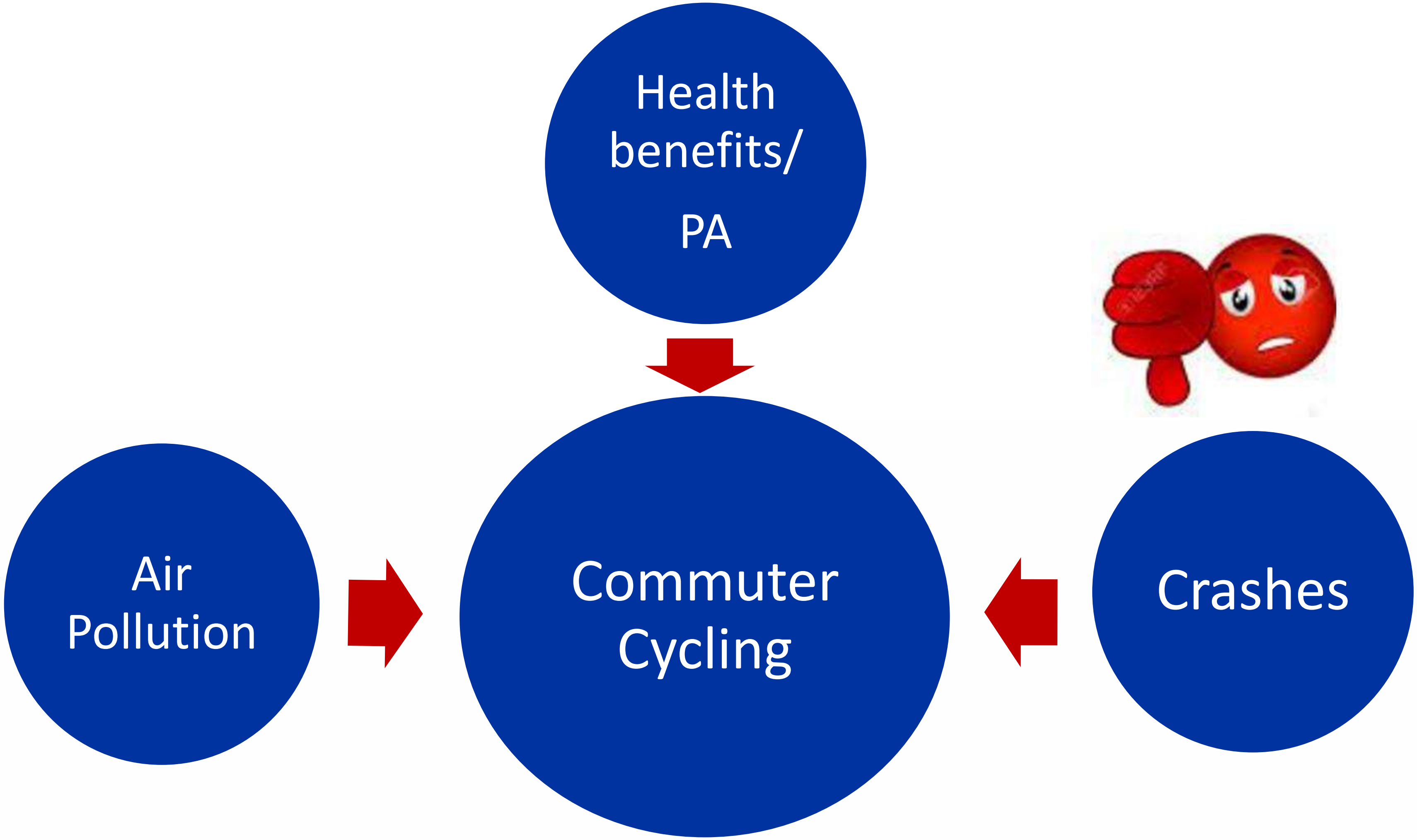
Incidence rate (risk) – minor bicycle crashes

Table 1
Incidence, exposure and incidence rate per region.

	Brussels-capital region	Flanders	Wallonia
Incidence			
Number of injuries (*N*)	28	34	8
Exposure			
Frequency (# of trips)	64,982	116,262	22,920
Time (h)	20,153	45,190	8540
Distance (km)	325,210	909,033	160,873
Incidence rate (95% CI)			
/1000 trips	0.431 (0.271–0.590)	0.292 (0.194–0.391)	0.349 (0.107–0.591)
/1000 h	1.389 (0.875–1.904)	0.752 (0.499–1.005)	0.937 (0.288–1.586)
/1000 km	**0.086 (0.054–0.118)**	**0.037 (0.025–0.050)**	0.050 (0.015–0.084)

Values in Bold indicate a significant difference ($P < 0.05$).
Note: 511 (2.54%) travel diaries could not be attributed to a specific region.

de Geus et al., 2012


Health benefits/
PA
Air Pollution
Commuter Cycling
Crashes

Air Pollution & Cycling

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Back-ground air pollution – Long-term

Sources: heating, motorised traffic, industry, neighbouring countries

The impact of exposure to air pollution on cognitive performance

Xin Zhang[a,1], Xi Chen[b,c,1], and Xiaobo Zhang[d,e,2]

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

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Back-ground air pollution – Vulnerability

Review Article

Adverse effects of outdoor pollution in the elderly

Marzia Simoni[1], Sandra Baldacci[1], Sara Maio[1], Sonia Cerrai[1], Giuseppe Sarno[1], Giovanni Viegi[1,2]

RESEARCH ARTICLE

Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study

Conclusions

Children attending schools with higher traffic-related air pollution had a smaller improvement in cognitive development.

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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.

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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

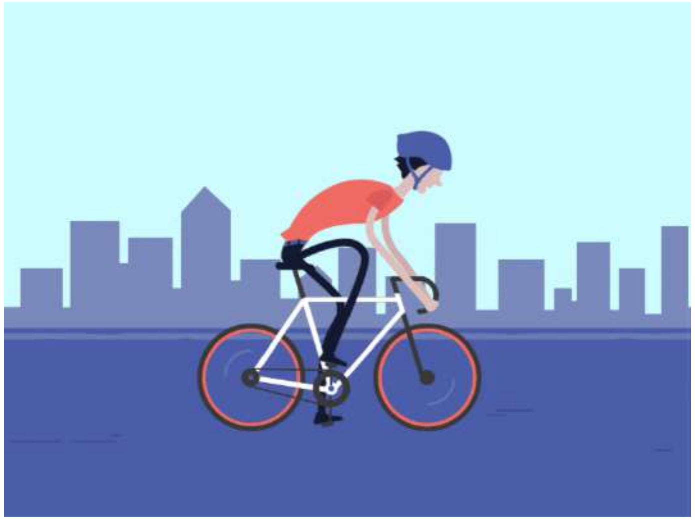
Differences in cyclists and car drivers exposure to air pollution from traffic in the city of Copenhagen

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 is forgotten?



