Online Report: Technical Background to the Cardiovascular Disease Model used in the BODE^3 Programme

Nhung Nghiem, Nick Wilson, Tony Blakely

BODE^3 Programme, University of Otago, Wellington, New Zealand

Originally March 2014, Updated February 2015

Contents

List of figures

List of Tables

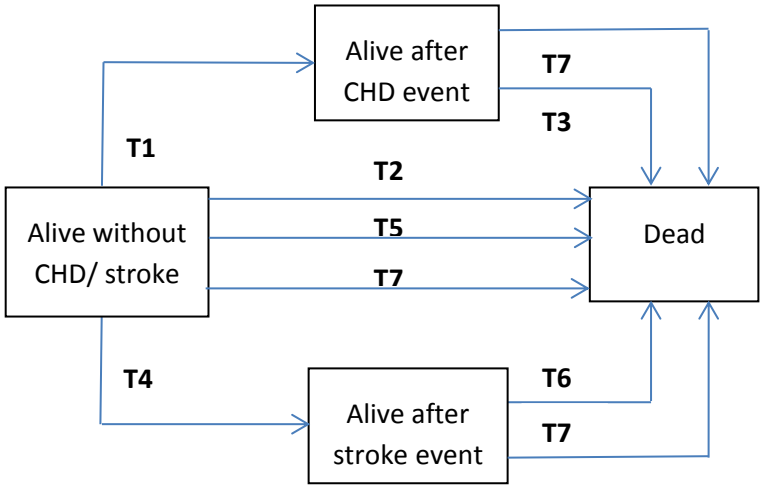
Introduction

This Main Technical Appendix related to the cardiovascular disease (CVD) Markov model built in TreeAge for the BODE^3 Programme (with a particular focus on salt/sodium reduction interventions). It covers key technical information around the model structure and around the parameters used in the model. For details on the model validation, please see a separate "Validation Appendix".

Model structure for the CVD model

The CVD model structure below is that of a macrosimulation Markov model. It includes four health states and seven transition probabilities among the health states. Note that the non-CVD mortality rate is the same for any health state, whether an individual has ever had any CVD event or not.

Figure S1 Structure of the Markov model for the CVD model built in TreeAge (simplified and not showing the different forms of stroke – see Cobiac et al (Cobiac et al. 2012))



Transitions:
T1: Incident CHD, non-fatal in 1st year
T2: Incident CHD, fatal in 1st year
T3: CHD case fatality in CHD survivors
T4: Incident stroke, non-fatal in 1st year
T5: Incident stroke, fatal in 1st year
T6: Stroke case fatality in stroke survivors
T7: Non-CHD and non-stroke mortality

Table S1 Details around the transition probabilities in the CVD Markov model: mathematical formula and descriptions

Transition probability	Formulae used in the TreeAge model	Mathematical formula and additional descriptions
T1: Incident CHD, non-fatal in 1st year	**Formula for Partial Null:** paCHD= (IncUCHD*RRCHDvin-5/12*CFR[age+iDat;7]*IncUCHD*RRCHDvin*If (trendIdx<10;exp(-CfrCHDtr *(trendIdx+5));exp(-CfrCHDtr*1515)))*If (trendIdx<10;exp(-IncCHDtr*(trendIdx+5));exp(-IncCHDtr*15)) **Formula for Intervention:** paCHDt=paCHD*(RRCHD_T*RRCHDsalt)	**Partial Null:** $T1 = \left(Inc28_{a,s,e} - \frac{5}{12} \times CFRpost28_{a,s,e} \times Inc28_{a,s,e}\right) \times CFRTrend \times IncTrend$ *Inc28*: 28 days survivor incident rate (see the formula below). *CFRpost28*: case fatality rate for people who survive at least 28 days after the first-ever CHD event (see the definition in Table S3). *CFR/IncTrend*: time trend for case fatality rate (CFR)/incident rate. *a*: age; *s*: sex; *e*: ethnicity. These subscripts applied for all key epidemiological parameters, eg, mortality rates. The value of 5/12 was used in the *CFRpost28* formula since we used a half-cycle correction for the model (so it was 6/12 months) and took into account 28 days for *CFRpre28*, which was 1/12 months. **Intervention:** $T1 = \left(Inc28_{a,s,e} - \frac{5}{12} \times CFRpost28_{a,s,e} \times Inc28_{a,s,e}\right) \times CFRTrend \times IncTrend \times RRCHD'_{sodium}$

Transition probability	Formulae used in the TreeAge model	Mathematical formula and additional descriptions
		$RRCHD'_{sodium}$: new relative risk for CHD after an intervention (see formula below) as a result of decreasing dietary sodium intake.
T2: Incident CHD, fatal in 1st year	**Partial Null:** pdCHD= (CFR[age+iDat;6]*If (trendIdx<10;exp(-CfrCHDtr *(trendIdx+5));exp(-CfrCHDtr*15))/(1-CFR[age+iDat;6]*If (trendIdx<10;exp(-CfrCHDtr *(trendIdx+5));exp(-CfrCHDtr*15)))+5/12*CFR[age+iDat;7]*If (trendIdx<10;exp(-CfrCHDtr *(trendIdx+5));exp(-CfrCHDtr*15)))*IncUCHD*RRCHDvin*If (trendIdx<10;exp(-IncCHDtr*(trendIdx+5));exp(-IncCHDtr*15)) **Intervention:** pdCHDt= pdCHD*RRCHD_T*RRCHDsalt	**Partial Null:** $T2 = \left(\frac{CFRpre28 \times Trend}{1 - CFRpre28 \times Trend} + \frac{5}{12} CFRpost28 \times Trend\right) \times (Inc28 \times Trend)$ *CFRpre28*: case fatality rate for people who died within 28 days after the first ever CHD event (see the definition in Table S3). *Trend*: a time trend for that variable. **Intervention:** See formula for *T1* intervention as above.
T3: CHD case fatality in CHD survivors	**Partial Null & Intervention:** pdpCHD= CFR[age+iDat;7]*If (trendIdx<10;exp(-CfrCHDtr *(trendIdx+5));exp(-CfrCHDtr*15))	$T3 = CFRpost28 \times Trend$

Transition probability	Formulae used in the TreeAge model	Mathematical formula and additional descriptions
T4: Incident stroke, non-fatal in 1st year	**Partial Null:** IS: paS= ((IncUIS*RRSTRvin)-5/12*CFR[age+iDat;4]*(IncUIS*RRSTRvin)*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))*If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15)) HS: paHS= ((IncUHS*RRSTRvin)-5/12*CFR[age+iDat;8]*(IncUHS*RRSTRvin)*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))*If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15)) **Intervention:** IS: paSt= ((IncUIS*RRSTRvin*(RRIS_T*RRSsalt))-5/12*CFR[age+iDat;4]*(IncUIS*RRSTRvin*(RRIS_T*RRSsalt))* If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))* If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15)) HS: paHSt= ((IncUHS*RRSTRvin*(RRHS_T*RRSsalt))-5/12*CFR[age+iDat;8]*(IncUHS*RRSTRvin*(RRHS_T*RRSsalt))* If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))* If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15))	See formula for *T1* (albeit adapted for stroke). We built the model to consider multiple forms of stroke (ischaemic, haemorrhagic) but given limitations with costing data we gave both types of stroke the same costs.

Transition probability	Formulae used in the TreeAge model	Mathematical formula and additional descriptions
T5: Incident stroke, fatal in 1st year	**Partial Null:** IS: pdIS= (CFR[age+iDat;5]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15))/(1-CFR[age+iDat;5]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))+5/12*CFR[age+iDat;4]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))*IncUIS*RRSTRvin*If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15)) HS: pdHS= (CFR[age+iDat;3]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15))/(1-CFR[age+iDat;3]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))+5/12*CFR[age+iDat;8]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)))*IncUHS*RRSTRvin*If (trendIdx<10;exp(-IncSTRtr *(trendIdx+5));exp(-IncSTRtr*15)) **Intervention:** IS: pdISt= pdIS*RRIS_T*RRSsalt HS: pdHSt= pdHS*RRHS_T*RRSsalt	See formula for *T2* (albeit adapted for stroke).
T6: Stroke case fatality in stroke survivors	**Partial Null & Intervention:** IS: pdpIS= CFR[age+iDat;4]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15)) HS: pdpHS= CFR[age+iDat;8]*If (trendIdx<10;exp(-CfrSTRtr *(trendIdx+5));exp(-CfrSTRtr*15))	See formula for *T3* (albeit adapted for stroke).

