Journal of Transport & Health 6 (2017) 358–365

Contents lists available at ScienceDirect

Journal of Transport & Health

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

Socioeconomic and demographic differences in walking and cycling in the Netherlands: How do these translate into differences in health benefits?

Jie Gao*, Marco Helbich, Martin Dijst, Carlijn B.M. Kamphuis

Department of Human Geography and Spatial Planning, Faculty of Geosciences, Utrecht University, Heidelberglaan 2, 3584CS Utrecht, The Netherlands

ARTICLE INFO

Keywords:
Walking
Cycling
Health Economic Assessment Tool
Health inequalities
The Netherlands

ABSTRACT

Walking and cycling are effective means to increase people's daily physical activity. Since little is known about how differences in walking and cycling translate into inequalities in health benefits on the population level, this study quantified these health benefits for demographic and socio-economic groups in the Netherlands. Population-representative data on walking and cycling among adults (aged 20–90 years) for the period 2010–2014 were analyzed with the Health Economic Assessment Tool (HEAT). Results showed pronounced differences between subgroups, with women, senior citizens (50–79 years), higher socioeconomic groups, and native-Dutch people walking and cycling more than others. Given the relatively high mortality rates and high levels of walking and cycling among senior citizens, it was found that a large number of deaths were prevented in that age group. In lower socioeconomic groups, despite their lower walking and cycling levels, it was found that even more deaths were prevented, given their large population size and higher mortality rates. The proportion of health benefits was found to be greater among the native Dutch because their walking and cycling levels as well as their population size were higher than among non-native groups. The study suggests that policies to increase walking and cycling among lower socioeconomic groups could induce further health benefits in the aggregate and thus help mitigate socioeconomic health inequalities.

1. Introduction

The Netherlands is well known for the prevalence of walking and cycling for transportation purposes (Pucher and Buehler, 2008). Cycling accounts for approximately a quarter of all journeys and about one-tenth of all kilometers traveled (Kennisinstituut voor Mobiliteitsbeleid, 2014). Walking and cycling levels are significantly higher there than in other European countries such as Italy or France (Fishman et al., 2015a; Pucher and Dijkstra, 2003; Scheepers et al., 2013). Nevertheless, there is room for improvement, since about 30% of the commuting trips within five kilometers are still made by car (Engbers and Hendriksen, 2010). The World Health Organization (WHO) recommends more active travel (i.e., walking and cycling) in people's daily life to reduce the risk of non-communicable diseases (Arsenio and Ribeiro, 2015; World Health Organization, 2010). Therefore, policy-makers are advised to develop strategies that stimulate active travel and discourage motorized transport (Fishman et al., 2015a; Kahlmeier et al., 2010).

To make the health benefits of walking and cycling more apparent to policy-makers, the WHO introduced the Health Economic Assessment Tool (HEAT) (Kahlmeier et al., 2011). The tool provides a method to estimate the number of deaths prevented by the

* Corresponding author.
E-mail addresses: j.gao1@uu.nl (J. Gao), M.Helbich@uu.nl (M. Helbich), M.J.Dijst@uu.nl (M. Dijst), C.B.M.Kamphuis@uu.nl (C.B.M. Kamphuis).

http://dx.doi.org/10.1016/j.jth.2017.06.001
Received 28 November 2016; Received in revised form 24 May 2017; Accepted 2 June 2017
Available online 09 June 2017
2214-1405/

beneficial health effects of both walking and cycling. Due to its transparency and simplicity, HEAT turned out to be highly appreciated, especially by non-health experts (Deenihan and Caulfield, 2014). Its value is reflected in the growing number of case studies applying the tool, especially in Western countries (Deenihan and Caulfield, 2014; Fishman et al., 2015b; Olabarria et al., 2013). These studies consistently report pronounced health benefits from walking and cycling at the general population level (i.e., all individuals in a sample without any stratification). Research on health inequalities provides solid evidence that physical and mental health varies significantly across the population taking education and age into account (Umberson and Montez, 2010; Wilkinson and Marmot, 2003). However, the literature remains inconclusive on whether the levels of walking and cycling among different demographic and socioeconomic groups also translate into differential health benefits.

A few mobility studies suggest that walking and cycling levels differ between population subgroups (Adams, 2010; Heesch et al., 2014; Kwasniewska et al., 2010; Scheepers et al., 2013). Kwasniewska et al. (2010) revealed a low prevalence of walking and cycling in high socio-economic groups (i.e., well-educated and higher-income groups) in Poland. Conversely, for the UK and the Netherlands respectively, both Adams (2010) and Scheepers et al. (2013) found that higher-educated people walk and/or cycle more than groups with low educational attainment. Beenackers et al. (2012) reviewed 11 studies related to socioeconomic inequalities in active transport in Europe. No consistent associations were found between socioeconomic indicators (e.g., income, education, occupation) and active transport or the duration of walking and/or cycling across socioeconomic groups. Additionally, Goodman et al. (2013) showed that well-developed walking and cycling infrastructure was more easily accessible by well-educated individuals with a higher income. Specifically for the Netherlands, Kamphuis et al. (2009) found that adults aged 55–75 years from lower-income and lower-educational groups were less likely to engage in recreational walking, compared to higher income and educational groups.

