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Dutch cycling: Quantifying the health and related economic benefits

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ABSTRACT
The Netherlands are well-known for their high bicycle usage. The approach of the Health Economic Assessment Tool and life table calculations were used to quantify the population-level health benefits due to Dutch cycling levels. The results show that, due to cycling, about 6,500 deaths are prevented each year, Dutch people have half-a-year longer life expectancy, and that these health benefits translate in economic benefits corresponding to some 3% of Dutch GDP. Our study confirms that investments in bicycle-promoting policies (e.g. improved bicycle infrastructure and facilities) are likely to yield a high benefit-cost ratio in the long term.

INTRODUCTION

The Netherlands are well-known for their high cycling levels.[1, 2] Currently, about 27% of all trips in the Netherlands is made by bicycle.[3] Investments in bicycle paths, bike parking, traffic calming, and other policies contribute to these high cycling levels, and therefore, the Dutch approach is internationally recognized as an example for other countries.[1, 2] Although the health benefits of cycling as a means to reduce the risk of sedentary lifestyle diseases and all-cause mortality are well-known,[4-6] no previous study has actually quantified the health benefits and related economic benefits at a population level in the Netherlands, which has the highest level of bicycle use in the world.[1] Quantifying and monetizing these benefits is important to inform policy makers in the field of transport.[7] Therefore, this paper sets out to examine the health benefits and health-related economic benefits of population cycling levels in the Netherlands.

METHODS

Data on age group-specific cycling levels (i.e. average time spent cycling weekly per person), population counts, and mortality rates in the Netherlands in 2010-2013 were retrieved from Statistics Netherlands.[3] Data about cycling levels had been collected by means of a travel diary survey (National Travel Survey, or "Onderzoek Verplaatsingsgedrag in Nederland") among a nationally representative random sample of about 50,000 persons each year. All types of travellers and households and all days of the year are proportionately represented.

The approach of the Health Economic Assessment Tool (HEAT) developed by the World Health Organization (WHO) was used[8] to estimate the mortality rate reduction and number of deaths prevented each year due to cycling. The tool estimates the value of reduced mortality that results from specified amounts of cycling (or walking). Based on a recent meta-analysis of studies about the impact of cycling on all-cause mortality,[4] HEAT assumes a reduction in mortality risk of 10% (95% confidence interval: 6 to 13%) for an exposure to cycling of 100 minutes per week. This risk reduction is controlled for other forms of physical activity, such as leisure time or occupational physical activity, and other health behaviours like smoking.[4] Negative side-effects due to increased exposure to road safety and air pollution risks are controlled for because the meta-analysis was about *all*-cause mortality. HEAT only considers ages between 20 and 65 years. Younger people are excluded because the evidence base for the health effects of physical activity on young people is not as large as that for adults. Older age groups are excluded because countries often lack mobility data for older age groups.[8] However, since the underlying meta-analysis did provide information for ages of 65 and over,[4] The annual number of deaths prevented per age group, was calculated by the product of the mortality rate reduction and the mortality rate (annual number of deaths per 100,000) for that age group.

To calculate the economic health benefits of cycling, HEAT uses a standard *value of a statistical life* (VSL) to monetize the number of deaths per year prevented by cycling participation. Certain costs such as expenditures related to medical treatment are not reflected in the VSL estimates but these are relatively small. HEAT applies a VSL of $3.6 million for the EU-27 countries, but advises a locally agreed VSL where available.[8] The Dutch VSL is €2.8 million per death at the 2013 price level.[3, 9]

Lastly, Dutch hazard rates were entered in the open-access life-table calculations, *IOMLIFET*, to estimate the life expectancy increases by age group in response to the reduced risk of mortality as calculated by the HEAT approach.[10]

RESULTS

The weekly time spent cycling is about 74 minutes per week for Dutch adults of 20 to 90 years of age (Table 1). This level of cycling is fairly stable over adulthood and reaches its peak around 65-70 years, in early days of retirement, and strongly drops after the age of 80 years. The mortality rate reduction, which is a direct result of the average time spent cycling of a certain age group, is therefore also highest between 65 and 70 years. As a result of the mortality reduction of all age groups together, about 6,500 deaths per year are prevented due to cycling in the Netherlands. With a VSL of € 2.8 million per prevented death, the total economic health benefits of cycling are estimated at € 19 billion per year. Life table calculations suggested people in the Netherlands would die about half a year earlier without cycling. More than half of this total life expectancy increase is achieved by cycling among adults aged 65 and older.

