Projecting Health Outcomes of Active Mode Use in New Zealand

Ralph D. Samuelson

Ph.D (Engineering-Economic Systems), MA (Economics),

MSc (Transportation Systems), BSc

Principal Data Analyst, Ministry of Transport

e-mail: r.samuelson@transport.govt.nz

Haobo Wang

Ph.D (Environmental Science), MS (Environmental Chemistry), BSc

Senior Data Analyst, Ministry of Transport

e-mail: h.wang@transport.govt.nz

Abstract

Low physical activity is associated with increased risk for a range of diseases. Active transport modes such as walking and cycling can help reduce these risks and enhance health outcomes. This paper describes the results of a model of these outcomes for New Zealand. The model was developed as part of the *Transport Outlook: Future State* project at the Ministry of Transport. The model was adapted for New Zealand by the University of Otago, Department of Public Health, based on the Integrated Transport and Health Impact Modelling Tool (ITHIM) produced at the Centre for Diet and Activity Research at the University of Cambridge, United Kingdom. The *Transport Outlook: Future State* projected 25-year transport futures for New Zealand for five scenarios, each varying a number of assumptions. This paper extends the *Transport Outlook: Future State* work by examining four alternative scenarios where only assumptions about the amount of future walking and cycling varied from the baseline.

Even though the scenarios assumed fairly modest changes in average time spent walking and cycling, the model results suggest that there would be very positive impacts in reducing the incidence of diseases of low physical activity. These impacts are likely to grow significantly in the future as the population ages. And these impacts far outweigh any resulting increase in deaths due to collisions of pedestrians and cyclists with motor vehicles. The model results also suggest the importance of a policy focus on creating a cycling environment that encourages older people, who are most at risk from diseases of inactivity, to cycle.

Introduction

Low physical activity is associated with increased risk for a range of diseases, including cardiovascular disease (heart attacks and stokes), diabetes, dementia, breast and colon cancer, and depression. Low physical activity was estimated by the Global Burden of Disease Study to cause about 1,100 deaths in New Zealand in 2016 (Institute for Health Metrics and Evaluation, 2018). Another study jointly sponsored by the Wellington Regional Strategy, the Waikato Regional Council and the Auckland Council put the toll of diseases of inactivity at 2121 deaths in 2009 among all age groups, with 246 of these deaths being among those under age 65 (Wellington Regional Strategy, et al, no date).

In comparison, accidents across all modes of transport were responsible for about 400 deaths in 2016 (Institute for Health Metrics and Evaluation, 2018). Those who die from diseases of low physical activity tend to be considerably older than the victims of transport accidents. As people who die when they are older have fewer years of remaining life lost compared with people who die when they are younger, estimates of the number of years of life lost (YLLs) compared to a normal life expectancy in 2016 for diseases of low physical activity (12,100 YLLs) are about two-thirds of those for transport accidents (18,400 YLLs). However, either way one looks at it, diseases of low physical activity are a major, and potentially preventable, cause of pre-mature death.

Increases in the use of motorised transport have been associated with declining levels of physical activity (World Health Organisation, 2018), but transport can also play a role in combating them. Active modes – walking and cycling – provide opportunities for exercise while travelling and, therefore, help to reduce the risk of diseases resulting from low physical activity.

To illustrate the impact that active modes might have on health, the Ministry of Transport's *New Zealand Transport Outlook: Future State* (Ministry of Transport 2017) projected the change to 2042/43 in the number of deaths and years of life lost due to diseases of low physical activity in response to changes in time spent walking and cycling in five alternative scenarios. This work was based on a model of the health impacts of active modes adapted for the Ministry by the University of Otago, Department of Public Health (Keall, et al, 2016). The model is based on the Integrated Transport and Health Impact Modelling Tool (ITHIM) produced at the Centre for Diet and Activity Research at the University of Cambridge, United Kingdom (Woodcock, et al, 2009). ITHIM has been used in a number of academic and government projects in many cities, regions and countries around the world, including the UK (for England and Wales and London specifically), California, Malaysia, Brazil, India, Canada, and Portland, Oregon.

A limitation of the *Transport Outlook: Future State* work was that the scenarios assumed combinations of modest changes in walking and cycling, along with other changes in the location and size of the population, which made it hard to estimate the impacts of significant changes in walking or cycling in isolation. This short paper seeks to remedy that limitation by using the same model to examine simple changes to walking and cycling with other assumptions held the same.