Regarding age differences, some European studies found that the elderly (age 65 + years) gain more benefits than younger individuals (Edwards and Mason, 2014; Fishman et al., 2015b; Mueller et al., 2015). For Greater Rotterdam, the Netherlands, Böcker et al. (2016) explored how socio-demographics, health, environmental and weather attributes were differentially associated with the walking/cycling behavior of the elderly and non-elderly. In particular, elderly women were more likely to walk and cycle than elderly men. This finding was challenged by Olabarria et al. (2013) and Woodcock et al. (2014), who reported the opposite, namely that men had higher walking and cycling levels than women, while Edwards and Mason (2014) found no gender differences in the U.S.A. Regarding ethnic differences in walking and cycling, another U.S. study found more active travel among migrants than native residents (Garni and Miller, 2008). In countries with relatively high cycling levels such as the Netherlands, however, the natives are significantly more likely to cycle than the non-native population (Pucher and Buehler, 2008).

Previous research (see above) has shown that socioeconomic and demographic differences in walking and cycling do exist. In light of these findings, it may be assumed that health benefits from active travel differ across population subgroups (Mueller et al., 2015). However, empirical evidence to support this premise is lacking so far. In a country like the Netherlands, where walking and cycling levels are high (de Vries et al., 2010; Fishman et al., 2015b; Helbich et al., 2016), differences in walking and cycling between population groups may be presumed to be considerable, which could significantly contribute to health inequalities in the population at large. To substantiate that premise, this study applied the HEAT model to estimate how the health benefits of walking and cycling in the Netherlands differ for subgroups stratified by age, gender, education, income, and ethnicity.

2. Materials and methods

2.1. Data

Data were collected on the average amount of time spent per week (in minutes) on walking and cycling per person in each population group. Furthermore, the size of population group and the average annual mortality rate of each group were determined. The demographic data were obtained from Statistics Netherlands for the years 2010–2014 (CBS, 2016a), while the data on walking and cycling were collected by *National Travel Survey in the Netherlands (NTS)* (OViN, 2015), a travel survey among a nationally representative sample carried out by Statistics Netherlands. To increase the sample size, the data were pooled for 2010–2014, raising the total to 506,933 individuals. The NTS database also contains information about transport modes, trip destinations, travel purposes (e.g. utilitarian vs. recreational trips), as well as the start and end time of the trips. Population counts and average annual mortality rates for age and gender groups were derived from Statistics Netherlands (CBS, 2016c).

Consistent with the approach of Fishman et al. (2015b), population and mortality data from Statistics Netherlands were divided into ten age categories: 20–29, 30–39, 40–49, 50–59, 60–64, 65–69, 70–74, 75–79, 80–84, and 85–90 years. For a more accurate calculation, the broad category of the elderly (aged 60–90) was divided into five-year intervals as their mortality rates are higher than for younger population. Income levels per year were divided into the following three categories (Fishman et al., 2015a): low income (< €20K), middle income (€20–€40K), and high income (> €40K). Educational attainment was stratified into low (i.e. primary school and lower general secondary school), middle (i.e. upper-division secondary school), and high (i.e. college and university) (CBS, 2016b).

2.2. The Health Economic Assessment Tool

HEAT is designed to quantify the health and economic benefit of walking and cycling among adults (Kahlmeier et al., 2011). The approach assumes a dose-response function between the number of minutes spent on walking or cycling and all-cause mortality reduction. More precisely, grounded in a meta-analysis by Kelly et al. (2014), HEAT assumes a 10% reduction in the mortality rate for each 100 min of cycling per week, and an 11% reduction for each 168 min walking per week. The following procedure is

Table 1
Annual number of deaths prevented due to time spent on walking for Dutch males and females, 2010–2014.