➔ Exposure = ventilation x concentration x distance

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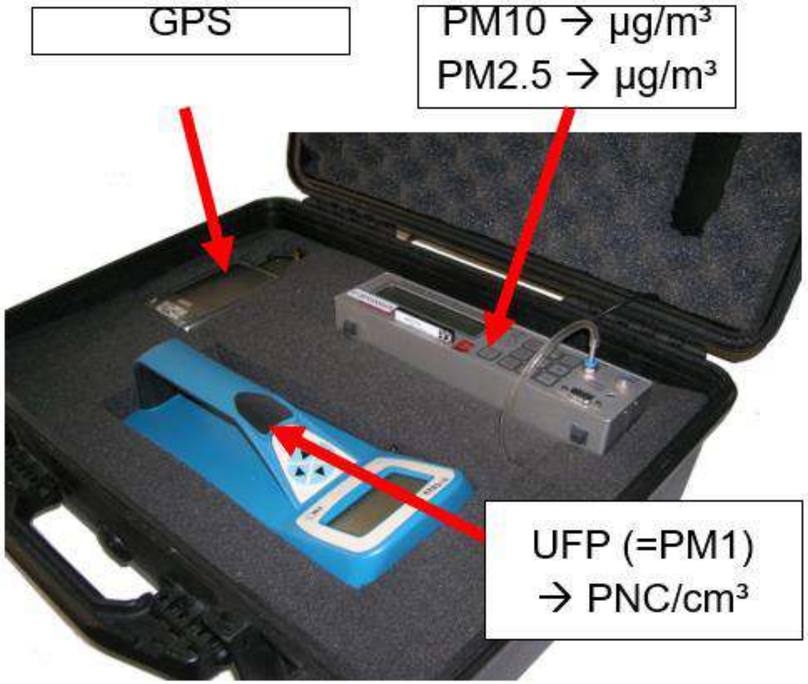
Materials & Methodes

➔ Exposure = ventilation per distance x concentration x distance



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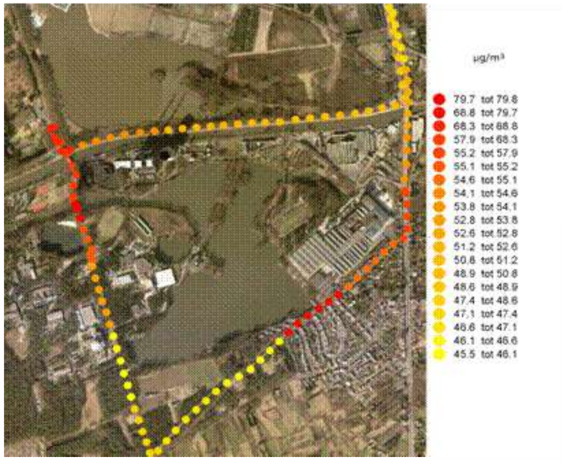
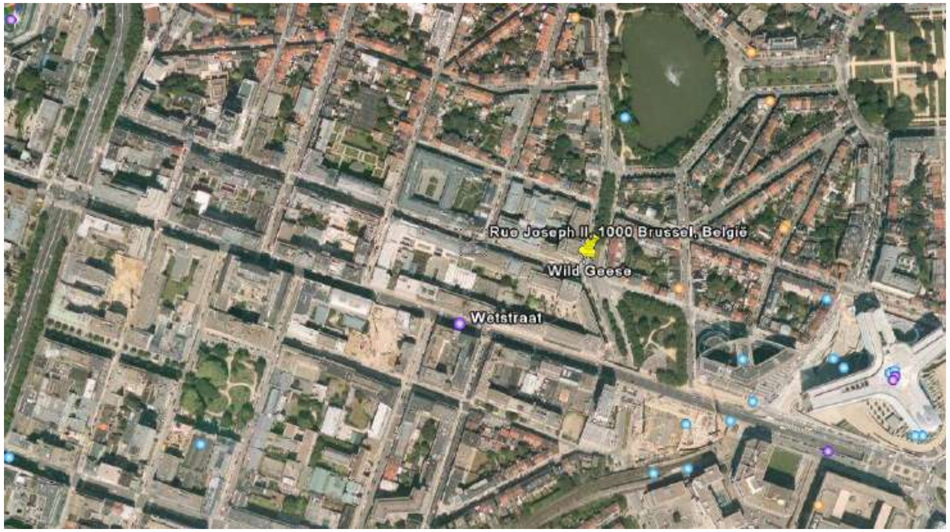
Materials & Methodes