Transition probability	Formulae used in the TreeAge model	Mathematical formula and additional descriptions
T7: Non-CHD and non-stroke mortality	**Partial Null & Intervention:** pdO= CFR[if(IDinequality+iDateth=1;age+iDat+600;age+iDat);2]* If (trendIdx<10;exp(-mortNonCVDtr *(trendIdx+5));exp(-mortNonCVDtr*15))	Direct input into the model: non-CVD background mortality rate by age, sex & ethnicity. (The formula in TreeAge took into account scenario analysis).
IncUCHD: Inc28	(IncCHD[age+iDat;1]/(1-IncCHD[age+iDat;2]+IncCHD[age+iDat;2]*exp(RRCHDstr_G)))*IncCHD[age+iDat;3]	Direct input into the model: incident rate by age, sex & ethnicity for people who survived at least 28 days after the first CVD event. (The formula in TreeAge was built based on the original ACE-Prevention (Australia) CVD model in an Excel spreadsheet but two variables in columns 2&3 of the "IncCHD" table were no longer used).
CfrCHDtr/CfrSTRtr	2%	Time trend in case fatality rate for CHD and all forms of stroke (see elsewhere for our justification of this future time trend)
IncSTRtr/IncCHDtr	2%	Time trend in incident rate for CHD and all forms of stroke (see elsewhere for our justification of this future time trend)
RRCHDvin	1	Relative risk CHD for different age groups: a reserved variable for future CVD modelling.
RRCHD_T	1	A reserved relative risk variable for future CVD modelling
$RRCHD'_{sodium}$ (RRCHDsalt/ RRSsalt)	dBP*effCHDsU_var*100+1	New relative risk for CHD after an intervention as a result of decreasing dietary sodium intake (with a pre-intervention relative risk equal to 1.0): $RRCHD'_{sodium} = \Delta BP \times EffectSize + 1$

Transition probability	**Formulae used in the TreeAge model**	**Mathematical formula and additional descriptions**
		ΔBP*:* absolute change in systolic blood pressure after an intervention (see formula below). *Effect size:* percentage change in CHD incident rate with a one mmHg change in systolic blood pressure.
dBP	(SBPm[age+iDat;1+iCounselling]*(dNAm/100)/	Absolute change in systolic blood pressure after an intervention regarding changing dietary sodium intake: $$\Delta BP = \Delta BP_{\mu} \times \frac{\Delta Na}{100}$$ $\Delta \mathrm{BP}_{\mu}$: the absolute change in SBP (mmHg) by age group for each 100mmol/24h change in dietary sodium intake. ΔNa: the absolute reduction in dietary sodium intake (mmol/24hours) by sex.

A fragment of the overall TreeAge (TA) model structure is shown below (Figure S2). The model structure has four levels: the health intervention, ethnicity, gender and age group. For the same levels of the model, there are no structural differences, but there are differences in parameters. For example, for the salt modelling work, the Endorsement label programme (Tick Programme) intervention differs from Mandatory interventions in terms of the level of sodium reduction in an individual after the interventions. The difference between ethnicity is mostly in the key epidemiology parameters, such as CVD specific mortality rates. This is similar for males and females, and for different age groups. The model includes five intervention arms, two ethnicities, two sexes, and 13 age groups.

The core structure of the Markov model for this CVD model in TreeAge is built for age group 37, see the next figure (Figure S3). This includes health state nodes and transition probabilities for age group 37 (this structure is the same for all age group, sex, ethnicity, and intervention). In particular, there are one healthy node that all people without CVD conditions enter at the start of the model, three CVD prevalent nodes that all CVD prevalent cases enter at the start of the model, and three CVD incident nodes and five dead nodes that have zero population at the start of the model. People at the healthy node can only: 1) stay there, 2) get a CVD event, 3) die from a CVD event, or 4) die from other causes. People at the CVD incident nodes can only: 1) transition to the same CVD prevalent node, 2) die from CVD, or 3) die from other causes. People at the CVD prevalent node can only: 1) stay there, 2) die from CVD, or 3) die from other causes. Transition probabilities are noted at each Markov branch for all health state nodes.

Figure S2 An illustrative section of TreeAge model structure for the CVD model

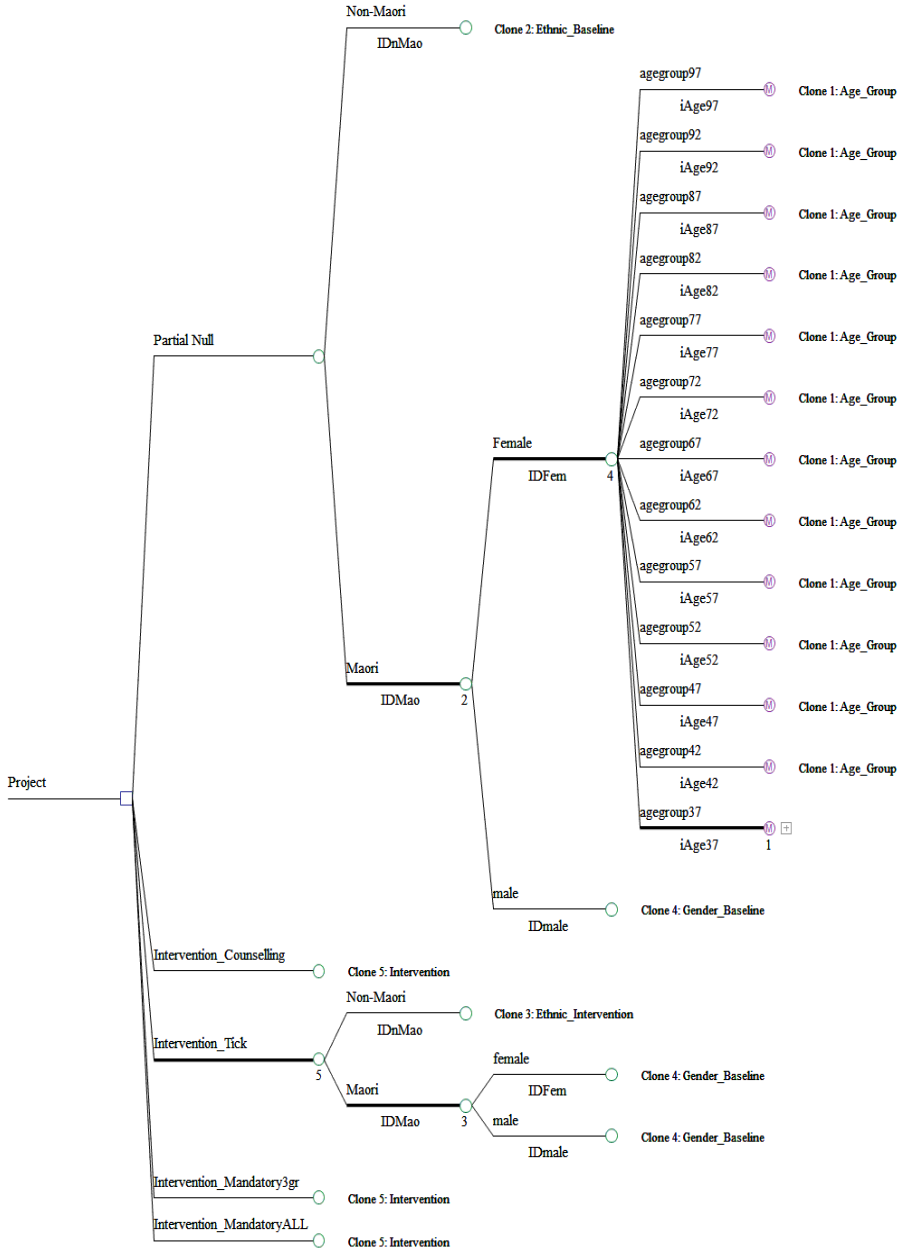
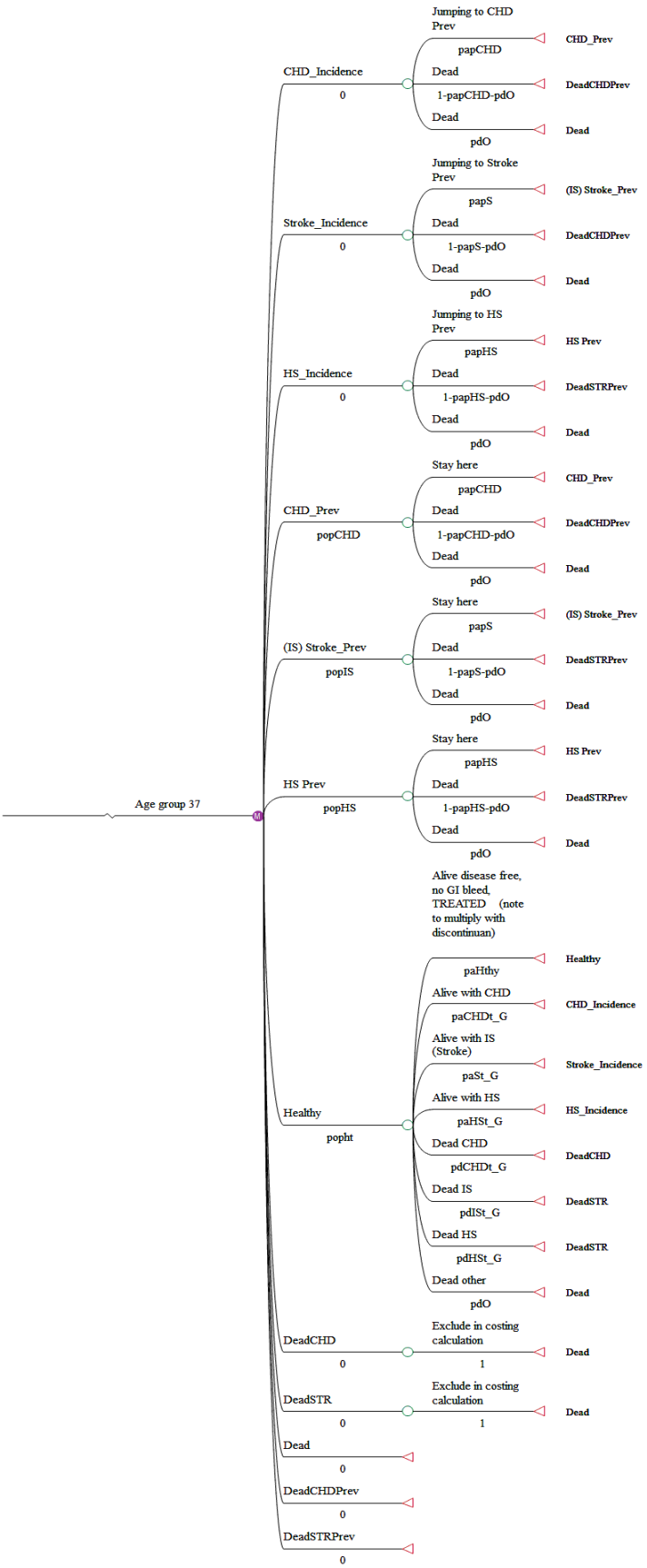