	Age groups	Average weekly minutes of walking	Population size	Average annual mortality rate per 100,000 population	Mortality rate reduction (%)[a]	Annual number of deaths prevented[b]
Males	20–29	42	1,038,353	43	2.7	12
	30–39	51	1,044,990	65	3.3	23
	40–49	49	1,294,324	156	3.2	64
	50–59	56	1,164,207	456	3.7	194
	60–64	74	535,181	920	4.9	239
	65–69	87	432,409	1548	5.7	382
	70–74	81	311,312	2531	5.3	417
	75–79	68	225,325	4501	4.5	452
	80–84	64	144,144	8161	4.2	496
	85–90	45	69,578	14,294	2.9	291
	Average	57	–	955	3.7	–
	Total	–	6,259,825	–	–	2571
Females	20–29	54	1,019,356	21	3.5	7
	30–39	68	1,044,356	44	4.5	20
	40–49	70	1,274,760	126	4.6	73
	50–59	79	1,156,278	347	5.2	207
	60–64	88	532,849	640	5.7	196
	65–69	87	441,219	991	5.7	248
	70–74	79	341,159	1542	5.2	271
	75–79	61	282,885	2719	4.0	306
	80–84	55	224,181	5308	3.6	429
	85–90	28	145,998	10,295	1.9	280
	Average	70	–	835	4.6	–
	Total	–	6,463,039	–	–	2038

[a] Based on an estimated mortality rate reduction of 11% per 168 min of walking per week according to the meta-analysis of Kelly et al. (2014).
[b] Annual number of deaths prevented is calculated for each age group using the HEAT formula: (population size/100,000) * average mortality rate per 100,000 * % mortality rate reduction.

implemented to estimate the annual prevented number of deaths due to walking for a specific population group. First, the reduced mortality rate for this population group is calculated based on their minutes of walking (e.g. for males 20–29 years, the reduced mortality rate is 11% / 168 min * 42 min = 2.7%; see Table 1). Second, the regular number of deaths in this population group is estimated by multiplying the population size and the mortality rate per 100,000 people (e.g. for males 20–29 years, the regular number of deaths is 1,038,353 * 43/100,000 = 447 deaths). Finally, the number of deaths prevented is calculated by multiplying the regular number of deaths by the reduced mortality rate (e.g. for males 20–29 years, this is: 447 * 2.7% = 12 prevented deaths per year). Since the mortality rates were not available for different socioeconomic groups, the age-specific mortality rate was used as a proxy in this study. Specifically, the number of deaths prevented was calculated for each age category of gender and socioeconomic groups and then these results were summed to get the total number of prevented deaths for those groups. A similar procedure was followed to calculate the prevented deaths due to cycling by applying the cycling-specific mortality rate reduction (i.e. a 10% reduction per 100 min cycled).

3. Results

3.1. Walking and cycling levels of different population groups

In general, Dutch adults spent 63 min on walking and 75 min on cycling per week. The duration of both activities peaks at around 65–69 years and starts to decline at the age of 80 (Fig. 1). Cycling duration per week for men and women was nearly equal (75 versus 74 min). In contrast, women walked more (70 min) than men (57 min). When stratified by gender and age, the walking (Table 1) and cycling duration (Table 2) for females was slightly higher than for males aged 20–64 years. In the age group 65 +, men cycled and walked more than women.

When socioeconomic groups were compared, it turned out that low-income groups were less likely to walk (31 min) and cycle (38 min) than higher-income groups (Table 3). The prevalence of walking and cycling peaked in the high-income group. This peak is particularly evident from the cycling duration, which was on average 113 min per week. Highly educated people also had a higher average weekly walking (79 min) and cycling (107 min) duration compared to low- and middle-educated groups. In terms of ethnicity, the native Dutch walked (64 min on average) and cycled (78 min) most, followed by people with a Western background.

3.2. Health benefits of walking and cycling for different population groups

The number of deaths prevented by walking and cycling was greatest among the age groups of and 80–84 and 75–79 years, respectively (Fig. 2). Despite the small population size of these elderly compared to younger people, death prevention was much

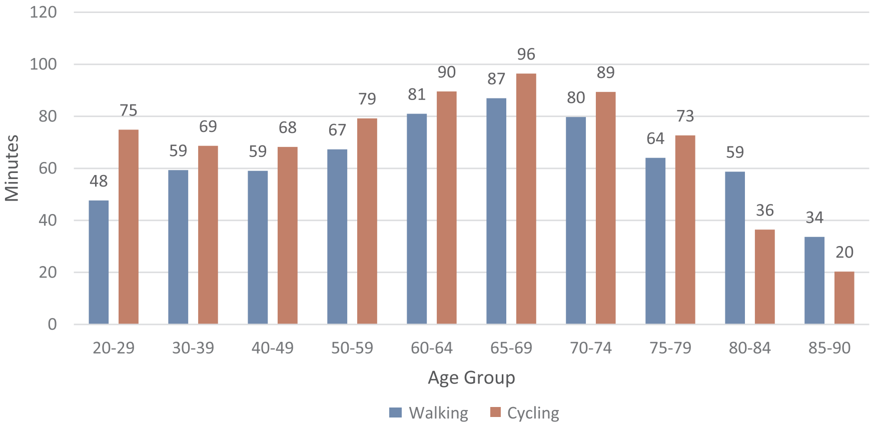

Fig. 1. Weekly walking and cycling duration per age group 2010–2014.

higher among the elderly because of their relatively high levels of walking and cycling and their higher mortality rate. The reduction in mortality rate was a direct result of the average walking and cycling duration for the target group. In terms of cycling duration, the reduction in mortality was similar for men and women, namely 7.5% and 7.4%, respectively. On the other hand, the mortality rate reduction attributed to walking was larger for women (4.6%) than for men (3.7%). Even though men and women had similar walking and cycling durations, the number of deaths prevented among men was larger, since men had higher mortality rates than women across all age groups.