The most similar work in the literature to ours that we are aware of is a paper by Graeme Lindsay, Alexandra MacMillan, and Alistair Woodward (2010), which estimated the effects on health, air pollution and greenhouse gas emissions in New Zealand if short trips (≤7 km) were undertaken by bicycle rather than by motor vehicle. This would shift about 5% of vehicle kilometres to cycling, which is similar to what we assume in Scenarios C and D below. They modified the World Health Organisation's Health Economic Assessment Tool (HEAT) for cycling to New Zealand, and concluded that the health effects would include about 116 deaths avoided annually as a result of increased physical activity, six fewer deaths due to local air pollution from vehicle emissions, and an additional five cyclist fatalities from road crashes. We have not attempted to explore the reasons for the differences between their results and ours, and have not projected the impacts of reductions in air pollution at all. However, given the level of uncertainty in both sets of results, their results are broadly consistent with ours.

Method

We examined the five alternative scenarios as shown in Table 1 below.

Table 1: Assumed walking and cycling scenarios

	Average minutes per day per person	
	Walking	**Cycling**
Baseline (2012/13)	7.6	0.9
Scenarios		
Scenario A: Double Walking (+7.6 minutes/day)	15.2	0.9
Scenario B: Double Cycling (+0.9 minutes/day)	7.6	1.8
Scenario C: Increase Cycling +7.6 minutes/day	7.6	8.5
Scenario D: Increase both Walking and Cycling +7.6 minutes/day	15.2	8.5

The 2012/13 baseline times spent walking and cycling are from the New Zealand Transport Outlook Household Travel Model (Ministry of Transport, 2018B) based on data from the New Zealand Household Travel Survey (Ministry of Transport, 2018A). These walking and cycling times are based on travel diaries kept by participants in the survey and would, therefore, not include walking inside homes and other buildings. In Scenario A and Scenario B, we double the baseline times spent walking and cycling, respectively. However, since the Baseline cycling time is quite small (0.9 minutes/day), doubling it has far less of an impact on cycling time than a doubling of walking time. For this reason, Scenario C adds the same number of minutes of cycling that a doubling of walking time would add to walking minutes (7.6 minutes/day), to create a cycling scenario more comparable to Scenario A. Scenario D combines Scenarios B and C.

In terms of distance travelled, Scenarios A and D would add about 0.5 kilometres per day per person of walking, while Scenario B would add about 0.2 kilometres per day of cycling and Scenarios C and D would add about 1.6 kilometres per day of cycling. For comparison, the average distance per day per person travelled by motor vehicle in New Zealand (as driver or passenger) was about 29.3 kilometres.

It is interesting to compare these times spent walking and cycling to those for the Netherlands, a country known for the popularity of active transport, especially cycling. In the Netherlands in the year 2014, walking time averaged about 9.8 minutes per day per person, a bit above the baseline New Zealand figure of 7.6 minutes/day, but below the 15.2 minutes per day we assume in Scenarios A and D. However, cycling in the Netherlands averaged about 13.3 minutes/day per person, almost double the 7.6 minutes we assume in even our Scenarios C and D (see European Commission, no date). These figures suggest that the walking and cycling times assumed in our scenarios are potentially achievable for New Zealand and, in the case of cycling, may even be conservative.

Findings

The projected change in the average time spent walking or cycling each day in the alternative scenarios is modest. However, the benefits of even these modest amounts of additional activity are quite significant, as shown in Table 2.

Table 2: Change in deaths and years of life lost in 2042/43 compared to 2012/13 baseline due to changes in transport-related physical activity

	(A) Assuming same population as in 2012/13		(B) Assuming projected population of 2042/43	
	Change in the number of deaths	Change in the number of years of life lost	Change in the number of deaths	Change in the number of years of life lost
Scenario A: Double Walking (+7.6 minutes/day)	-470	-5856	-1221	-12,373
Scenario B: Double Cycling (+0.9 minutes/day)	-40	-914	-76	-1500
Scenario C: Increase Cycling +7.6 minutes/day	-171	-4051	-314	-6437
Scenario D: Increase Walking and Cycling +7.6 minutes/day	-626	-9227	-1525	-17,661

Column A assumes that the population size and age/sex distribution in 2042/43 are the same as in the base year (2012/13) under all scenarios. Column B assumes a projected 2042/43 population size and age/sex distribution based on Stats NZ subnational population projections, by age and sex, 2013(base)-2043 under all scenarios.

Several observations about the results shown in Table 2 are in order.