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

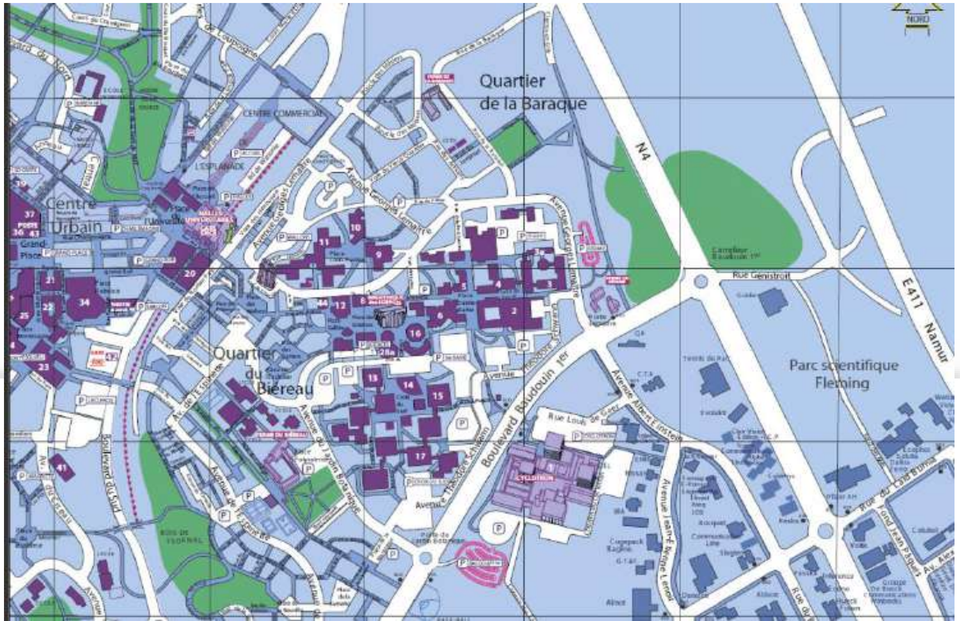
Mol





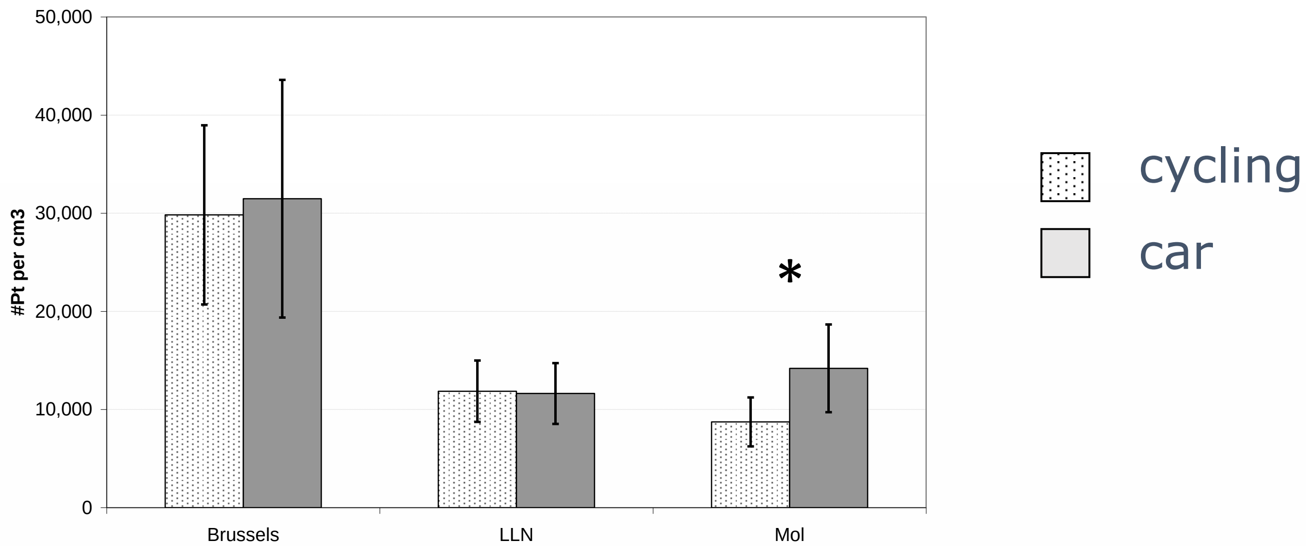
Brussels

LLN



Results – Air pollution

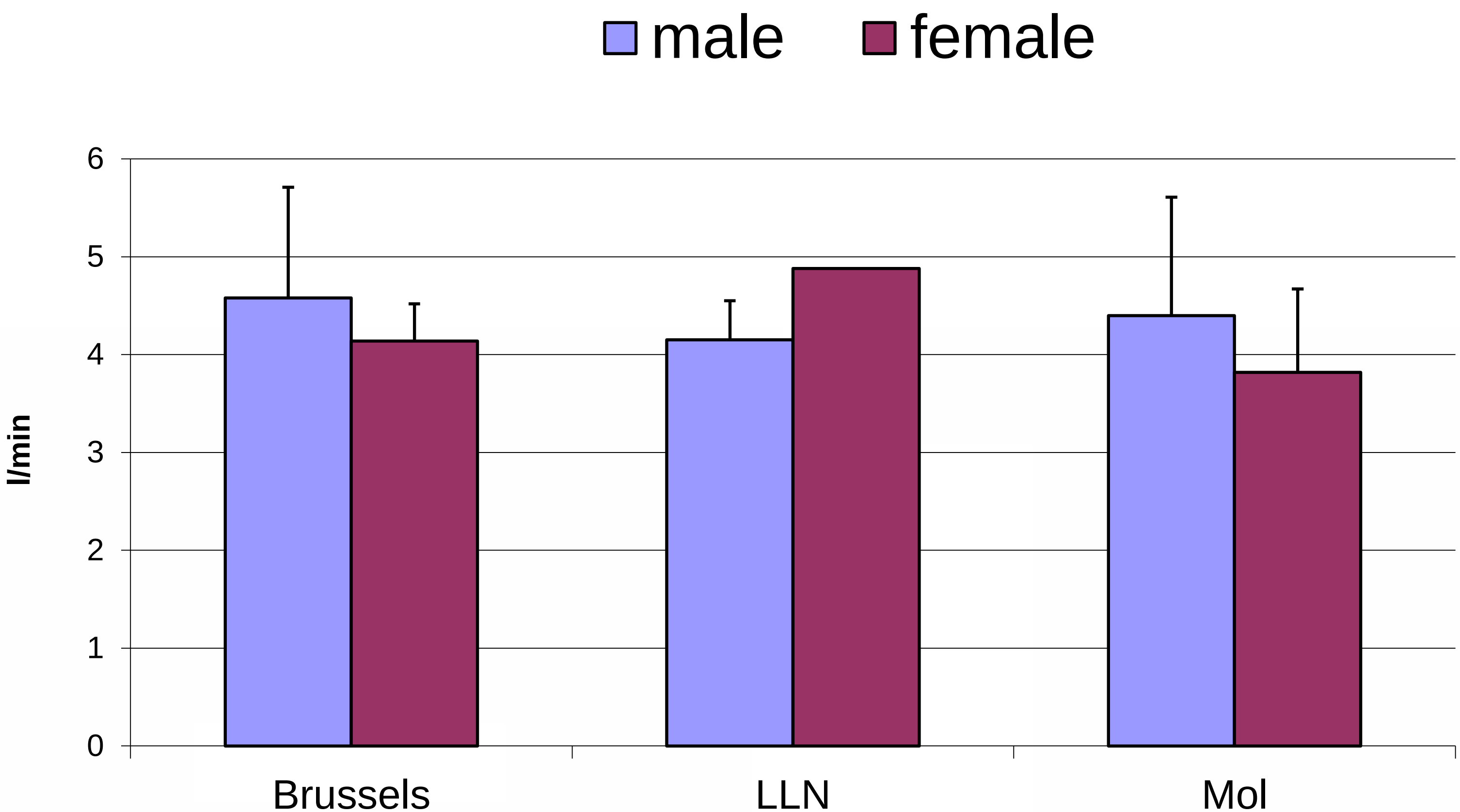
UFP (PNC/cm³)



Values are mean (SD)

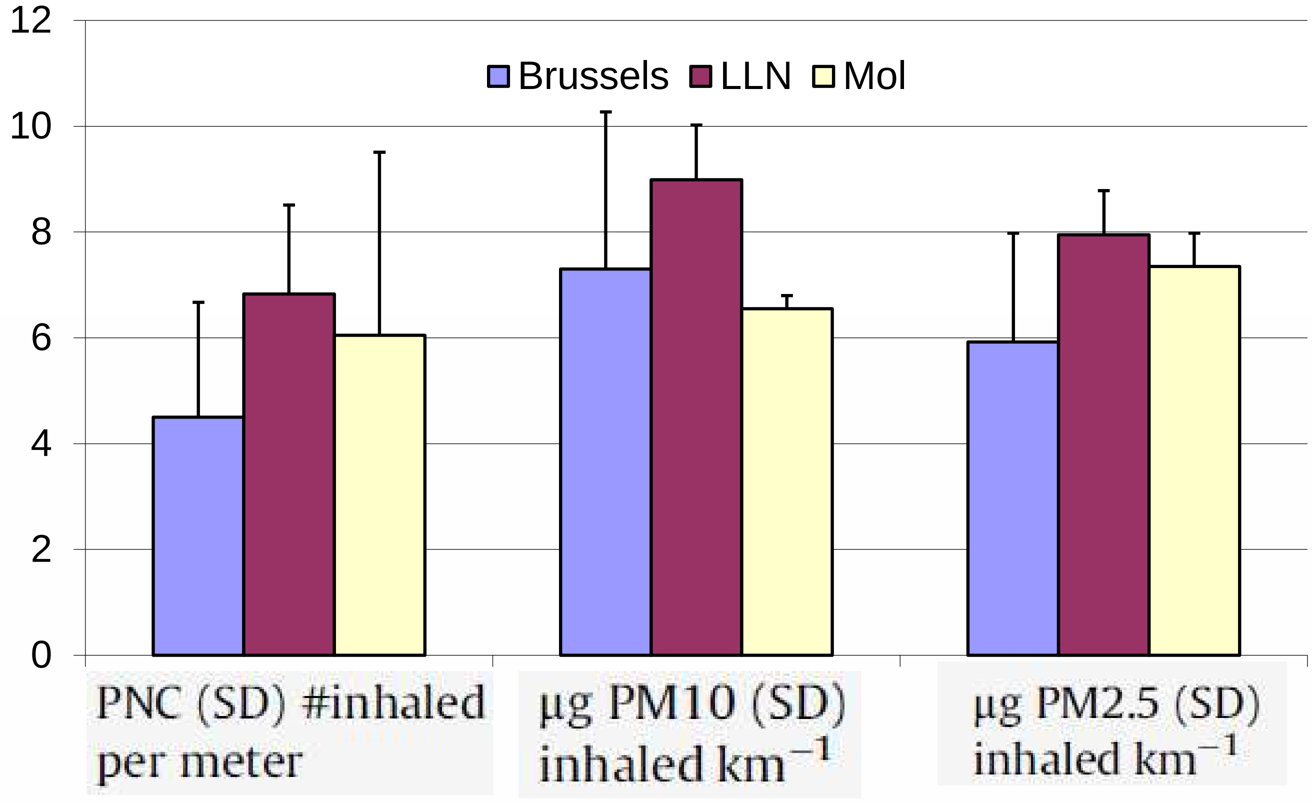
* Sign diff car vs bicycle

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



Values are mean (SD)