On a population level, the health benefits of walking and cycling were greater among the low-educated than the middle- and high-educated groups. This reflects not only their large share of the population but also the fact that a large proportion of the low-educated group was elderly, an age group with a relatively high mortality rate. High-income groups had lower health benefits from walking than other income groups, caused by their smaller population size. Among the ethnic groups, the native Dutch benefited most from walking and cycling, as they had the highest prevalence of walking and cycling and comprised the largest share of the population. Conversely, the non-native groups had less health benefits due to their small population size (i.e. 10% of the total population) coupled with a lower prevalence of walking and cycling.

Table 2
Annual number of deaths prevented due to cycling for Dutch males and females, 2010–2014.

	Age groups	Average weekly minutes of cycling	Population	Average annual mortality rate per 100,000 population	Mortality rate reduction (%)[a]	Annual number of deaths prevented[b]
Males	20–29	74	1,038,353	43	7.4	33
	30–39	68	1,044,990	65	6.8	46
	40–49	62	1,294,324	156	6.2	126
	50–59	77	1,164,207	456	7.7	409
	60–64	89	535,181	920	8.9	439
	65–69	100	432,409	1548	10.0	669
	70–74	100	311,312	2531	10.0	791
	75–79	89	225,325	4501	8.9	899
	80–84	51	144,144	8161	5.1	604
	85–90	42	69,578	14,294	4.2	418
	Average	75		955	7.5	–
	Total	–	6,259,825	–	–	4434
Females	20–29	76	1,019,356	21	7.6	16
	30–39	69	1,044,356	44	6.9	32
	40–49	74	1,274,760	126	7.4	119
	50–59	81	1,156,278	347	8.1	326
	60–64	90	532,849	640	9.0	307
	65–69	93	441,219	991	9.3	406
	70–74	79	341,159	1542	7.9	417
	75–79	60	282,885	2719	6.0	461
	80–84	27	224,181	5308	2.7	319
	85–90	10	145,998	10,295	1.0	150
	Average	74	–	835	7.4	–
	Total	–	6,463,039	–	–	2554

[a] Based on an estimated mortality rate reduction of 10% per 100 min of cycling per week according to the meta-analysis of Kelly et al. (2014).
[b] Annual number of deaths prevented is calculated for each age group using the HEAT formula: (population size/100,000) * average mortality rate per 100,000 * % mortality rate reduction.

Table 3
Annual health benefits of the time spent walking and cycling for socio-economic groups, 2010–2014.

	Groups		Average weekly duration (min)	Population	Annual number of deaths prevented[a]
Walking	**Income**	< 20K euro	31	5,082,285	1,152
		20–40K euro	80	4,528,951	2,251
		> 40K euro	92	3,111,629	970
	Education	Low	58	4,350,791	2,266
		Middle	57	4,948,923	1,162
		High	79	3,423,151	1,125
	Ethnicity	Dutch	64	10,159,001	3,963
		Western	66	1,291,000	474
		Non-Western	58	1,272,863	144
Cycling	**Income**	< 20K euro	38	5,082,285	1,398
		20–40K euro	88	4,528,951	3,504
		> 40K euro	113	3,111,629	1,611
	Education	Low	59	4,350,791	3,225
		Middle	65	4,948,923	1,722
		High	107	3,423,151	1,778
	Ethnicity	Dutch	78	10,159,001	6,049
		Western	70	1,291,000	576
		Non-Western	52	1,272,863	140

[a] Annual number of deaths prevented is calculated for each group using the HEAT formula: (population size/100,000) * average mortality rate per 100,000 * % mortality rate reduction.

4. Discussion

4.1. Key findings

This is the first study to present a detailed picture of how health benefits of walking and cycling differ between population subgroups based on age, gender, and socioeconomic characteristics (i.e. education, income, and ethnicity) in the Netherlands. This study used HEAT to estimate the mortality rate reduction (i.e. a direct result of average walking and/or cycling durations) and the number of deaths prevented by walking and cycling on a population level (i.e. taking the size of the population subgroup and the average mortality rate into account). The results showed large differences in walking and cycling levels between different groups, with women, senior citizens (50–79 years), higher socioeconomic groups, and the native Dutch walking and cycling more than members of the other subgroups. Among senior citizens (50–79 years), as a result of relatively high mortality rates and high walking and cycling levels, a large number of deaths were prevented. In low educated groups, despite their lower walking and cycling levels, more deaths were still prevented than in higher educated groups due to the large population size of the low educated group and their higher mortality rates. Native Dutch people derived more benefit from walking and cycling than the non-natives because of their higher walking and cycling levels and larger population size.