Figure S3 An Illustrative Section of the Markov model of the CVD model in TreeAge



Disease definitions and ICD10 codes used

How the disease states are defined, then operationalised in searching New Zealand data, is fundamental to how disease incidence, prevalence, mortality and case fatality estimates are determined. Here we review the ICD codes, and various algorithms for extracting 'cases' from New Zealand data-sets (e.g. HealthTracker).

Table S2: ICD-10 codes for stroke used in the modelling

Classification used	Comments
Haemorrhagic stroke	
I60 Subarachnoid haemorrhage	These were the same ICD-10 codes as used in the NZBDS. However, the NZBDS used ARCOS study data – which produced fairly similar results (see the Validation Appendix).
I61 Intracerebral haemorrhage	
I62 Other nontraumatic intracranial haemorrhage	
Ischaemic stroke	
G45 Transient cerebral ischaemic attacks and related syndromes	As above.
G46* Vascular syndromes of brain in cerebrovascular diseases (I60-I67+)	
I63 Cerebral infarction	
I65 Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction	
I66 Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction	
Other types of stroke	
I64 Stroke, not specified as haemorrhage or infarction	We divided strokes with this coding between ischaemic and haemorrhagic as per all results for the distribution for all the other codes for strokes listed above.
I67 Other cerebrovascular diseases - only considered: I67.9 Cerebrovascular disease, unspecified.	As per the split for "I64" above.
I68* Cerebrovascular disorders in diseases classified elsewhere	Not included in this study.
I69 Sequelae of cerebrovascular disease	Not included in this study.

Coronary heart disease ICD-10 codes: I20-I25

As per the NZ Burden of Disease Study [Ministry of Health 2012]:
I20 Angina pectoris
I21 Acute myocardial infarction
I22 Subsequent myocardial infarction
I23 Certain current complications following acute myocardial infarction
I24 Other acute ischaemic heart diseases
I25 Chronic ischaemic heart disease

Pharmaceuticals for ischaemic heart disease (CHD)

Cases of CHD were also identified from the dispensing of pharmaceuticals where these were specific for angina. That is, two or more dispensings of any of the following drugs in the most recent 12 month period:

- Glyceryl trinitrate (drug code used in the NZBDS = 1577)
- Isosorbide dinitrate (2377)
- Isosorbide mononitrate (2836)
- Nicorandil (1272)
- Perhexiline maleate (1949)

No additional inclusion of heart failure (HF) cases: A proportion of heart failure cases are attributed to CHD in the NZBDS study (48%), along with 1% attributed to hypertensive heart disease (the rest is due to valvular heart disease, cardiomyopathies etc). Nevertheless, expert consultation (Dr Wing Cheuk Chan, Auckland DHB, 30/7/13) suggested that the above list of CHD codes would capture nearly all cases of heart failure attributable to CHD. That is, no deaths in NZ are coded to heart failure and any hospitalisation due to heart failure, should also include CHD codes (if the heart failure is related to CHD). Community-based cases of mild heart failure that have had no past CHD hospitalisations (eg, the HF arises from a previous silent MI) may be missed, but often such people may have investigations for their HF symptoms in outpatients eg, echocardiograms. Such investigations may often result in a CHD related coding that would be picked up by HealthTracker. Given this information we did not add additional cases of heart failure to our definition of CHD.

Stroke (ICD-10 codes): G45-46; I60-69

As per the NZBDS [Ministry of Health 2012]:

G45 Transient cerebral ischaemic attacks and related syndromes
G46* Vascular syndromes of brain in cerebrovascular diseases (I60-I67+)
I60 Subarachnoid haemorrhage
I61 Intracerebral haemorrhage
I62 Other nontraumatic intracranial haemorrhage
I63 Cerebral infarction
I64 Stroke, not specified as haemorrhage or infarction
I65 Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction
I66 Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction
I67 Other cerebrovascular diseases
I68* Cerebrovascular disorders in diseases classified elsewhere
I69 Sequelae of cerebrovascular disease

Key epidemiological parameter inputs

This section describes how key epidemiological parameters inputs in the CVD model were generated and calculated from HealthTracker and other data sources (eg, Statistics New Zealand). All the epidemiological input rates used in the CVD modelling were smoothed using Poisson regression in SAS 9.3. All the negative rates, if any, were dealt with in SAS.

Table S3 Definition of key epidemiological parameters used in the CVD model and how they were generated from HealthTracker data

Key epidemiological parameters	Definitions
Input variables (that were actually put into TreeAge)	
Incident rate for people who survive at least 28 days after their first-ever CVD event.	We used the HealthTracker database from 2001 to 2010 to extract incident cases, prevalent cases, and death counts in order to calculate epidemiological data inputs. We used a look-back period of 5 years (2001-2006) to identify a "first-ever CVD event" (eg, a non-fatal heart attack, stroke, or being started on CVD medicines after a diagnosis of CVD). An incident case in a particular year, say 2007, was identified if the person had a CVD event in that year and hadn't had any CVD event between 2001 and 2006. Only incident cases in 2010 were used to calculate incident rates to put into TreeAge. Incident 28 days survivors refer to people who had a first-ever CVD event and survived for at least 28 days after that event. The incidence rate for people who survive at least 28 days after their first-ever CVD event was calculated by dividing the number of 28 days survivor incident cases by the total healthy population (by age, sex & ethnicity).