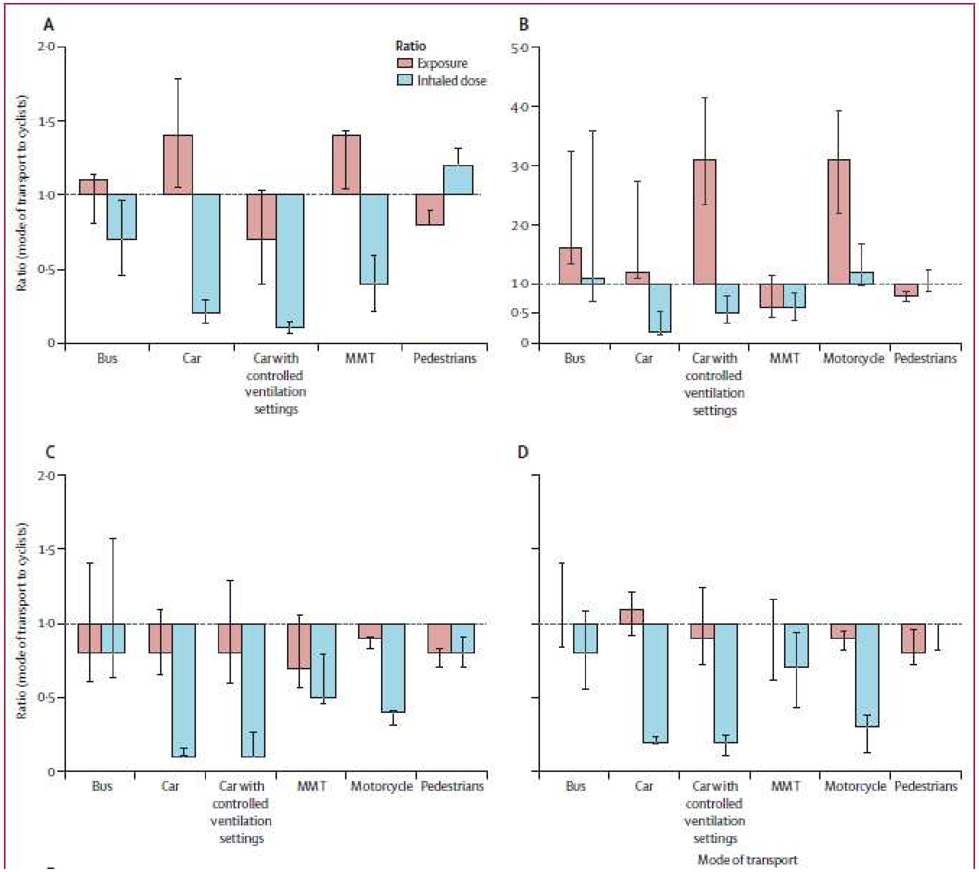
Results: inhaled quantities: bike/car ratio

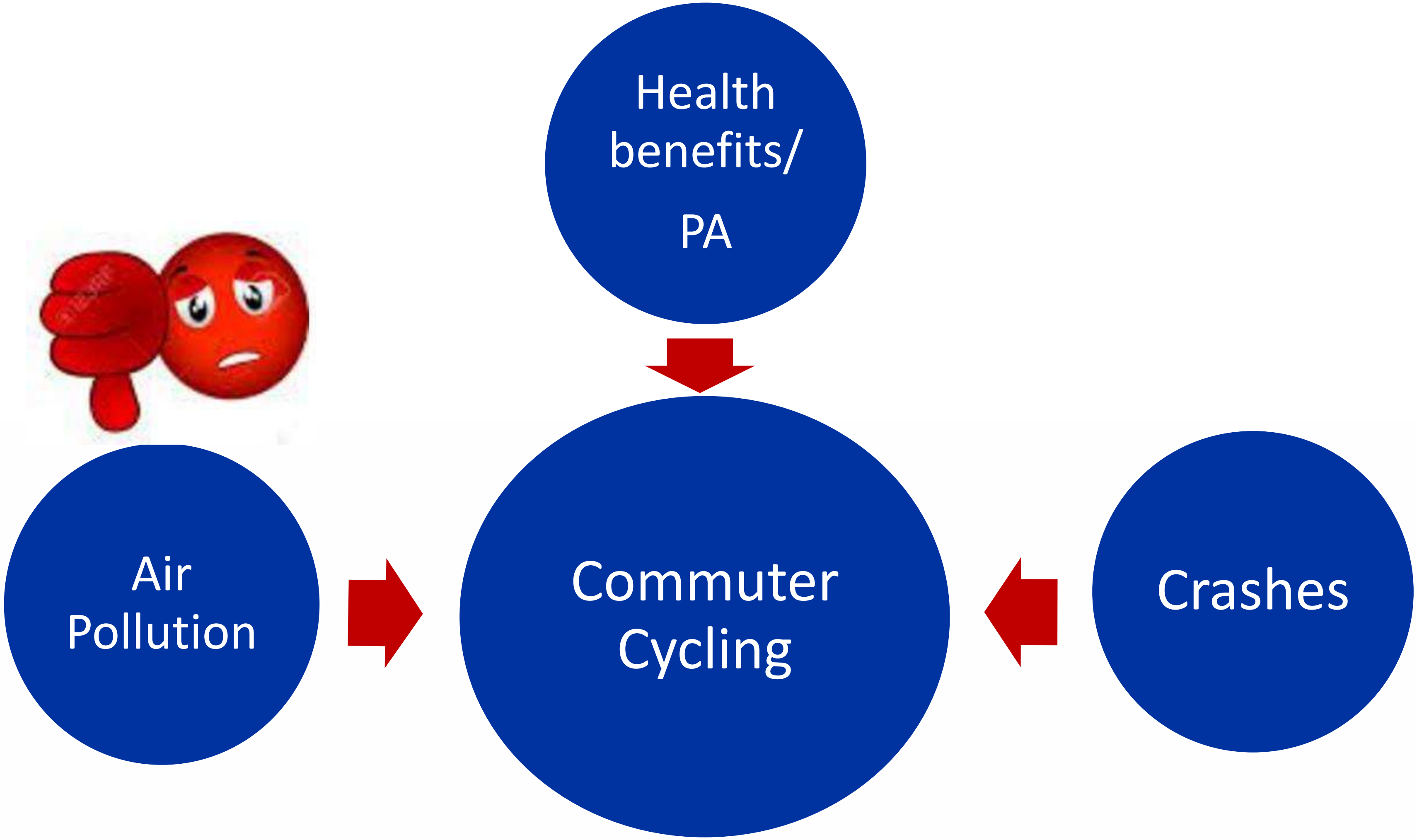


Review Inhaled dose of Air Pollution

Levels of ambient air pollution according to mode of transport: a systematic review

Magda Cepeda, Josje Schoufour, Rosanne Freak-Poli, Chantal M Koolhaas, Klodian Dhana, Wichor M Bramer, Oscar H Franco