We found that women tend to walk more than men, which is consistent with the results of Olabarria et al. (2013). This may reflect the fact that women are more likely to engage in habitual active travel. A possible explanation may be that women make more trips for utilitarian reasons (household/personal physiological and biological needs-related business (Garrard, 2003)). In the Netherlands, women are more likely to work at a part-time job that is closer to home and make shorter, linked journeys (e.g. work, shops, school, and home). Therefore, they may be more likely to walk rather than take the car. Women also have less discretionary time than men, particularly when they combine work and family responsibilities (Garrard et al., 2008). On the other hand, elderly women showed

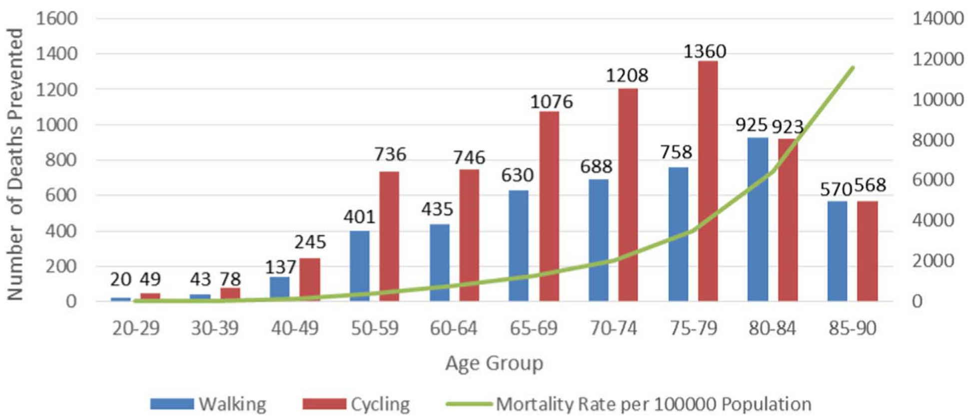

Fig. 2. Number of death prevented per year and Mortality rate, per age group attributed to walking and cycling 2010–2014.

lower levels of cycling compared to elderly men, which is consistent with the findings of previous studies (Curtis et al., 2000; Lee, 2005; Sun et al., 2013). In terms of age groups, we found that people in their early stage of retirement (age 65–75) walk and cycle more than members of other age groups. More free time combined with relatively good health may offer them the opportunity to spend more time on active travel (Fishman et al., 2015b).

With regard to socioeconomic groups, our results revealed that the higher-income and higher-educated groups were the most likely to be active. This is in line with previous studies showing that higher socioeconomic groups are likely to engage in more physical activity (Fishman et al., 2015a; Heinen, 2011; Kitchen et al., 2011; Scheepers et al., 2013). As illustrated by Heinen (2011) and Beenackers et al. (2012), people with high incomes tend to cycle more for leisure and exercise, while low-income groups used the bike mostly for utilitarian purposes. Among different ethnic groups, in line with Harms et al. (2014), people with a non-Western background walked and cycled less than the native Dutch. Indeed, people with an ethnic background usually rely on public transport instead of bicycles, possibly because of a lack of cycling skills, cultural norms that are not in favor of cycling, or since the long distance of their journey to work discourages cycling (Harms, 2007).

Our findings suggested that a large number of prevented deaths in certain population groups does not always reflect high walking and cycling levels but can also stem from a large population size, a high mortality rate or both. First, despite the small population size compared to younger people, the death prevention of the elderly (age 65 +) was much higher due to their higher walking and cycling levels and higher mortality rate. Particularly, elderly men gained higher health benefits than elderly women due to their higher walking and cycling levels. This is consistent with the findings of Mueller et al. (2015) that elderly people are at high risk for chronic degenerative disease, and physical activity can substantially mitigate those diseases. Secondly, while the lowest socioeconomic groups spent less time walking and cycling than other groups, the health benefits accruing to this category as a whole were much higher as a result of its large proportion of the population and high mortality rate. This could also be explained by the fact that a large number of the elderly belong to low socioeconomic groups. Considering ethnicity, the native Dutch as a group benefited more from walking and cycling than the category of non-natives because of their higher walking and cycling levels and their larger share of the population. It may be that people from different educational or cultural backgrounds live in different environmental circumstances, or view the same built environment differently, leading to different walking and/or cycling levels (Sallis et al., 2013).

4.2. Strengths and limitations

This is the first study to explore how and to what extent the health benefits of walking and cycling on a population level vary across different subgroups. A major strength is the large sample, being representative for the Dutch population. Its size not only allowed a specific analysis of the inequality of the health benefits of walking and cycling across different subgroups but also provided sufficient evidence to explain each indicator (i.e., population size, duration of walking and cycling, mortality rates) in terms of inequality issues.

