

**New Zealand Transport Outlook**  
**Health Outcomes of Active Transport Model**

**December 2017**

**Short name**

Health Model

**Purpose of the Model**

The Transport Outlook Health Outcomes of Active Transport Model projects household transport-related health outcomes, including changes in pre-mature deaths, years of life lost (YLLs), years living with disability (YLD), and disability-adjusted life-years (DALYs) due to diseases of inactivity. The model also projects the health outcomes associated with collisions of pedestrians and cyclists with motor vehicles.

**Software Used**

Excel

Tableau

SAS

**For questions and comments:**

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## New Zealand Transport Outlook

### Health Outcomes of Active Transport Model

#### 1. At a high-level, what does this model do?

Low physical activity is associated with increased risk for a range of diseases, including cardiovascular disease (heart attacks and strokes), diabetes, dementia, breast and colon cancer, and depression. Active transport modes such as walking and cycling can help reduce the risk and enhance health outcomes. The Transport Outlook Health Outcomes of Active Transport Model projects household transport-related health outcomes, including changes in pre-mature deaths, years of life lost (YLLs), years living with disability (YLD), and disability-adjusted life-years (DALYs) due to diseases of inactivity. The model also projects the health outcomes associated with collisions of pedestrians and cyclists with motor vehicles.

The model uses 2012/13 physical activity levels as the baseline. Results for a scenario are expressed as differences in health outcomes for 2042/43 physical activity levels for the scenario compared to physical activity levels for the baseline. There are two broad sets of health outcomes, each of which assumes like population sizes and age/sex distributions for both the scenario and baseline physical activity levels. One shows the differences in the health outcomes assuming the population size and age/sex distribution as of 2012/13. The other shows the differences in health outcomes assuming the 2042/43 population size and age/sex distribution hypothesised in the scenario.

For example, if we assume a 2012/13 population size and age/sex distribution, then the change in deaths for the 'Staying Close to the Action' scenario reflects deaths for a 2012/13 population size and age/sex distribution assuming every age/sex group exercises as they would under the Staying Close to the Action Scenario in 2042/43 compared to deaths for a 2012/13 population size and age/sex distribution assuming every age/sex group exercises as they actually did in 2012/13.

The 2012/13 population size and age/sex distribution assumption may be used to provide an apples-to-apples comparison of scenarios that may have quite different 2042/43 assumed populations and or age/sex distributions. However, the 2042/43 population size and age/sex distribution assumption would model the actual overall impact of physical activity for each scenario.

The model was adapted for the Ministry of Transport by the School of Public Health at the University of Otago. It is based on the Integrated Transport and Health Impact Modelling Tool (ITHIM) produced by James Woodcock et al at the Centre for Diet and Activity Research at the University of Cambridge, United Kingdom<sup>1</sup>. The ITHIM has previously been adapted to a number of countries and regions worldwide. More technical details can be found in the report prepared by Keall et al<sup>2</sup>.

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<sup>1</sup> Woodcock J, et al Edwards P, Tonne C, Armstrong BG, Ashiru O, Banister D, et al., "Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport", *Lancet*, 374:1930 – 1943.

<sup>2</sup> Michael Keall, Ed Randal, Jagadish Guria, and Alistair Woodward, "Health outcomes projected from Transportation Modelling for the New Zealand Transport Outlook", August 2016

## 2. Where do I find the model results?

This is a spreadsheet model, with all scenarios capable of being modelled in a single workbook. The scenario for which results are displayed is determined by the scenario number specified in cell Y1 on the “user page” sheet. Refer to Table 1 for the scenario number corresponding to each scenario name. In the case of the ‘What If’ scenario, the user can enter their own assumptions about active transport use in the ‘Visions person’ sheet, cells O59, O64, O67 and O69. The Ministry of Transport has not tested or used the ‘What If’ feature.