VUB VRIJE UNIVERSITEIT BRUSSEL

Cost-benefit analysis / Health Impact Assessment

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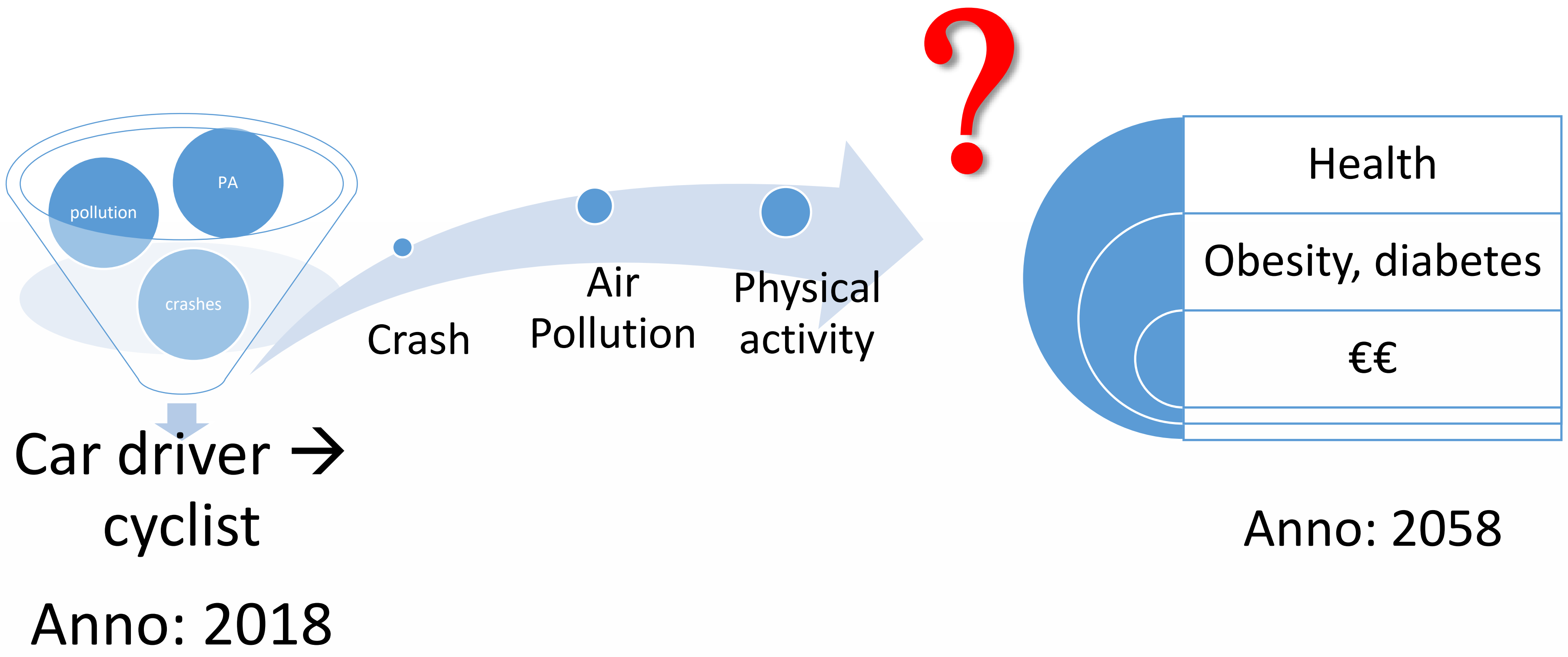
Predictive models – population level



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.

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de Hartog et al. (2010)

Economic cost: health

Total benefits, external costs and cost:benefit analysis over 20 years for Antwerp–Mechelen bicycle highway (scenario 1[a])

Impact factor	euro
Physical activity (reduced mortality)	1.2×10^7
Physical activity (reduced morbidity)	2.3×10^6
Reduced air pollution society (mortality)	7.4×10^4
Air pollution active mobility	-8.9×10^5
Crash risk	-1.4×10^6
Total	$+\mathbf{1.2 \times 10^7}$
Infrastructure construction costs	-6.0×10^6
Benefit:cost ratio	**2.0**

(Buekers et al, 2018)

Health impact assessment of active transportation: A systematic review

Preventive Medicine 76 (2015) 103–114

Contents lists available at ScienceDirect

Preventive Medicine

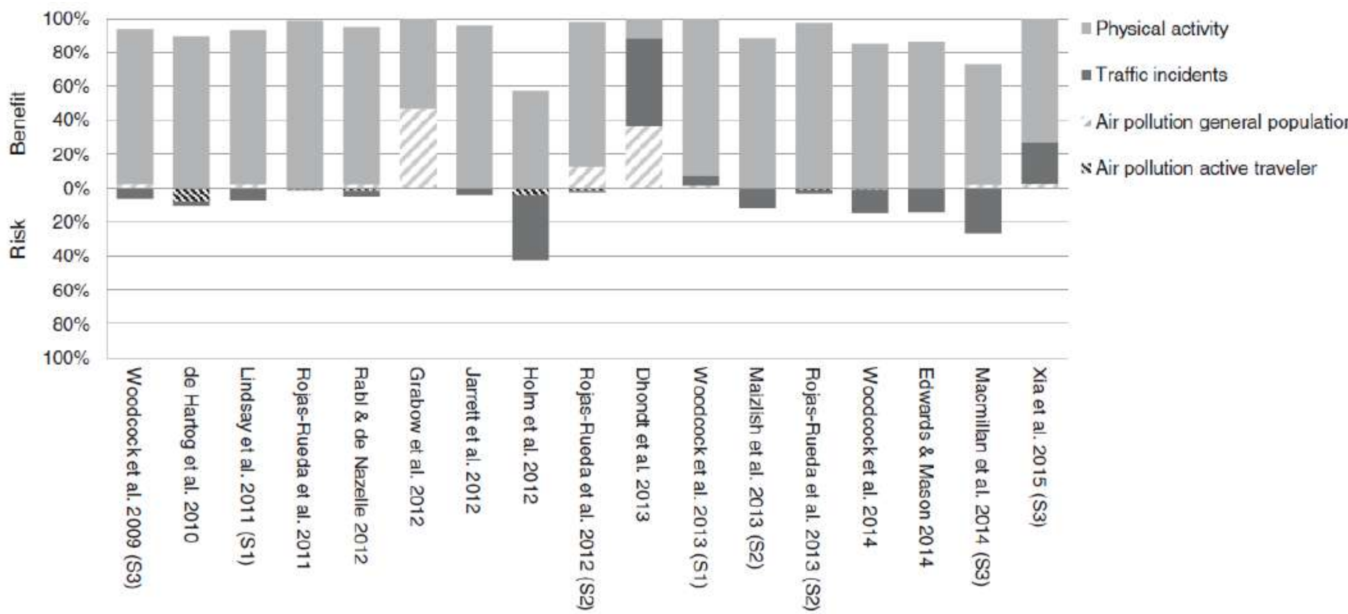
journal homepage: www.elsevier.com/locate/ypmed

ELSEVIER

Review

Health impact assessment of active transportation: A systematic review

Natalie Mueller [a,b,c,*], David Rojas-Rueda [a,b,c], Tom Cole-Hunter [a,b,c], Audrey de Nazelle [d], Evi Dons [e,f], Regine Gerike [g], Thomas Götschi [h], Luc Int Panis [e,i], Sonja Kahlmeier [h], Mark Nieuwenhuijsen [a,b,c]



Mueller et al. (2015)

London bicycle sharing system: health impact modelling

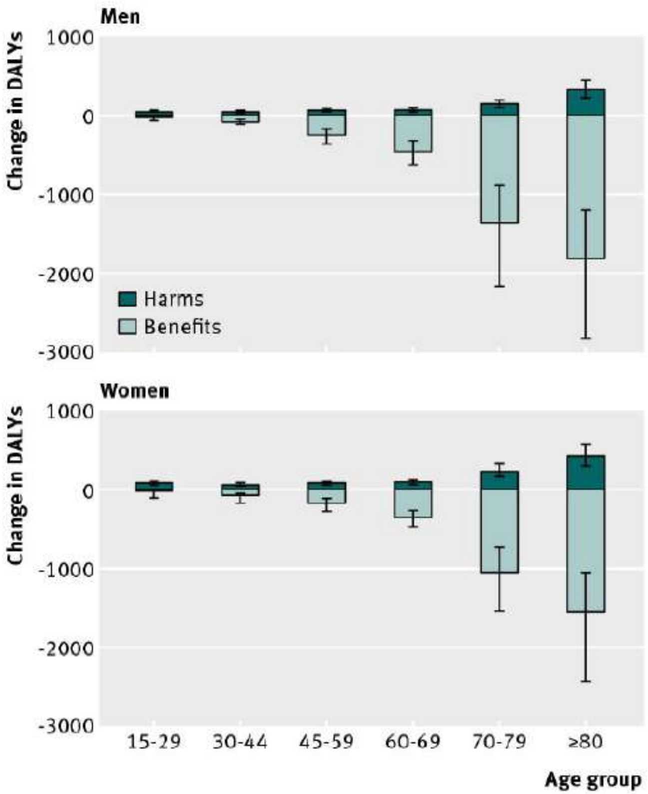


Fig 2 Trade-off of benefits to harms for cycling in central London: effects by age and sex, per million population (although few older people used cycle hire). Benefits come through impacts on diseases related to physical activity, harms come from exposure to road traffic injuries (see table 28 in appendix 4). Results use background injury rates and so should be interpreted as the trade-off for cycling in general in the cycle hire zone and not for specifically using cycle hire bicycles (which may carry lower risks of injury)