However, this study also has some limitations. First, information on all-cause mortality rates for specific socioeconomic groups (i.e. income, education, and ethnicity) was not accessible. Therefore, all-cause mortality rates for each age group were used as a proxy for specific socioeconomic groups, which may induce inaccuracies. Second, our results are likely to underestimate the true total health benefits. Only mortality without prevented morbidity is taken into account in HEAT. Further, HEAT calculations have three components: population size, average mortality rates, and mortality rate reduction due to walking/cycling. According to our results, most deaths are prevented among the low socioeconomic groups. That outcome may be confusing to policy-makers, who could conclude that the low socioeconomic groups have sufficiently high levels of walking and cycling. In fact, their walking and cycling levels are lower than those of high socioeconomic groups, but their ‘higher’ health benefits merely a reflection of their larger population size and/or higher mortality rates. Thus, increasing the walking and cycling levels of lower socioeconomic groups could still be an effective way to reduce socioeconomic health inequalities. Finally, since the current study pooled the data-set for an entire country, possible variations in walking and cycling levels across different areas of the Netherlands were ignored. Therefore, it would be interesting to explore spatial differences in walking and cycling levels, and how these translate into health benefits, across the country.

4.3. Implications for policy

It is important to develop policies and interventions that encourage the population groups with lower walking and cycling levels to do more walking and cycling, as this behavior offers great potential for improving population health and may contribute to mitigating health inequalities. As shown by our results, despite a low level of cycling (59 min per week), the annual number of deaths prevented among the low-educated group is already about 3225. If the amount of time they spent cycling could be increased to match that of the high-educated group (i.e. to 107 min per week), this would result in an increase of about 40% more prevented deaths among the low-educated group above the current number. Increasing walking and/or cycling levels may thus have enormous aggregate health benefits among these lower socioeconomic groups and could contribute to a reduction of socioeconomic health inequalities. Therefore, policy-makers should focus more on subgroups with a high mortality rate and large population size but low walking and/or cycling levels. With such policies, achievement of mitigating health inequalities between low and high socioeconomic groups should be possible (Mackenbach et al., 2003; Singh and Siahpush, 2002; Stringhini et al., 2010).

5. Conclusions

This study is the first to examine how levels of walking and cycling among different income, education, ethnic and age groups translate into inequalities in health benefits on a population level. In the Netherlands, women, senior citizens (50–79 years), higher socioeconomic groups, and the native Dutch showed higher walking and cycling levels than other population subgroups. Our findings suggest that a large number of prevented deaths in some population subgroups does not always reflect high walking and cycling levels, but can also stem from a large population size, a high mortality rate or both. Particularly among senior citizens, as a result of their relatively high mortality rates and high walking and cycling levels, a large number of deaths were prevented. In lower socioeconomic groups, despite their relatively low walking and cycling levels, more deaths were prevented than among higher socioeconomic groups due to the large population size and higher mortality rates of low socioeconomic groups. In aggregate, the native Dutch gained more health benefits from walking and cycling than the non-natives because of their higher walking and cycling levels and larger population size. In conclusion, interventions as well policies aiming to increase walking and cycling levels in lower socioeconomic groups could potentially result in large health benefits on the population level, which in turn may reduce health inequalities across socioeconomic groups.

References

Adams, J., 2010. Prevalence and socio-demographic correlates of “active transport” in the UK: analysis of the UK time use survey 2005. Prev. Med. 50, 199–203. http://dx.doi.org/10.1016/j.ypmed.2010.01.006.

Arsenio, E., Ribeiro, P., 2015. The economic assessment of health benefits of active transport. Transp. Sustain. http://dx.doi.org/10.1108/S2044-994120150000007011.

Beenackers, M.A., Kamphuis, C.B.M., Giskes, K., Brug, J., Kunst, A.E., Burdorf, A., van Lenthe, F.J., 2012. Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: a systematic review. Int. J. Behav. Nutr. Phys. Act. 9. http://dx.doi.org/10.1186/1479-5868-9-116.

Böcker, L., van Amen, P., Helbich, M., 2016. Elderly travel frequencies and transport mode choices in Greater Rotterdam, the Netherlands. Transportation 1–22. http://dx.doi.org/10.1007/s11116-016-9680-z.

CBS, 2016a. 〈http://statline.cbs.nl/Statweb/?LA=en〉. (Accessed by Februrary 2016) [WWW Document].

CBS, 2016b. 〈http://statline.cbs.nl/Statweb/selection/?DM=SLNL&PA=82275NED&VW=T〉. (Accessed in Feburary 2016) [WWW Document].

CBS, 2016c. Research Travel in Netherlands (OViN) [WWW Document]. URL 〈http://www.cbs.nl/nl-NL/menu/themas/verkeer-vervoer/methoden/dataverzameling/korte-onderzoeksbeschrijvingen/ovin-beschrijving-art.htm〉.