**Table 1: Alternative scenarios**

Scenario number	Scenario name
0	Baseline 2013
1	Base Case 2043
2	Scenario A: Staying Close to the Action
3	Scenario B: Metro-Connected
4	Scenario C: Golden Triangle
5	Scenario D: @Home in Town and Country
6	What if

The major health outcomes are displayed in the “Health summary” sheet. This sheet shows two tables. The top table shows the differences in health outcomes assuming the population size and age/sex distribution as in 2012/13. Row 11 shows the difference in number of pre-mature deaths, row 21 the difference in YLLs, row 31 the difference in YLDs, and row 41 the difference in DALYs. Columns AC (for males) and AD (for females) in these rows show total differences in health outcomes resulting from the specific diseases shown to the left. Columns AE (for males) and AF (for females) show differences in health outcomes based on an all-cause mortality methodology. Note that these are two different modelling approaches and their health outcomes are not directly comparable. In the *Transport Outlook: Future State*, we have used the specific diseases methodology, which is generally more conservative.

The bottom table presents the same health outcomes assuming the population size and age/sex distribution in 2042/43 for a specific scenario. Row 55 shows the difference in number of pre-mature deaths, row 65 the difference in YLLs, row 75 the difference in YLDs, and row 85 the difference in DALYs. Columns AC and AD in these rows show total differences in health outcomes resulting from the specific diseases shown to the left. Columns AE and AF show differences in health outcomes based on an all-cause mortality methodology.

In the same sheet, columns AE to AH from row 116 to 118 show the health outcomes associated with collisions of pedestrians and cyclists with motor vehicles assuming the population size and age/sex distribution as in 2012/13. Columns AE to AH from row 120 to 122 show the health outcomes associated with collisions of pedestrians and cyclists with motor vehicles assuming the population size and age/sex distribution in 2042/43 for the specific scenario. The “Travel Summary” sheet (top left table) shows average distance travelled (in km) by mode per capita in a time period for the different scenarios. If the value in cell I2 is 1, the time period will be one day and the distances shown will be distance per day. If the value is 7, they will be distance per week. If the value is 365, they will be distance per year.

### 3. What are the inputs to this model and where do they come from?

A key input are the per capita mean daily travel times and distances for the various travel modes, which are found in the “MoT Travel Input” sheet. For the baseline, these are found in column E, while for the five alternative scenarios, they are found in columns I to M. These figures may be derived from the results of the separately-documented Transport Outlook Household Travel model, with the values in these cells typically linked to values from that model.

Another key input are the national population projections. The 2013 national population estimate may be found in cell E21, while national population projections in 2042/43 for the different scenarios are found in their respective columns of row 21. These figures typically come from the separately-documented population and GDP assumptions file, with values in these cells typically linked to values in that file. We have used Stats NZ’s medium population projection for the Base Case, Staying Close to the Action, and Metro-Connected scenarios, and Stats NZ’s high population projection for the Golden Triangle, and @Home in Town and country scenarios.

We also need a distribution of the population by age and sex as a percentage of the total population for the different scenarios. For 2012/13, these are found in column R, rows 49-64 of the ‘Calibration Data’ sheet. The 2042/43 projections are found in column U in the “Scenario Data” worksheet. Rows 40 to 55 are for the Base Case; rows 107 to 122 for the Staying Close to the Action scenario; rows 174 to 189 for the Metro-Connected scenario, rows 241 to 256 for the Golden Triangle scenario, and rows 308 to 323 for the @Home in Town and Country scenario. We have used data from Stats NZ’s Subnational population projections, by age and sex, 2013(base)-2043.

The ‘user page 2’ sheet shows the per capita mean daily walking and cycling travel times for each age-sex group, as a ratio to that of females aged 15-29. This data comes from the New Zealand Household Travel Survey.

The GBDNZ sheet shows the baseline New Zealand health outcomes (deaths, YLLs, YLDs, and DALYs) for each disease and each age/sex group from the Global Burden of Disease database.<sup>3</sup>

Other data, including parameters relating the burden of each disease to activity levels (in the ‘Phy activity RRs’ sheet) and non-travel-related activity (in the ‘Non travel METS’ sheet), were inherited from the original overseas version of the model and have not been changed.

Operation of the model is controlled from the “user page” sheet. On this sheet there are several options to be selected. First, the shape of the physical activity risk function to be applied is specified in cell R36. The shape of this function determines the relationship between the amount of physical activity and disease risk. The relationship is generally believed to be non-linear, with the greatest relative risk reduction accruing to those moving from sedentary to moderate activity levels. We have generally assumed a “power 0.5” relationship, that is, risk is reduced with the square root of the amount of physical activity.