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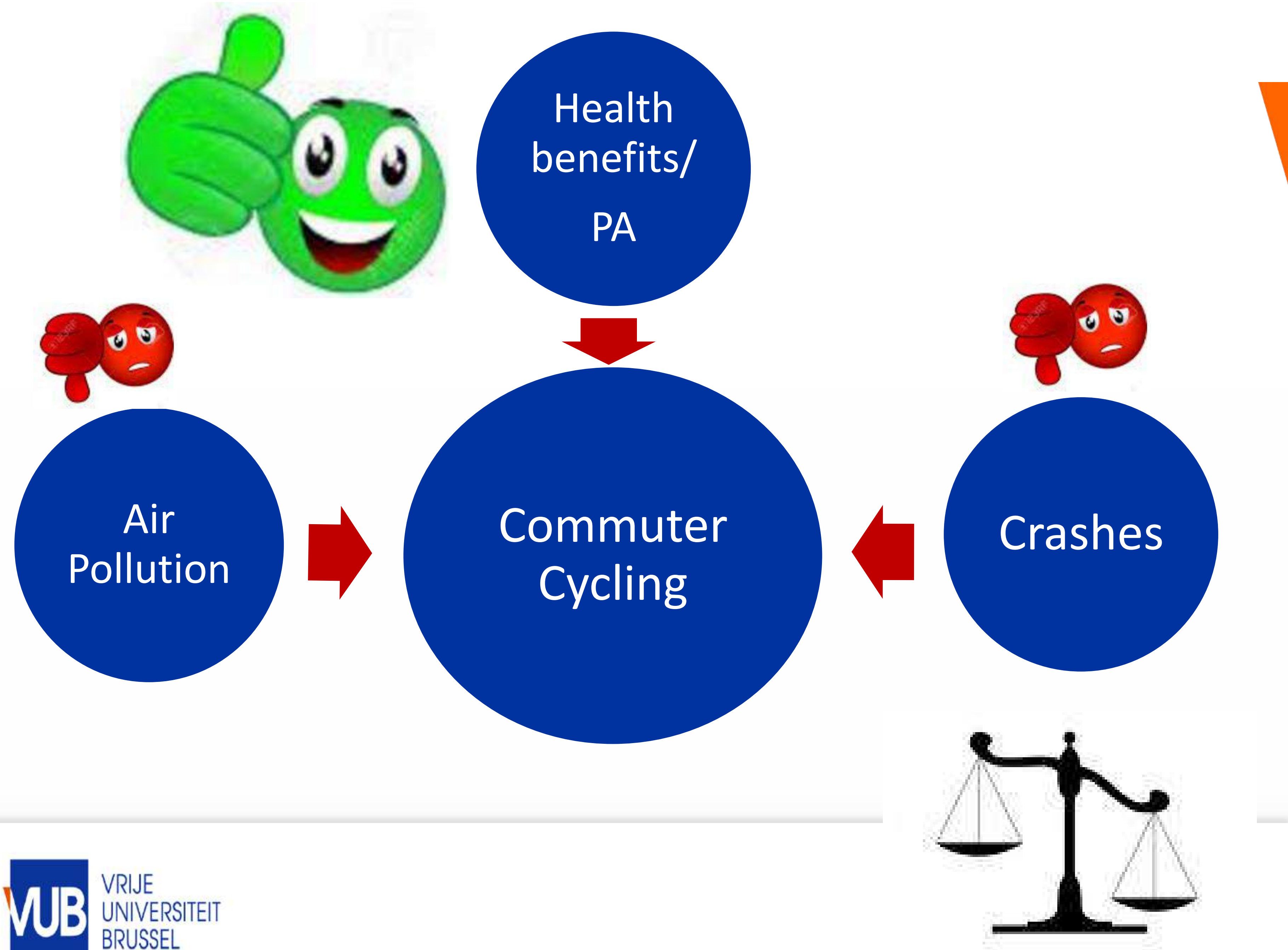
Woodcock et al. (2014)



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What to do next?

Society: Reduce the number of cars

- Reduce number of cars
  - Law enforcement
  - Mentality change

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Society: Bicycle infrastructure

Bicycle infrastructure:

- Attracts people to cycle
- Reduces Crash Risk
- Reduces Exposure to Air Pollution

Individual: Rout choice

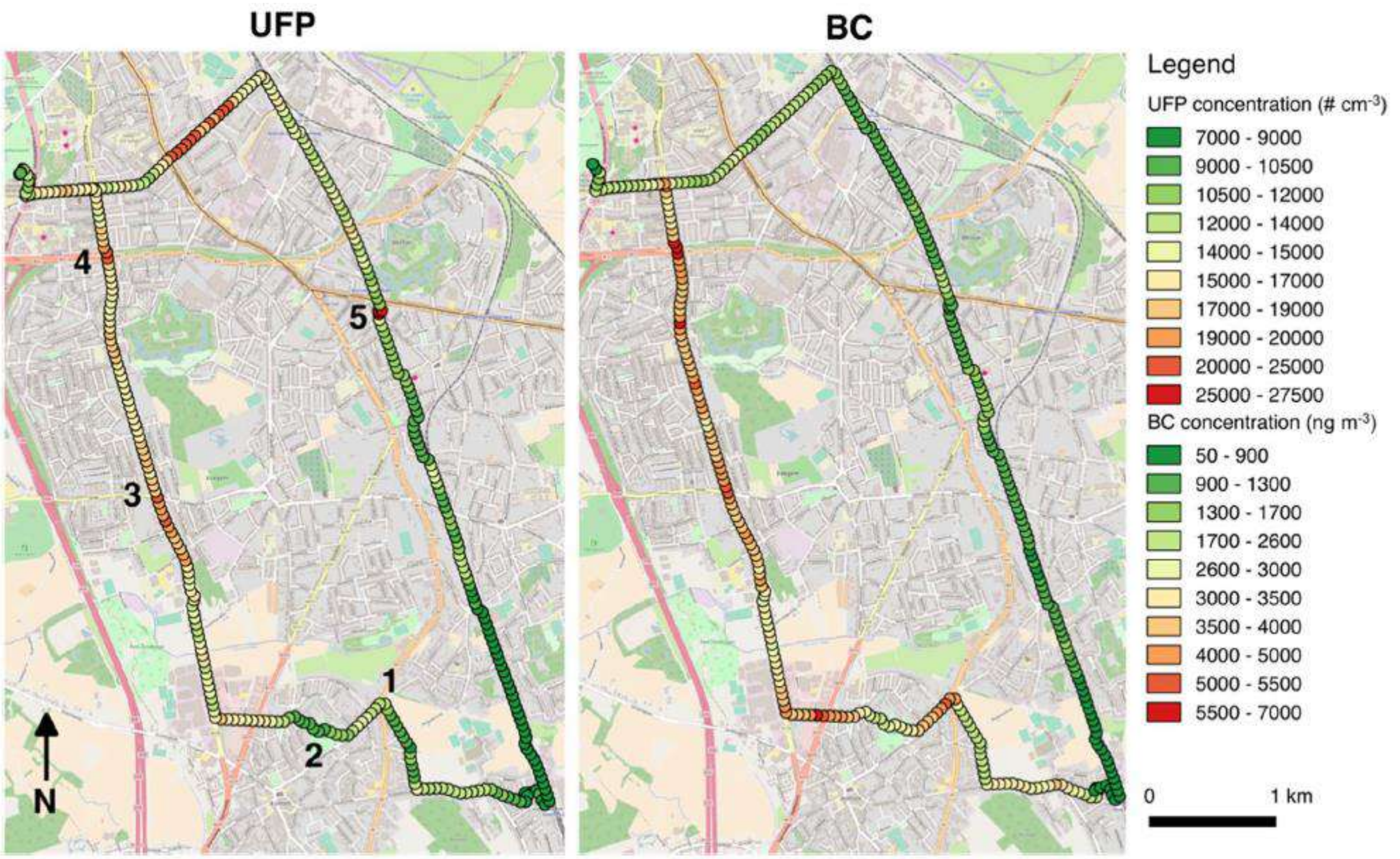

Fig. 2. Buffer-averaged UFP (# cm^{-3}) and BC (ng m^{-3}) concentrations at 50 m intervals (represented by each dot) along the considered commuting routes with heavy-trafficked intersections (1, 3 and 4), a small urban park (2) and a market location (5; only on Wednesdays).