Curtis, J., White, P., McPherson, B., 2000. Age and physical activity among Canadian women and men: findings from longitudinal national survey data. J. Aging Phys. Act. 8, 1–19.

de Vries, S.I., Hopman-Rock, M., Bakker, I., Hirasing, R.A., van Mechelen, W., 2010. Built environmental correlates of walking and cycling in dutch urban children: results from the SPACE study. Int. J. Environ. Res. Public Health 7, 2309–2324. http://dx.doi.org/10.3390/ijerph7052309.

Deenihan, G., Caulfield, B., 2014. Estimating the health economic benefits of cycling. J. Transp. Heal. 1, 141–149. http://dx.doi.org/10.1016/j.jth.2014.02.001.

Edwards, R.D., Mason, C.N., 2014. Spinning the wheels and rolling the dice: life-cycle risks and benefits of bicycle commuting in the U.S. Prev. Med. 64, 8–13. http://dx.doi.org/10.1016/j.ypmed.2014.03.015.

Engbers, L.H., Hendriksen, I.J.M., 2010. Characteristics of a population of commuter cyclists in the Netherlands: perceived barriers and facilitators in the personal, social and physical environment. Int. J. Behav. Nutr. Phys. Act. 7. http://dx.doi.org/10.1186/1479-5868-7-89.

Fishman, E., Böcker, L., Helbich, M., 2015a. Adult active transport in the Netherlands: an analysis of its contribution to physical activity requirements. PLoS One 10. http://dx.doi.org/10.1371/journal.pone.0121871.

Fishman, E., Schepers, P., Kamphuis, C.B.M., 2015b. Dutch cycling: quantifying the health and related economic benefits. Am. J. Public Health 105, e13–e15. http://dx.doi.org/10.2105/AJPH.2015.302724.

Garni, A., Miller, A., 2008. Localized immigration policy and migrant life experiences: the case of Mexican migrants in Southern California. J. Immigr. Refug. Stud. 6, 435–450. http://dx.doi.org/10.1080/15362940802371929.

Garrard, J., 2003. Healthy revolutions: promoting cycling among women. Health Promot. J. Aust. 14, 213–215. http://dx.doi.org/10.1071/HE03213.

Garrard, J., Rose, G., Lo, S.K., 2008. Promoting transportation cycling for women: the role of bicycle infrastructure. Prev. Med. 46, 55–59. http://dx.doi.org/10.1016/j.ypmed.2007.07.010.

Goodman, A., Sahlqvist, S., Ogilvie, D., 2013. Who uses new walking and cycling infrastructure and how? Longitudinal results from the UK iConnect study. Prev. Med. 57, 518–524. http://dx.doi.org/10.1016/j.ypmed.2013.07.007.

Harms, L., 2007. Mobilität ethnischer Minderheiten in den Stadtgebieten der Niederlande.

Harms, L., Bertolini, L., te Brömmelstroet, M., 2014. Spatial and social variations in cycling patterns in a mature cycling country exploring differences and trends. J. Transp. Health 1, 232–242. http://dx.doi.org/10.1016/j.jth.2014.09.012.

Heesch, K.C., Giles-Corti, B., Turrell, G., 2014. Cycling for transport and recreation: associations with socio-economic position, environmental perceptions, and psychological disposition. Prev. Med. 63, 29–35. http://dx.doi.org/10.1016/j.ypmed.2014.03.003.

Heinen, E., 2011. Bicycle Commuting. Delft Univiersity Press, Delft.

Helbich, M., Emmichoven, M.J.Z.V., Dijst, M.J., Kwan, M.P., Pierik, F.H., Vries, S.I.D., 2016. Natural and built environmental exposures on children's active school travel: a Dutch global positioning system-based cross-sectional study. Health Place 39, 101–109. http://dx.doi.org/10.1016/j.healthplace.2016.03.003.

Kahlmeier, S., Cavill, N., Dinsdale, H., Rutter, H., Götschi, T., Foster, C.E., 2011. Health Economic Assessment Tools (HEAT) for Walking and Cycling. Methodology and User Guide. World Health Organization Regional Office for Europe, Copenhagen.

Kahlmeier, S., Racioppi, F., Cavill, N., Rutter, H., Oja, P., 2010. “Health in all policies” in practice: guidance and tools to quantifying the health effects of cycling and walking. J. Phys. Act. Health 7, S120–S125.

Kamphuis, C.B.M., van Lenthe, F.J., Giskes, K., Huisman, M., Brug, J., Mackenbach, J.P., 2009. Socioeconomic differences in lack of recreational walking among older adults: the role of neighbourhood and individual factors. Int. J. Behav. Nutr. Phys. Act. 6. http://dx.doi.org/10.1186/1479-5868-6-1.