Key epidemiological parameters	Definitions
Case fatality rate (CFR) pre-28 days	Case fatality rates pre-28 days were calculated by dividing all CVD deaths from people who had a first-ever CVD event and died in under 28 days after that event, by total CVD incident cases.
Case fatality rate post-28 days	Case fatality rates post-28 days were calculated by dividing the difference between deaths observed from 28-day-incident-survivors and deaths expected (from the non-CVD background mortality rate – see below), by person-years lived among those with a past CVD event. Of note is that we suspect that due to the constraints on the look-back period with HT data (leading to an under-estimate in the number of CVD prevalent cases), the estimated CFR will tend to be over-estimated by our methods. However, this is something that can potentially be addressed (eg, via DisModII outputs).
Non-CVD background mortality rate	Non-CVD mortality rates were calculated by dividing the total deaths (excluding CVD deaths) by the total New Zealand population in 2010. The death counts were estimated from HealthTracker, and the New Zealand population data were adopted from Statistics New Zealand.
Prevalent cases (CVD)	Prevalent cases were defined as all people with a reported CVD event from 2001 to 2010 (but incident cases arising in each year were excluded from prevalent counts for that year, but included in subsequent years). We recognise that this will be an underestimate for two reasons: (i) Individuals could have had a CVD much earlier (even decades) and still be alive; (ii) Some individuals will have had CVD events eg, a “silent myocardial infarction” that have never been diagnosed. We consider this issue further when using DisModII outputs. We considered prevalent cases for coronary heart disease (CHD) and the different forms of stroke.
Other related input variables (that were not put into TreeAge)	
Person-years	Person-time (person-years) was calculated by summing up all the days that people lived from the date that they were diagnosed with various CVD conditions until they died or until the end of the period. The starting date was 1 January 2007, and the ending date was 31 December 2010. So a person could have a maximum of four years of “person-time”. The reason we used the period of 2007-2010 to calculate CFR was that the TreeAge model involves a one year step and we applied the same CFR for all the 28 day survivors until they died. It would be ideal to use a longer period but we only had cost data from 2007 and mortality data up to 2010.
Deaths observed	Deaths observed from 28-day-incident-survivors were for all causes of death, based on death certificates for the period of 2007-2010.
Deaths expected	Deaths expected were all causes background mortality rate multiplying with CVD person-years for the period of 2007-2010.

Table S4: Summary of input parameters to the modelling, selected base case parameters (subsequent tables contain further details)

Variable	Data source	Comment and best estimate	Variation/ uncertainty range
Disease incidence rates			
Ischaemic heart disease (CHD)	HealthTracker	By age, sex and ethnicity.	SD=5%, lognormal distribution
Ischaemic stroke (IS)	HealthTracker	By age, sex and ethnicity.	
Haemorrhagic stroke (HS)	HealthTracker	By age, sex and ethnicity.	
Other strokes (OS)	HealthTracker	By age, sex and ethnicity.	
Disease prevalence rates			
CHD/IS/HS/OS	HealthTracker and modified by DisMod II analysis	By age, sex and ethnicity.	Nil
Mortality rates			
Background mortality counts (for checking purposes)	HealthTracker	By age, sex and ethnicity.	Nil
Population	See BODE[3] protocol	By age, sex and ethnicity.	Nil
Background mortality rates	HealthTracker & Statistic New Zealand	By age, sex and ethnicity.	Nil
CVD (CHD/IS/HS/OS) mortality counts	HealthTracker	By age, sex and ethnicity.	Nil
Disease case fatality rates			
CHD	HealthTracker and modified by DisMod II analysis	By age, sex and ethnicity.	Nil
IS		By age, sex and ethnicity.	Nil
HS		By age, sex and ethnicity.	Nil
OS		By age, sex and ethnicity.	Nil
Disability weights			
CHD	NZBDS 2006/GBD 2010	By age, sex and ethnicity.	Beta distribution
Stroke (post six weeks)	As above	By age, sex and ethnicity.	Beta distribution
Stroke (acute events)	As above	By age, sex and ethnicity.	Beta distribution
Prevalent years lived with disability NZ population	As above	By age, sex and ethnicity.	Nil
Health system costs			
Population/citizen health system costs (per person year)	HealthTracker	By age and sex.	SD=10%, gamma for all

Variable	Data source	Comment and best estimate	Variation/ uncertainty range
Disease specific costs (per person per year)	HealthTracker	By age and sex for the first year and subsequent years of disease.	As above

Incidence data for CVD (CHD/IS/HS/OS)

First-ever incidence 2010 - Counts

Figure S4: First-ever CHD & stroke incidence counts by age-group, sex & ethnicity in 2010 (the latest year for available data) (where CHD=1, ischaemic stroke (IS)=2, haemorrhagic stroke (HS)=3, & other stroke (OS)=4)

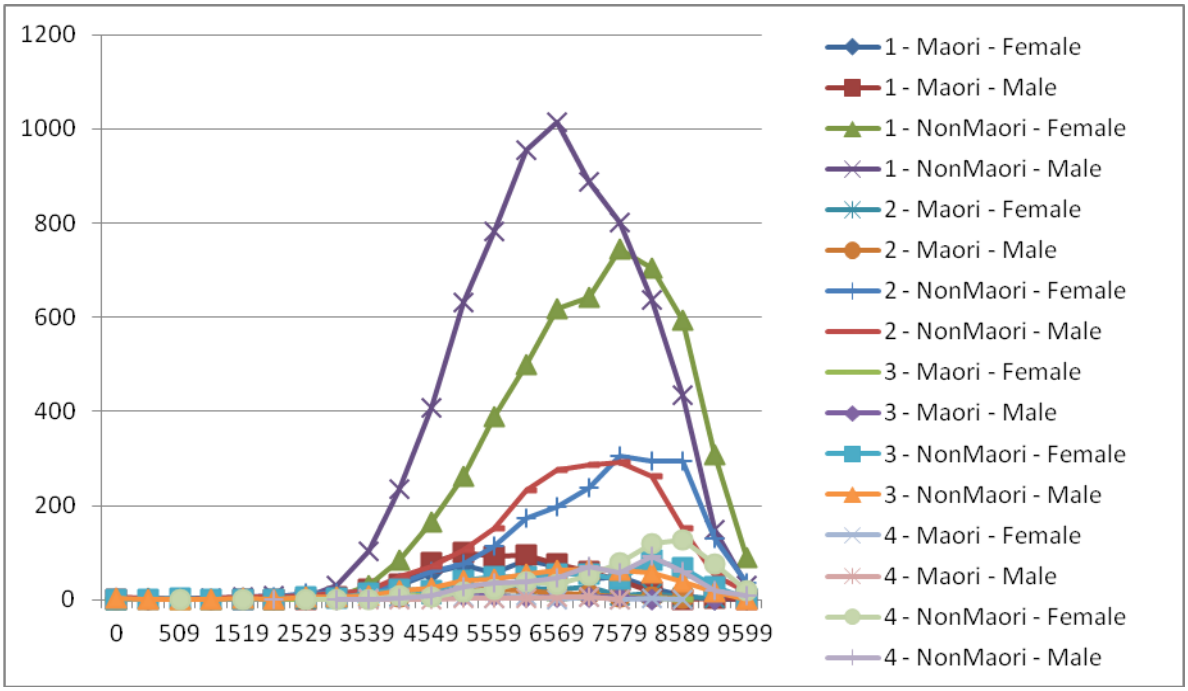


Figure S5: First-ever ischaemic stroke incidence counts in 2010

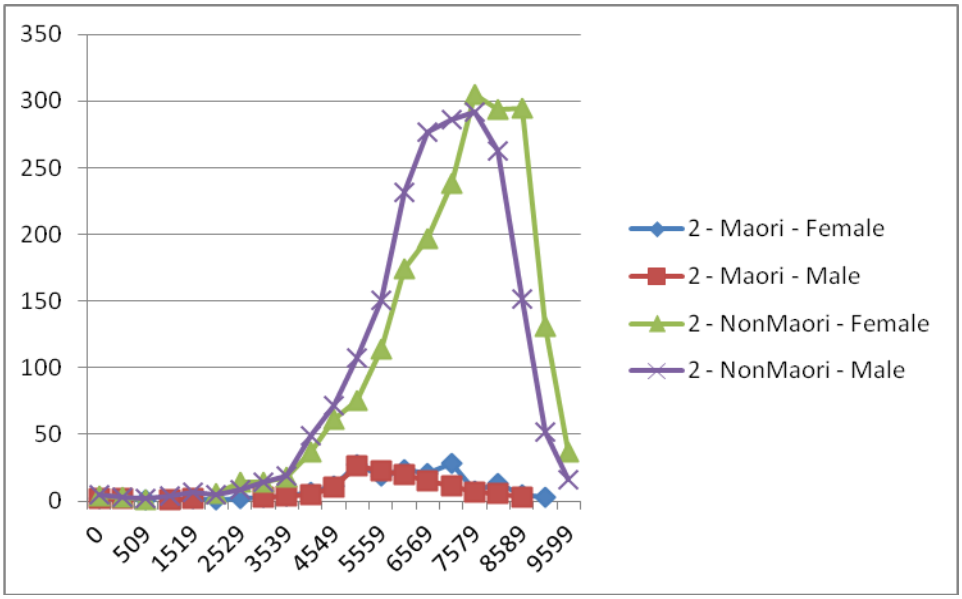


Figure S6: First-ever haemorrhagic stroke & "other stroke" incidence counts in 2010