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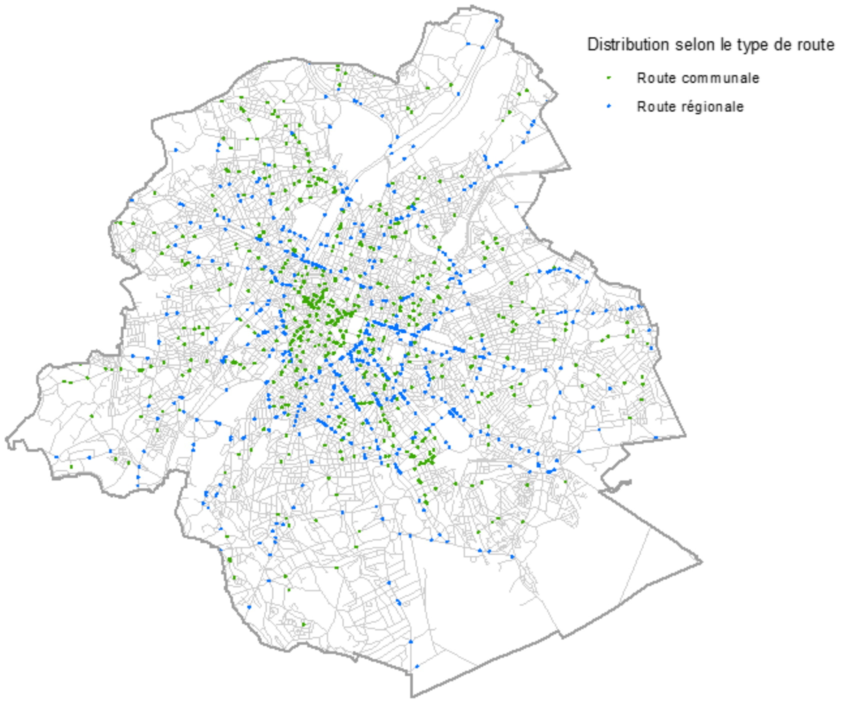
Individual: Rout choice

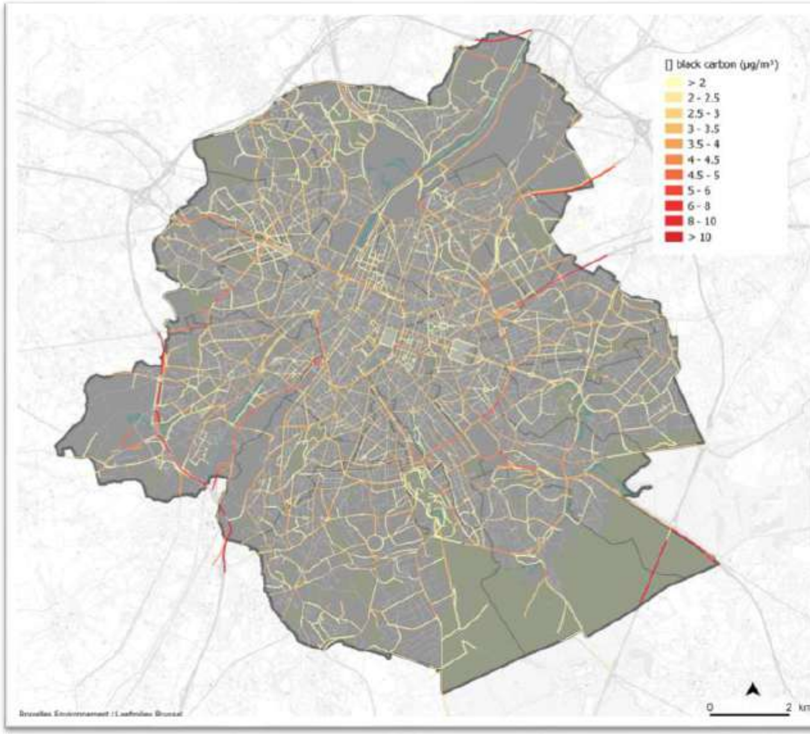
- Chose the safest and less polluted trajectory (less motorized traffic as possible)

Figure 15 Localisation des accidents corporels impliquant un cycliste (2010-2013) selon que l'accident s'est produit sur route communale ou sur route régionale (n=1340)



Source : SPF Économie DG Statistique | Données spatiales et infographie : IBSR

Map 1 - Black Carbon mean concentration (averaging period: 2014-2016) (source: (Bruxelles Environnement, 2017)



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Individual: Bicycle safety measurements

- Protect yourself and make yourself visible in traffic, especially when the light conditions are poor

Individual: Bicycle safety measurements

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The effect of a yellow bicycle jacket on cyclist accidents

Harry Lahrmann[a,*], Tanja Kidholm Osmann Madsen[a], Anne Vingaard Olesen[a], Jens Chr. Overgaard Madsen[b], Tove Hels[c]

A B S T R A C T

This study is the first randomised controlled trial (RCT) of the safety effect of high-visibility bicycle clothing. The hypothesis was that the number of cyclist accidents can be reduced by increasing the visibility of the cyclists. The study design was an RCT with 6793 volunteer cyclists – 3402 test cyclists (with a yellow jacket) and 3391 control cyclists (without the jacket). The safety effect of the jacket was analysed by comparing the number of self-reported accidents for the two groups. The accident rate (AR) (accidents per person month) for personal injury accidents (PIAs) for the test group was 47% lower than that of the control group. For accidents involving cyclists and motor vehicles, it was 55% lower. The study was non-blinded, and the number of reported single accidents was significantly lower in the test group than in the control group. This is likely a result of a response bias, since the bicycle jacket was not expected to affect the number of single accidents. To compensate for this bias, a separate analysis was carried out. This analysis reduced the effect of the jacket from 47% to 38%.

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THANK YOU FOR YOUR ATTENTION