1) Despite the modest increases in walking and cycling times, the reduction in deaths and years of life lost are quite large and significant. Recall that accidents for all modes of transport amounted to about 400 deaths and 18,400 years of life lost in 2016.
2) The benefits of the increased walking and cycling grow much faster than the projected population growth from 4.4 million in 2012/13 to about 5.9 million in 2042/43. The reason is that the population in 2042/43 is not only larger than in 2012/13, but also older, and therefore, more at risk of death due to low physical activity.
3) Doubling the time spent walking has a quite large impact, while doubling the time spent cycling has a much smaller impact. This is mainly because the 2012/13, time spent cycling was so much smaller than the time spent walking.
4) However, even if both walking and cycling are increased by the same 7.6 minutes per day, as in scenarios A and C, the model results suggest that the increase in walking has a much larger impact. This result is despite the fact that the model assumes cycling to be the more physically intense activity. In the model, the amount of exercise an activity yields is measured in units called ‘metabolic equivalents of task’ or METs. The METs for a certain duration of activity is obtained by multiplying the duration of the activity in hours by the assumed METs/hour for the activity. The assumed METs/hour for walking range from about 3.3 to about 4.0, depending upon the sex and age group, and are generally smaller for children and older people, and for females. METs for cycling are assumed to be 6.0 for all sexes and age groups. So, in general, cycling is assumed to deliver 50-80% more health benefits per hour than walking.
5) The larger health impact of increases in walking is rather a function of assumptions in the model that increases in walking and cycling by sex/age group are proportional to baseline walking and cycling by sex/age group. Unfortunately, the Household Travel Survey results indicate that cycling in New Zealand is currently heavily concentrated among younger and middle-age males. Hence, even large proportional increases in cycling in each sex/age group have only a modest impact on older people

who are most at risk from diseases of inactivity. Walking, on the other hand, is more evenly spread across sex/age groups, and quite popular with older people, thus explaining the larger health impact of increases in walking.

6) These results are, of course, a function of the model assumption that increases in walking and cycling will be proportional to baseline walking and cycling by sex/age group. In fact, it is not hard to imagine that if cycling were to become a more accepted ‘mainstream’ mode of transport, as envisioned in these scenarios, it would attract people of all ages and sexes. In the Netherlands, for example, men and women cycle in similar numbers, and the number of cycle trips per day made by 65-75 year olds actually exceeds that of 25-30 year olds for both men and women (Fietsersbond, 2011).
7) However, there is a message here that, for maximum health benefits, any policies to promote the use of cycling need to especially consider the needs of older people and women.
8) Not surprisingly, the sum of the separate impacts of increasing walking and cycling by 7.6 minutes/day in Scenarios A and C is slightly greater than the combined impact of the two in Scenario D. This reflects the assumption built into the model that there are decreasing returns to increasing physical activity.

Would these reductions in deaths and years of life lost from diseases of low physical activity be offset by increases in deaths and years of life lost due to motor vehicle collisions involving pedestrians and cyclists? The model can provide an answer, as it also projects changes in deaths and years of life lost by pedestrians and cyclists due to collisions with motor vehicles, as shown in Table 3.

Table 3: Change in deaths and years of life lost in 2042/43 for pedestrians and cyclists due to collisions with motor vehicles

	(A) Assuming same population as in 2012/13		**(B) Assuming projected population in 2042/43**	
	Change in the number of deaths	**Change in the number of years of life lost**	**Change in the number of deaths**	**Change in the number of years of life lost**
Scenario A: Double Walking (+7.6 minutes/day)	+21	+772	+28	+1029
Scenario B: Double Cycling (+0.9 minutes/day)	+5	+247	+7	+329
Scenario C: Increase Cycling +7.6 minutes/day	+25	+1214	+34	+1619
Scenario D: Increase Walking and Cycling +7.6 minutes/day	+46	+1986	+61	+2648

Deaths from collisions with motor vehicles generally rise with increases in walking or cycling. However, the relationship is not a simple proportionate one, as the rate of collisions tends to decline as there are more cyclists or pedestrians on the streets relative to cars—the ‘safety in numbers’ effect (Jacobsen, 2003).

Several observations about the results shown in Table 3 are in order.

1) The increase in deaths and years of life lost as a result of collisions with motor vehicles shown in Table 3 are small relative to the decrease in deaths and years of life lost as result of reduced diseases of low physical activity shown in Table 2.
2) Growth in deaths and years of life lost from collisions with motor vehicles is generally proportional to the increase in population, meaning that the decrease in deaths and years of life lost as a result of reduced diseases of low physical activity grows over time relative to the increase in deaths and years of life lost as a result of collisions with motor vehicles.
3) For increases in walking, the ratio of reduced deaths from diseases of low physical activity to increased deaths from collisions with motor vehicles is about 20 to 1, while the same ratio for years

of life lost is about 8 to 1. The ratio for deaths is larger than the ratio years of life lost because deaths from diseases of low physical activity tend to be concentrated among older people, who have less years of remaining life to lose, while deaths from collisions with motor vehicles tend to affect all age groups.