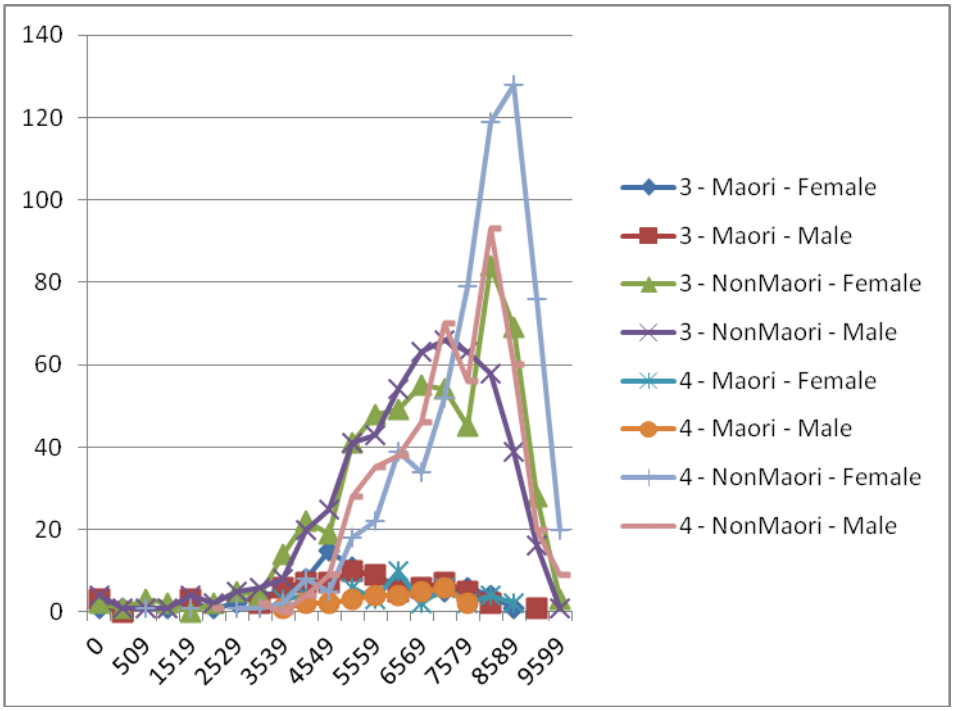


Table S5: First-ever CVD incidence counts by age-group, sex & ethnicity in 2010

Age group	CHD				IS				HS				OS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	9	22	29	103	4	4	18	19	5	6	14	8	3	1	2	0
40-44	30	34	83	234	7	5	37	49	8	7	22	20	4	2	8	4
45-49	58	79	165	408	11	10	61	72	15	7	19	25		2	5	9
50-54	74	101	262	632	27	26	75	107	11	10	41	41	6	3	18	28
55-59	58	91	389	783	19	23	114	151	8	9	48	43	3	4	22	35
60-64	85	95	499	954	24	20	174	232	7	5	49	54	10	4	39	38
65-69	70	75	619	1014	21	15	197	277	4	6	55	63	2	5	34	46
70-74	45	60	642	887	28	11	238	286	5	7	54	66	6	6	52	70
75-79	48	41	746	802	8	7	305	292	6	5	45	63	2	2	79	56
80-84	26	16	705	638	13	6	294	263	4	2	84	58	4		119	93
85-89	9	2	595	434	5	3	295	152	1		69	39	2		128	60
90-94	2	3	307	150	3		131	52		1	28	16			76	20
95+	1	1	89	30			37	16			3	1			20	9
Total	**527**	**632**	**5152**	**7130**	**181**	**140**	**2018**	**2017**	**86**	**73**	**550**	**521**	**42**	**29**	**606**	**471**

28 day survivor first-ever incidence counts, 2010

Showing all new cases who survived the first 28 days after various CVD events (CHD=1, IS=2, HS=3, & OS=4).

Figure S7: 28 day first-ever CVD survivor counts by age group, sex & ethnicity in 2010

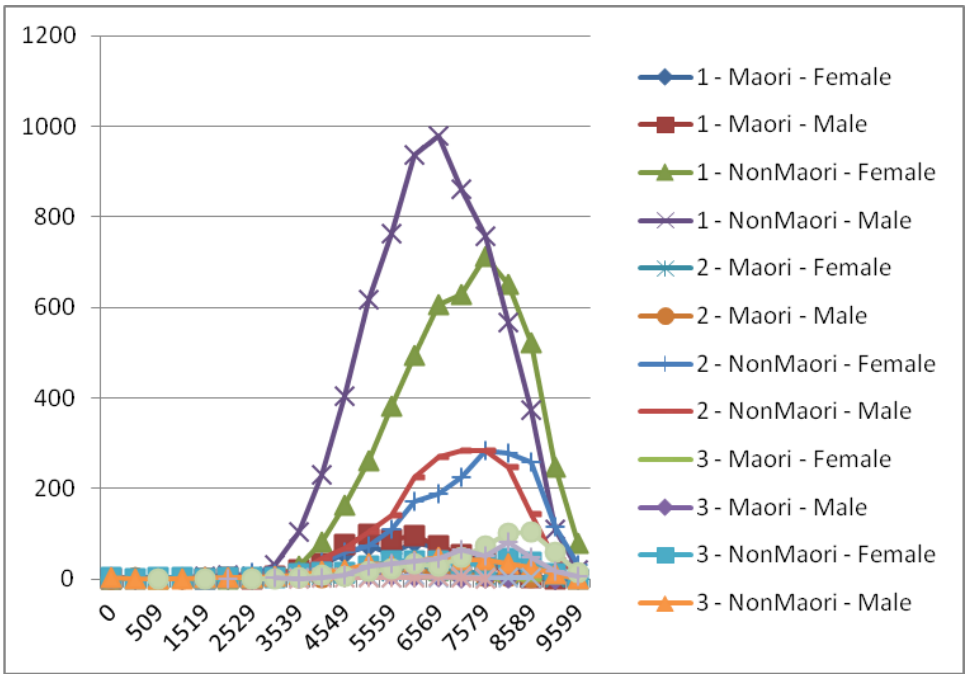


Figure S8: 28 day first-ever ischaemic stroke survivor counts in 2010

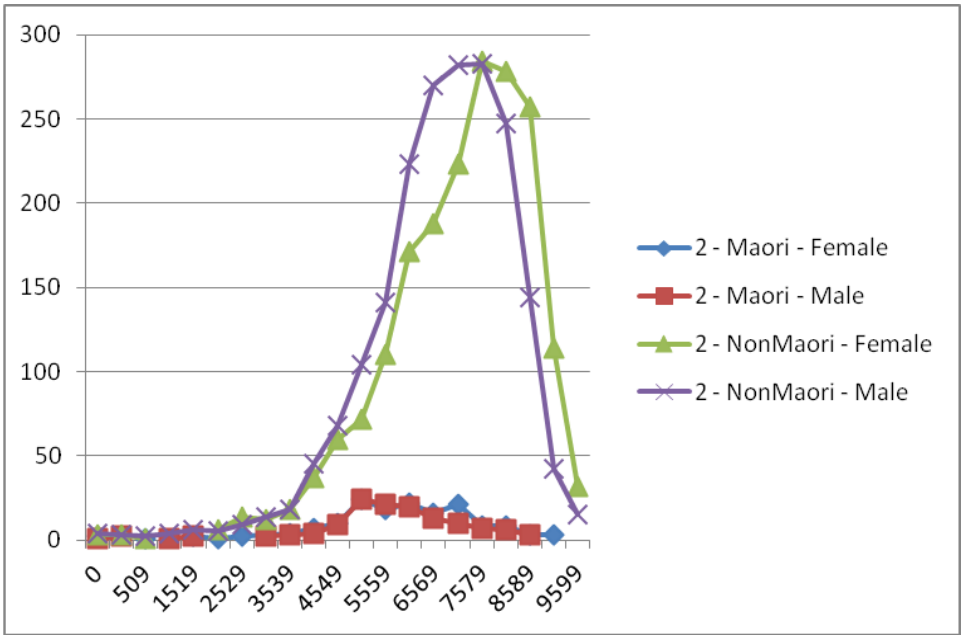


Figure S9: 28 day First-ever haemorrhagic and other stroke survivor counts in 2010