Kelly, P., Kahlmeier, S., Götschi, T., Orsini, N., Richards, J., Roberts, N., Scarborough, P., Foster, C., 2014. Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. Int. J. Behav. Nutr. Phys. Act. 11. http://dx.doi.org/10.1186/s12966-014-0132-x.

Kennisinstituut voor Mobiliteits, 2014. Mobiliteitsbeeld 2014 (Mobility Image2014). http://dx.doi.org/978-90-8902-124-3.

Kitchen, P., Williams, A., Chowhan, J., 2011. Walking to work in Canada: health benefits, socio-economic characteristics and urban-regional variations. BMC Public Health 11. http://dx.doi.org/10.1186/1471-2458-11-212.

Kwasniewska, M., Kaczmarczyk-Chalas, K., Pikala, M., Broda, Kozakiewicz, K., Pajak, A., Tykarski, A., Zdrojewski, T., Drygas, W., 2010. Socio-demographic and lifestyle correlates of commuting activity in Poland. Prev. Med. 50, 257–261. http://dx.doi.org/10.1016/j.ypmed.2010.02.011.

Lee, Y.S., 2005. Gender differences in physical activity and walking among older adults. J. Women Aging 17, 55–70. http://dx.doi.org/10.1300/J074v17n01_05.

Mackenbach, J.P., Bos, V., Andersen, O., Cardano, M., Costa, G., Harding, S., Reid, A., Hemström, Ö., Valkonen, T., Kunst, A.E., 2003. Widening socioeconomic inequalities in mortality in six Western European countries. Int. J. Epidemiol. 32, 830–837. http://dx.doi.org/10.1093/ije/dyg209.

Mueller, N., Rojas-Rueda, D., Cole-Hunter, T., de Nazelle, A., Dons, E., Gerike, R., Götschi, T., Int Panis, L., Kahlmeier, S., Nieuwenhuijsen, M., 2015. Health impact assessment of active transportation: a systematic review. Prev. Med. 76, 103–114. http://dx.doi.org/10.1016/j.ypmed.2015.04.010.

Olabarria, M., Pérez, K., Santamariña-Rubio, E., Novoa, A.M., Racioppi, F., 2013. Health impact of motorised trips that could be replaced by walking. Eur. J Public Health 23, 217–222. http://dx.doi.org/10.1093/eurpub/cks015.

OViN, 2015. Onderzoeksbeschrijving OViN. 2010–2014.

Pucher, J., Buehler, R., 2008. Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. Transp. Rev. 28, 495–528. http://dx.doi.org/10.1080/01441640701806612.

Pucher, J., Dijkstra, L., 2003. Promoting safe walking and cycling to improve public health: lessons from The Netherlands and Germany. Am. J Public Health 93, 1509–1516.

Sallis, J.F., Conway, T.L., Dillon, L.I., Frank, L.D., Adams, M.A., Cain, K.L., Saelens, B.E., 2013. Environmental and demographic correlates of bicycling. Prev. Med. 57, 456–460. http://dx.doi.org/10.1016/j.ypmed.2013.06.014.

Scheepers, E., Wendel-Vos, W., van Kempen, E., Panis, L.I., Maas, J., Stipdonk, H., Moerman, M., den Hertog, F., Staatsen, B., van Wesemael, P., Schuit, J., 2013. Personal and environmental characteristics associated with choice of active transport modes versus car use for different trip purposes of trips up to 7.5 km in The Netherlands. PLoS One 8. http://dx.doi.org/10.1371/journal.pone.0073105.

Singh, G.K., Siahpush, M., 2002. Increasing inequalities in all-cause and cardiovascular mortality among US adults aged 25–64 years by area socioeconomic status, 1969–1998. Int. J. Epidemiol. 31, 600–613.

Stringhini, S., Sabia, S., Shipley, M., Brunner, E., Nabi, H., Kivimaki, M., Singh-Manoux, A., 2010. Association of socioeconomic position with health behaviors and mortality. J. Am. Med. Assoc. 303, 1159–1166. http://dx.doi.org/10.1001/jama.2010.297.

Sun, F., Norman, I.J., While, A.E., 2013. Physical activity in older people: a systematic review. BMC Public Health 13. http://dx.doi.org/10.1186/1471-2458-13-449.

Umberson, D., Montez, J.K., 2010. Social relationships and health a flashpoint for health policy. J. Health Soc. Behav. 51, S54–S66.

Wilkinson, R.G., Marmot, M.G., 2003. Social Determinants of Health: The Solid Facts. World Health Organization.

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., Goodman, A., 2014. Health effects of the London bicycle sharing system: health impact modelling study. Br. Med. J. 348. http://dx.doi.org/10.1136/bmj.g425.

World Health Organization, 2010. Global Recommendations on Physical Activity for Health (Report). World Health Organization, Switzerland.