4) For increases in cycling, the ratio is about 7 to 1 for deaths and about 3 to 1 for years of life lost. Although these ratios are still quite favourable, there is no denying that cyclists are at greater risk of collisions with motor vehicles than pedestrians.
5) Results for Scenario D, which combines the assumptions of Scenario A and C, are essentially the sum of the results for Scenario A and Scenario C.
6) None of these figures take into account the fact that, to the extent people shift from travelling by motor vehicle to travel by active modes, motor vehicle fatalities should decline.

Conclusions

Tables 2 and 3 suggest that increases in walking and cycling are likely to lead to significant favourable overall health impacts, even with allowance for some increases in deaths from collisions with motor vehicles. They also suggest that the favourable health impacts of increased walking and cycling are likely to grow significantly in the future as the population ages.

The story here is quite uncertain, however, and may be even more favourable than these results suggest. In particular, the health benefits of increased cycling would be even greater were it not for the model assumption that increases in cycling by sex/age group are proportional to baseline cycling by sex/age group. This is because cycle usage in New Zealand is currently heavily concentrated among younger and middle-age males. If older people, who are most at risk from diseases of inactivity, were to cycle more, as they actually do in the Netherlands, the health benefits of cycling would be considerably larger. The results, therefore, also suggest the importance of a policy focus on creating a cycling environment that encourages older people to cycle.

Acknowledgements

The authors appreciate the advice and modelling assistance of Ed Randal and Michael Keall of the University of Otago, Department of Public Health, but take full responsibility for any errors or omissions.

References

European Commission and World Health Organisation Regional Office for Europe (no date), "Netherlands Physical Activity Factsheet". Weblink: http://www.euro.who.int/__data/assets/pdf_file/0011/288119/NETHERLANDS-Physical-Activity-Factsheet.pdf?ua=1.

Fietsersbond (Cyclists' Federation) (2011), "Fietsen in cijfers Nederland, fietsland" (Cycling in numbers Netherlands, cycleland), Figure 3. Weblink: http://media.fietsersbond.nl.s3.amazonaws.com/fietsenincijfers/fietsen_in_cijfers_web.pdf.

Graeme Lindsay, Alexandra MacMillan, and Alistair Woodward (2010), "Moving urban trips from cars to bicycles: impact on health and emissions", *Australian and New Zealand Journal of Public Health,* Volume 35, Issue 1, pp. 54-60. Weblink: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1753-6405.2010.00621.x.

Institute for Health Metrics and Evaluation (2018), "Global Health Data Exchange (GHDx)" database (2018), Seattle. Weblink: http://ghdx.healthdata.org/gbd-results-tool.

Jacobsen, P. (2003), "Safety in numbers: more walkers and bicyclists, safer walking and bicycling", *Injury Prevention,* Volume 9, Number 3, pp. 205–209. Weblink: www.ncbi.nlm.nih.gov/pmc/articles/PMC1731007/ .

Keall, M., Randal, E., Guria, J., Woodward, A. (2016), “Health outcomes projected from Transportation Modelling for the New Zealand Transport Outlook”, Ministry of Transport, Wellington. Weblink: www.transport.govt.nz/transportoutlook.

Ministry of Transport (2017), *Transport Outlook: Future State*, Wellington. Weblink: https://www.transport.govt.nz/resources/transport-outlook/. pp. 42-44.

Ministry of Transport (2018A), “Household Travel Survey” web page, Wellington. Weblink: https://www.transport.govt.nz/resources/household-travel-survey/.

Ministry of Transport (2018B), “Transport Outlook: Future State Model Results” web page, Wellington. Weblink: https://www.transport.govt.nz/resources/transport-outlook/transport-outlook-future-state-model-results/.

Wellington Regional Strategy, Waikato Regional Council and Auckland Council, “The Costs of Physical Inactivity: Toward a regional full cost accounting perspective”, Tables 2.8, and Table 2.9. Weblink: https://www.waikatoregion.govt.nz/assets/PageFiles/25488/The_Costs_of_Physical_Inactivity.PDF.

Woodcock, J., et al (2009), “Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport”, *Lancet*, Volume 374, Issue 9705, pp. 1930-1943 and web appendix. Weblink: https://www.sciencedirect.com/science/article/pii/S0140673609617141?via%3Dihub.

World Health Organisation (2018), “Physical Inactivity: A Global Public Health Problem” fact sheet, Geneva. Weblink: www.who.int/dietphysicalactivity/factsheet_inactivity/en/.

Declaration of competing interests

The authors declare no competing financial interests.