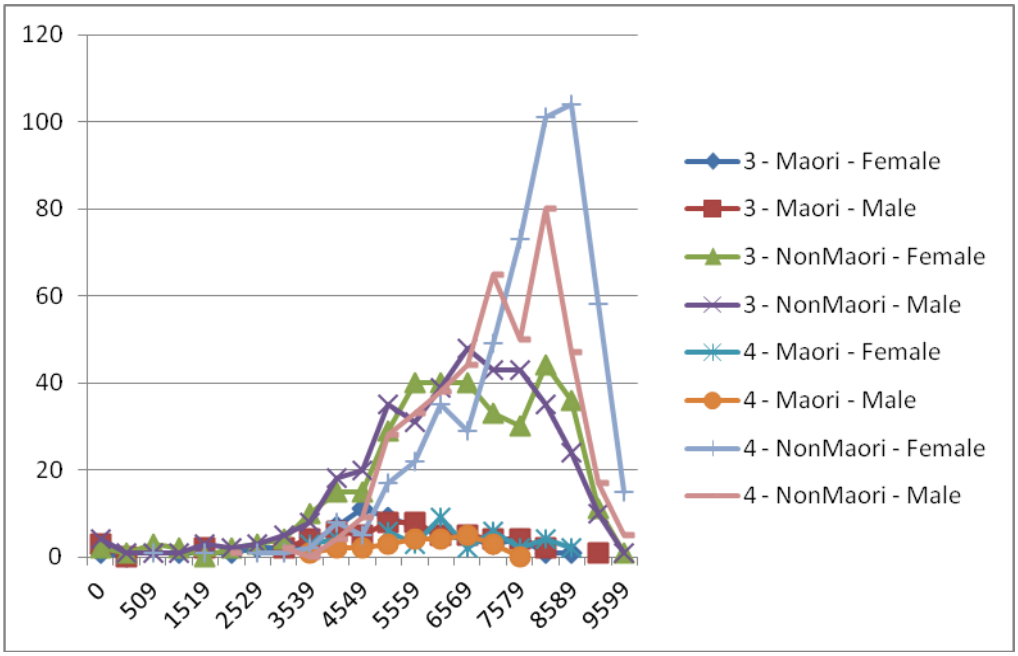


Table S6: 28 day first-ever CVD survivor counts by age group, sex & ethnicity in 2010

Age group	CHD				IS				HS				OS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	9	21	29	103	4	3	18	18	3	4	10	8	3	1	2	0
40-44	30	33	81	230	7	4	37	45	7	6	15	18	4	2	8	4
45-49	55	76	163	405	10	9	60	68	11	5	15	20		2	5	9
50-54	72	97	262	618	24	24	72	104	9	8	29	35	6	3	17	28
55-59	57	88	382	764	18	21	110	141	7	8	40	31	3	4	22	33
60-64	80	94	493	938	22	20	171	223	5	5	40	39	9	4	35	38
65-69	67	72	605	979	16	13	188	270	4	5	40	48	2	5	29	44
70-74	39	52	628	860	21	10	223	282	3	4	33	43	6	3	49	65
75-79	39	39	711	756	8	7	284	283	4	4	30	43	2	0	73	50
80-84	23	13	652	566	8	6	278	247	1	2	44	35	4		101	80
85-89	6	2	522	372	3	3	257	144	1		36	24	2		104	47
90-94	1	1	248	110	3		114	42		1	11	10			58	17
95+	1		78	19			32	15			1	1			15	5
Total	**491**	**600**	**4876**	**6781**	**155**	**128**	**1883**	**1929**	**63**	**59**	**361**	**375**	**41**	**24**	**522**	**423**

Table S7: Probabilities of becoming a 28 day First-ever CVD survivor (Australian population in 2003, adjusted to no-intervention baseline and for those free of previous CHD and Stroke for comparison purposes)

Age	Incidence CHD survivors first event		Incidence all stroke survivors first event		Incidence IS survivors first event		Incidence HS survivors first event	
	M	F	M	F	M	F	M	F
35	0.00094	0.00026	0.00030	0.00021	0.00022	0.00016	0.00004	0.00003
40	0.00211	0.00058	0.00031	0.00021	0.00023	0.00016	0.00005	0.00003
45	0.00343	0.00107	0.00081	0.00073	0.00059	0.00055	0.00012	0.00010
50	0.00653	0.00159	0.00086	0.00076	0.00063	0.00057	0.00013	0.00010
55	0.00837	0.00306	0.00142	0.00077	0.00121	0.00067	0.00020	0.00007
60	0.01292	0.00434	0.00149	0.00081	0.00128	0.00070	0.00021	0.00007
65	0.01512	0.00631	0.00351	0.00229	0.00300	0.00199	0.00050	0.00020
70	0.01701	0.00817	0.00342	0.00229	0.00293	0.00199	0.00049	0.00020
75	0.01595	0.00959	0.00841	0.00628	0.00736	0.00562	0.00105	0.00053
80	0.01998	0.00997	0.00766	0.00608	0.00671	0.00544	0.00095	0.00051
85	0.02058	0.01054	0.01769	0.01868	0.01549	0.01672	0.00220	0.00157
90	0.02174	0.01112	0.01769	0.01868	0.01549	0.01672	0.00220	0.00157
95	0.02328	0.01171	0.01769	0.01868	0.01549	0.01672	0.00220	0.00157
100	0.02384	0.01211	0.01769	0.01868	0.01549	0.01672	0.00220	0.00157

Deaths observed amongst cases who survived 28 days after a first-ever CVD event (2007-2010)

The figure below shows the number of deaths observed from HealthTracker among people who got an incident event between 2007 and 2010 and survived at least 28 days after that event. Where: CHD=1, IS=2, HS=3 & OS=4

Figure S10: Death counts among 28 day first-ever CVD incidence survivors 2007-2010

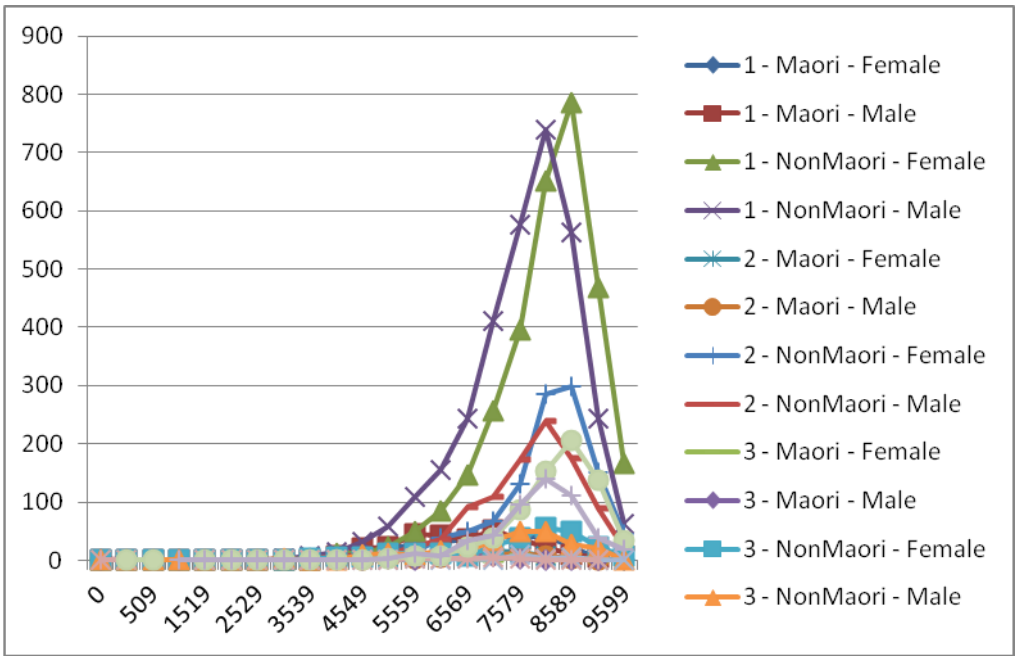


Figure S11: Death counts among 28 day First-ever IS incidence survivors 2007-2010