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Face masks - Cycling

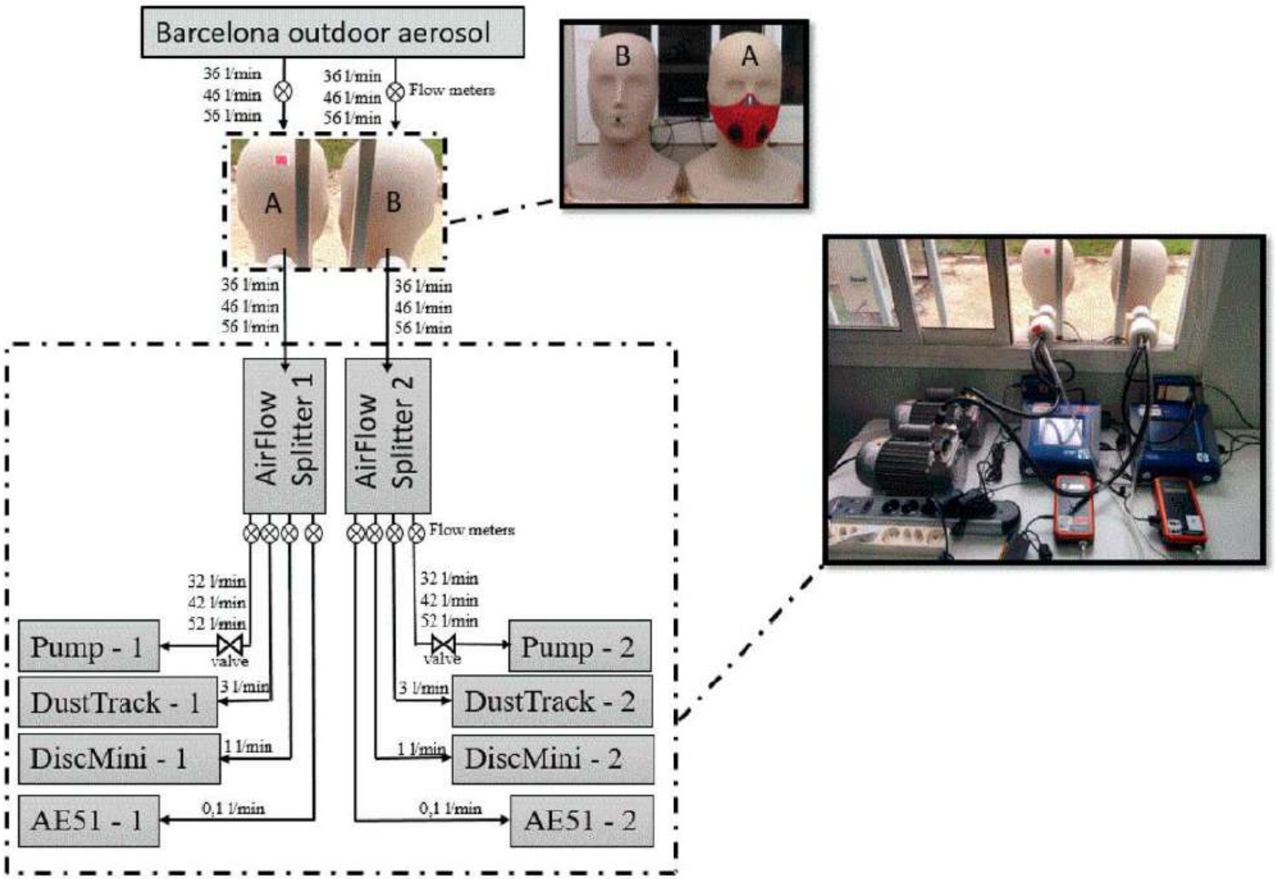
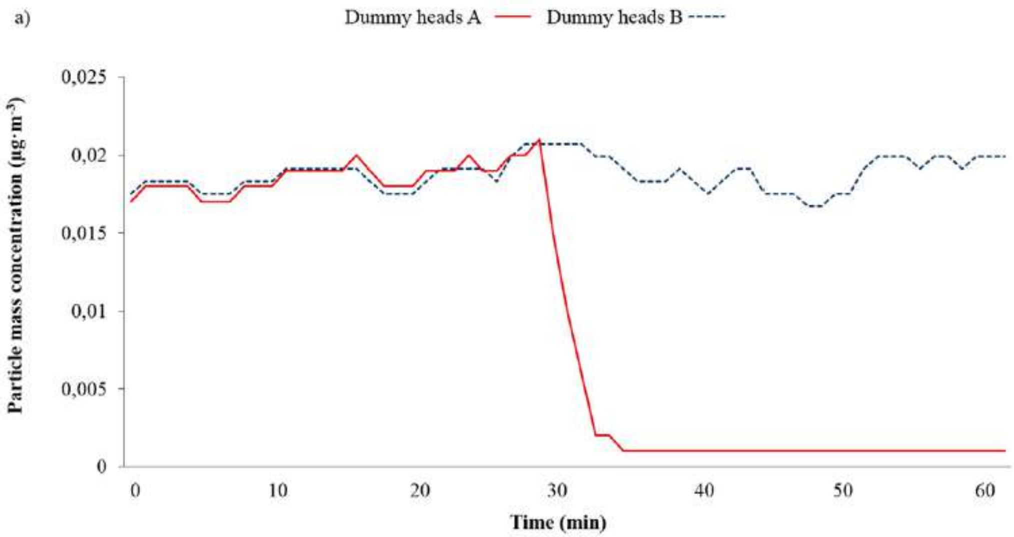
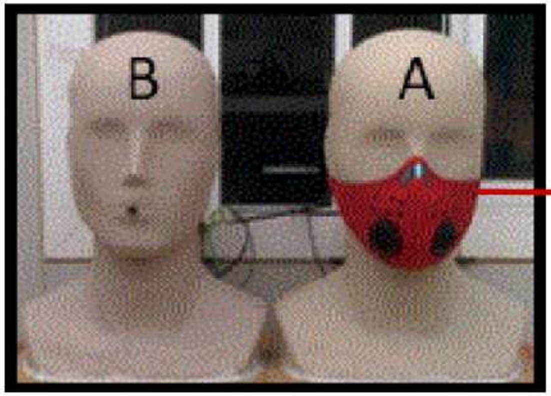


Fig. 1. Scheme of measurement set-up.

Pacitto et al., 2019

Face masks - Cycling





PM2.5 (-48%)
LDSA (-22%)
BC (-19%)
UFP (-19%)

Pacitto et al., 2019

Face masks - Walking

Parameter	Walk	
	Mask	No mask
Systolic blood pressure (mmHg)	126.9 ± 15.9	128.1 ± 16.5
Diastolic blood pressure (mmHg)	78.0 ± 9.3	79.5 ± 8.6
Mean arterial pressure (mmHg)	93.3 ± 9.7*	95.7 ± 10.0
Heart rate (bpm)	81.5 ± 8.7	81.5 ± 10.1
LF power ($msec^2$)	133 (68–97)	136 (52–227)
HF power ($msec^2$)	54 (27–108)*	40 (20–69)
LFn (msec)	58.4 (45.6–69.1)*	62.9 (51.1–75.5)
HFn (msec)	23.5 (18.0–32.4)*	20.5 (13.5–27.9)
HF:LF ratio	0.418 (0.258–0.712)	0.328 (0.207–0.573)
pNN50 (%)	1.2 (0.2–2.8)	0.7 (0.0–2.3)
RMSSD (msec)	16.7 (13.2–22.5)*	14.8 (10.9–19.6)
SDNN (msec)	59.8 (46.4–79.1)	60.1 (41.0–79.3)
Ischemic burden (mV-sec)		
Inferior (II) territory	–66 (–118 to –26)	–52 (–149 to –21)
Anterior (V2) territory	–66 (–142 to –16)	–50 (–124 to –13)
Lateral (V5) territory	–37 (–104 to –8)	–43 (–85 to –18)
Sum (II + V2 + V5)	–189 (–382 to –90)	–188 (–340 to –112)

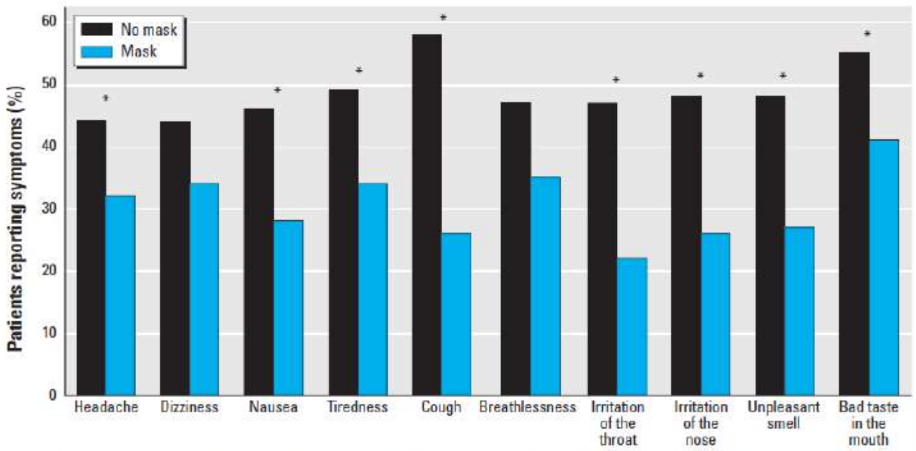


Figure 1. Self-reported symptoms of well-being in the presence or absence of the face mask. *$p < 0.05$.

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Face masks