Second, the travel time/distance data to be used for the baseline is specified in cell R38. If this parameter is set to zero, the model will use New Zealand Household Travel Survey data from the “Calibration Data” sheet. If the parameter is set to one, the model will use data from the “Scenario

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<sup>3</sup> <http://www.healthdata.org/gbd/data>.

Data” sheet as the baseline, which in our case comes from the Transport Outlook Household Travel Model. The two datasets are very similar, but for consistency, we have always set this parameter to one.

Third, the age/sex distribution of the population used to calculate activity levels by age/sex group from the population-wide average and to calculate the 2042/43 health outcomes in the bottom table of the ‘Health summary’ page is specified in cell R39. This option does not affect the age/sex distribution used to calculate the health outcomes from the given activity levels in the top table of the ‘Health summary’ tab, which is always that of the actual 2012/13 population. If this option is set to one, then the projected 2042/43 population age/sex distribution is used. This is the normal setting that we have always used.

If this parameter is set to zero, the actual 2012/13 population age/sex distribution is used calculate activity levels by age/sex group from the population-wide average and to calculate the 2042/43 health outcomes for the given activity levels in the bottom table of the ‘Health summary’ page . Setting this parameter to zero may be used to see what the health outcomes would be if there were no change in the age/sex distribution between 2012/13 and 2042/43—that is, to separate the impact of population growth from the impact of population ageing.

Note that, in the model, activity level by age/sex group is a function of the age/sex distribution. The reason is that the population-wide average activity level is specified for the scenario, and it must be the weighted average of the activity level of each age/sex group. So changing the age/sex distribution of the population without changing the population-wide average activity level usually means that the activity level of some age/sex groups must change. In particular, if young people tend to exercise more, and the population gets older between 2012/13 and 2042/43, then switching from a 2012/13 age/sex distribution to a 2042/43 age/sex distribution requires some, or (in the model) all, age/sex groups to have more activity. For this reason, switching the parameter to zero to use a 2012/13 age/sex distribution will typically *increase* deaths and other adverse health outcomes, as activity levels decrease.

Fourth, the scenario walking and cycling time ratios are specified in cell R40. If the data is entered into the “Scenario Data” sheet and the option is set to one in cell R40, the ratios of walking and cycling times specific to the scenario are used, otherwise the baseline ratios are used. We have always used option one.

Finally, the source of benefit/harm to be modelled can be selected in cell R41. Here the user can choose whether to model the impacts of PM2.5 air pollution or physical activity effects alone or together. If both physical activity and PM2.5 effects are to be modelled double-counting of effects can occur. Instructions on how to adjust for this can be found in rows 113-117 of the “Health Summary” sheet.

We have always use option two, which models the impact of physical activity alone. The baseline PM2.5 data currently in the ‘air pollution’ sheet is for California, and we have not attempted to use the model to analyse the impact of PM2.5 pollution.

#### **4. How does this model derive its results?**

The calculations used in the model are quite complex and are documented in the two papers referenced in Section 1. We, therefore, do not attempt to duplicate the explanation here.

A brief overview of the structure of the model is that the assumed ratios of walking and cycling times for each age/sex group to that of women aged 15-29 is shown on the 'user 2' sheet, along with overall population average walking and cycling times for the scenario, are used to infer walking and cycling times for the scenario by age/sex group in the 'Scenarios' sheet. The 'Scenarios' sheet also uses an assumed distribution of walking and cycling times within each age/sex group to calculate to calculate walking and cycling times for five equal-size percentiles of activity levels (centered on the 10%, 30%, 50%, 70% and 90% points on the distribution) within each age/sex group. The 'Baseline' sheet does the same calculations for the Baseline.

The sheets for each disease then use this data on walking and cycling times by percentile within each age and sex group, along with data on the baseline health outcomes for each age/sex group and assumed relationships between activity and disease risk to calculate health outcomes for each percentile within each age/sex group for the scenario and the baseline, as well as the difference between them.

These differences are then summarised in the top table of the 'Health summary' sheet, showing scenario health outcomes for each age/sex group in the baseline population. In the bottom table of the 'Health summary' sheet, the outcomes for each age/sex group are multiplied by the growth of the population in that age/sex group between the baseline and 2042/43. This gives the health outcomes for the assumed 2042/43 population.