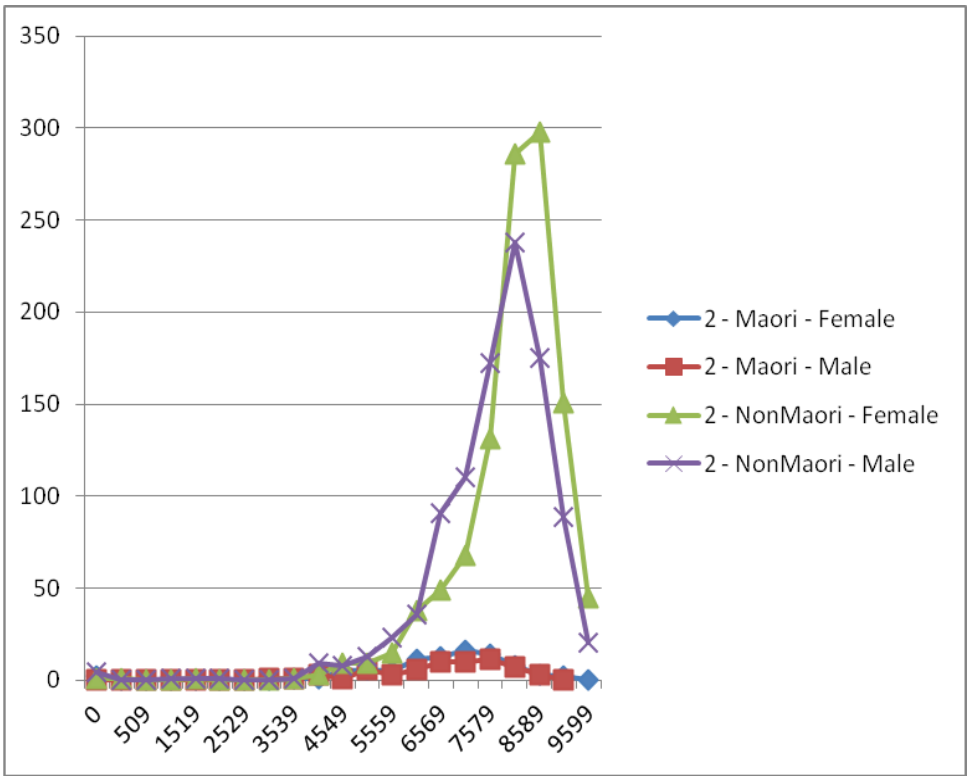


Figure S12: Death counts amongst those cases of HS and OS who survived the first 28 days (2007-2010)

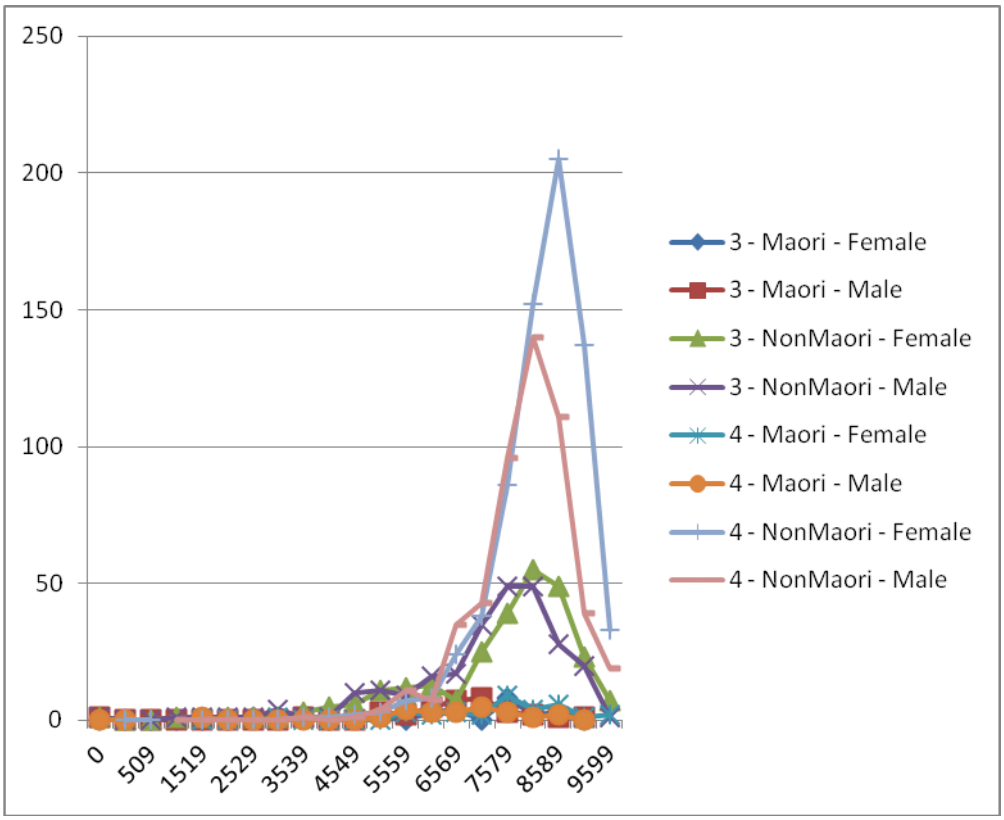


Table S8: Death counts amongst those who survived the first 28 days for various forms of CVD (2007-2010)

Age group	CHD				IS				HS				OS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	3	1	2	8	1	1	1	1	1	1	3	1	0	0	1	1
40-44	6	7	11	14	1	3	3	9	0	0	5	1	0	0	1	0
45-49	8	20	11	31	5	1	9	8	1	0	6	10	0	0	2	1
50-54	23	22	24	59	6	6	9	13	1	3	11	11	0	1	3	4
55-59	25	44	50	110	5	3	15	23	0	2	12	9	3	4	7	11
60-64	32	42	85	156	11	6	38	36	3	5	13	16	2	3	8	7
65-69	37	36	146	243	13	10	49	91	4	7	7	17	3	3	24	35
70-74	42	52	257	411	16	10	68	110	0	8	25	35	2	5	38	43
75-79	38	37	395	577	14	11	131	172	8	3	39	49	9	3	86	96
80-84	42	23	651	739	8	7	286	238	2	2	55	49	4	1	152	140
85-89	23	9	785	562	3	3	298	175	3	1	49	28	6	2	205	111
90-94	4	5	469	244	2	0	151	89	0	1	23	20	1	0	137	39
95+	1		166	62	0		45	20			7	1	2		33	19
Total	**287**	**303**	**3053**	**3219**	**87**	**62**	**1106**	**992**	**25**	**34**	**261**	**256**	**33**	**23**	**697**	**507**

Person time for those surviving at least 28 days after a first-ever CVD event (2007-2010)

Person time (years)
CHD=1, IS=2, HS=3 & OS=4

Figure S13: Person-time (years) for those surviving at least 28 days after a First-ever CVD event (2007-2010)

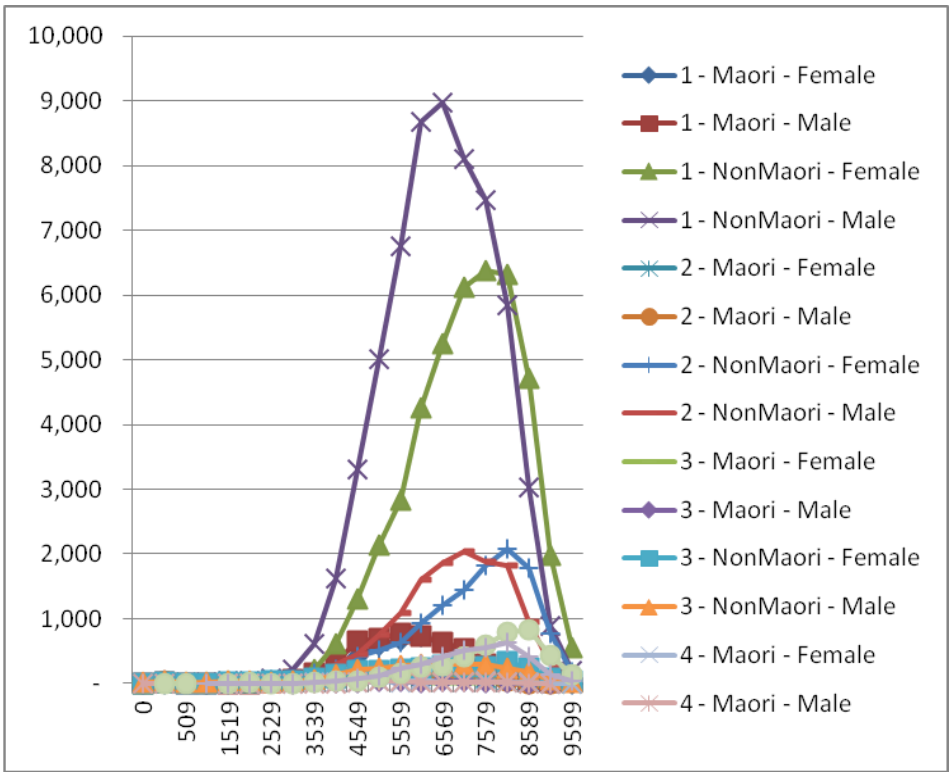


Figure S14: Person-time (years) for those surviving at least 28 days after an IS (2007-2010)