TABLE 1. Health economic assessment based on time spent cycling and mortality rates of the Dutch population between 20 and 90 years in 2010-2013

	Input data			Outcome HEAT approach			Life table calculation
Age group	Average weekly minutes of cycling p.p.	Popula-tion (x 1,000)	Average annual mortality rate per 100,000 pop.	Mortality rate reduction (%)[1]	Number of deaths prevented per year[2]	Annual benefit of current Dutch cycling (billon €)[3]	Increase of average life expectancy[4]
20-30	73	2,058	31	7.3	47	0.1	0.01
30-40	69	2,087	53	6.9	77	0.2	0.02
40-50	69	2,573	135	6.9	241	0.7	0.03
50-60	79	2,320	390	7.9	715	2.0	0.08
60-65	89	1,071	757	8.9	719	2.0	0.07
65-70	94	872	1,232	9.4	1,009	2.8	0.09
70-75	88	652	1,963	8.8	1,127	3.2	0.10
75-80	73	507	3,422	7.3	1,274	3.6	0.09
80-85	36	369	6,328	3.6	842	2.4	0.05
85-90	24	216	11,663	2.4	606	1.7	0.03
Total / Average	74	12,725	878	7.4	6,657	18.6	0.57

[1] Based on an estimated mortality rate reduction of 10% per 100 minutes of cycling per week according to the meta-analysis.[5,7] For instance, for the age group of 20-30 years 73/100 = 7.3%
[2] The product of the mortality rate reduction, population and mortality rate (per 100,000 population)/100,000
[3] The product of the number of deaths multiplied by the standard value of a statistical life year (VSL) of 2.8 million euro.
[4] Based on lifetable calculations using IOMLIFET with Dutch mortality rates between 2010 and 2013[3]

DISCUSSION

Cycling levels in the Netherlands have great population level health benefits: about 6,500 deaths are prevented annually and Dutch people have half-a-year longer life expectancy. These large population level health benefits translate into economic benefits of €19 billion per year, which represent more than 3% of the Dutch Gross Domestic Product (GDP) between 2010 and 2013.[3]

About 6,500 deaths that are saved annually due to cycling is a huge number, but becomes even more impressive when compared to the population-health effects of other preventive measures. An overview of Mackenbach et al (2013) showed that the 22 new preventive interventions that have been introduced in the Netherlands between 1970 and 2010 (e.g. tobacco control, population based screening for cancer, and road safety measures), altogether avoid about 16,000 deaths per year.[11]

Still, our results are likely to be an underestimation of the true total health and economic benefits. The benefits calculated are for health only (excluding, for instance, reduced traffic congestion), and within the health category, only for mortality and not for prevented morbidity. There is considerably uncertainty regarding the monetization of morbidity,[5] which is why it is not included in the WHO’s HEAT Model.[8]

Compared to the capital investments by all levels of Dutch government in road and parking infrastructure for cycling of almost €0.5 billion per year over the last decades [12], the annual benefits of €19 billion are much higher than the annual costs. We acknowledge that this comparison excludes private spending on bicycles and savings on fuel costs if the same trips would be covered by car. Moreover, next to safe and efficient cycling infrastructure and facilities, also geographical factors, like the Dutch flat terrain, and mild climate, and cultural factors are likely to contribute to high volumes of cycling.[13] These are unrelated to capital investment by governments. However, infrastructural and safety measures are important to facilitate cycling.[13] For instance, elderly, the group among whom the largest health and economic benefits can be achieved, indicated to prefer separate bicycle paths.[14] The Dutch case shows it is likely that investments in bicycle-promoting policies (e.g. improved bicycle infrastructure and facilities) yield a high benefit-cost ratio in the long term. We therefore recommend investments in bicycle policies as suggested earlier by Pucher and Dijkstra.[1, 2]

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