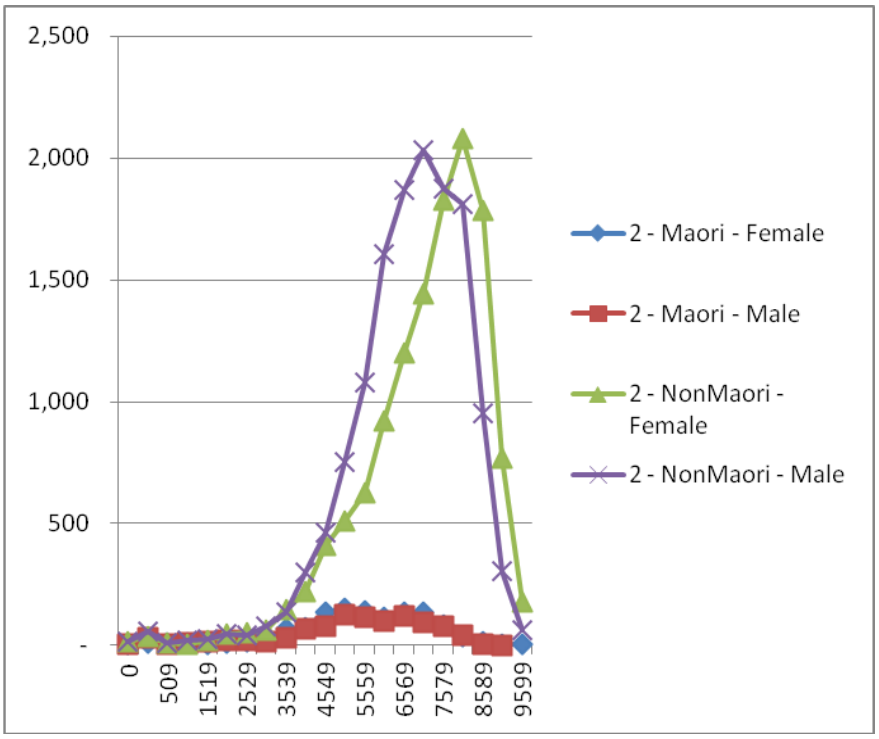


Figure S15: Person time (year) for those surviving at least 28 days after a HS or OS (2007-2010)

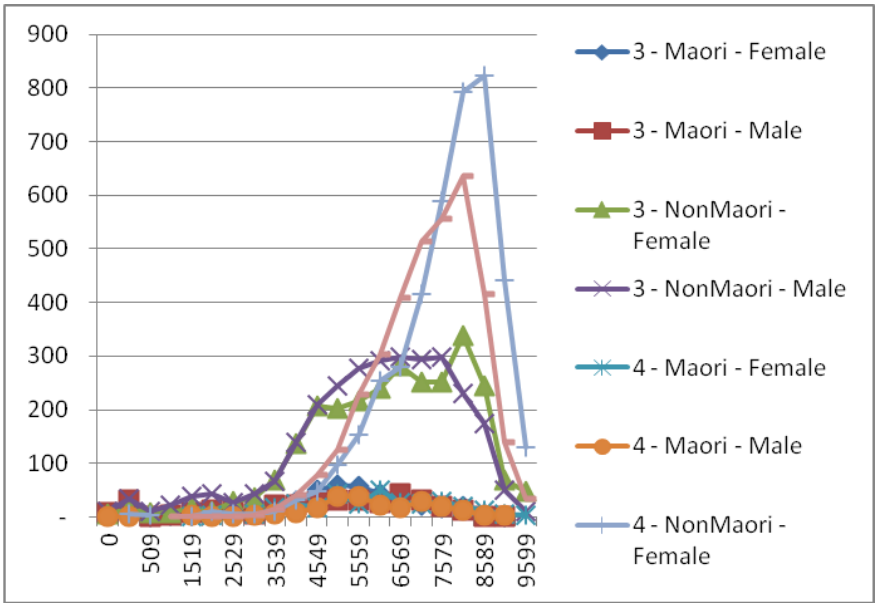


Table S9: Person-time (years) for those surviving at least 28 days after a CVD event, by age group, sex & ethnicity in 2007-2010

Age group	CHD				IS				HS				OS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	68	162	213	608	69	32	149	138	17	23	70	66	17	5	11	14
40-44	211	346	618	1629	71	70	222	301	29	23	138	140	23	9	32	42
45-49	419	647	1298	3316	137	76	408	462	51	29	207	210	18	18	47	79
50-54	595	697	2144	5018	151	128	511	753	61	32	202	245	44	40	97	126
55-59	679	767	2825	6763	142	115	629	1079	56	30	217	279	25	38	153	229
60-64	726	724	4257	8682	115	102	922	1608	44	28	240	291	49	21	253	304
65-69	607	636	5252	8981	139	121	1198	1868	21	44	282	298	28	18	279	410
70-74	457	538	6122	8109	139	92	1442	2034	22	32	252	294	24	29	415	514
75-79	298	293	6369	7458	82	77	1829	1872	18	21	250	298	30	21	589	555
80-84	221	127	6318	5845	39	41	2079	1812	20	12	339	231	20	12	793	636
85-89	84	42	4710	3036	14	7	1786	951	5	0	245	173	13	2	822	416
90-94	22	12	1970	893	8	0	769	306	0	1	69	51	5	3	441	140
95+	1		547	197	3		177	61			47	9	4		129	33
Grand Total	**4,469**	**5,103**	**42,853**	**60,964**	**1,193**	**983**	**12,368**	**13,544**	**382**	**358**	**2,690**	**2,812**	**307**	**226**	**4,089**	**3,510**

Prevalence of CVD cases in 2010

As shown in the Table below, incident counts from HT data go down fairly fast and prevalent cases go up fairly quickly. This reflects the longer diagnostic period than the trend in incidence/prevalence itself. Therefore only prevalent cases in 2010 were used as inputs into TreeAge (while recognising this will slightly under-estimate the true prevalence by missing those cases who had a first CVD prior to 2001).

Table S10: Incident and prevalent counts for the total New Zealand population over the period 2007-2010

Year	2007	2008	2009	2010
Incident counts	23,675	22,866	22,108	21,389
Prevalent counts	145,505	156,476	166,221	175,223

Source: HT

CHD=1, IS=2, HS=3 & OS=4

Figure S16: CVD prevalence counts by age group, sex & ethnicity in 2010

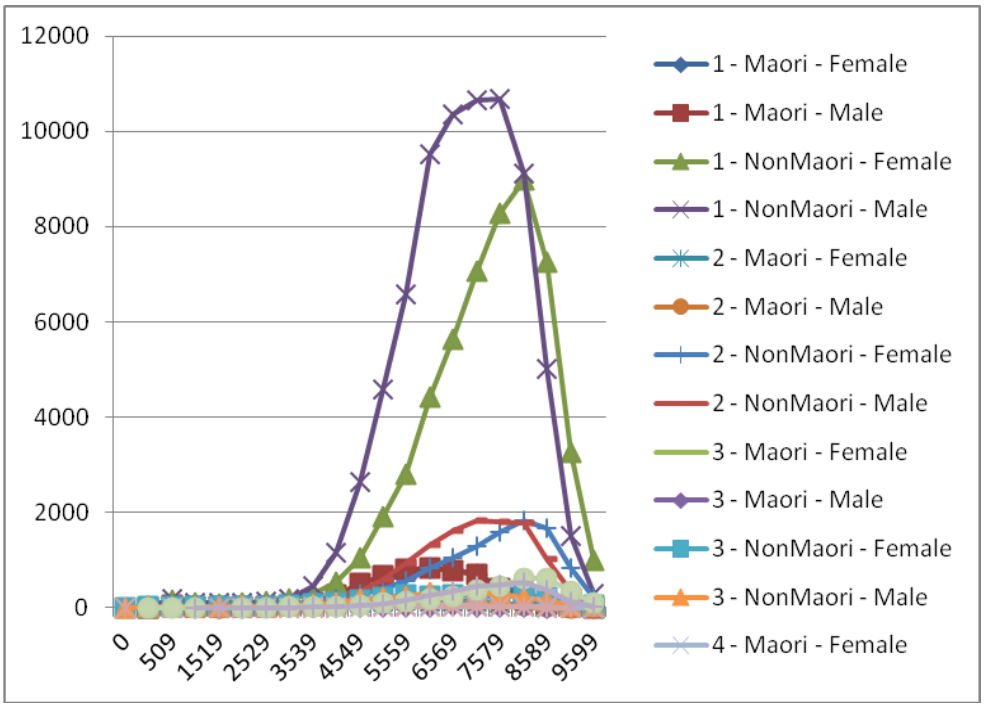


Figure S17: IS prevalence counts in 2010

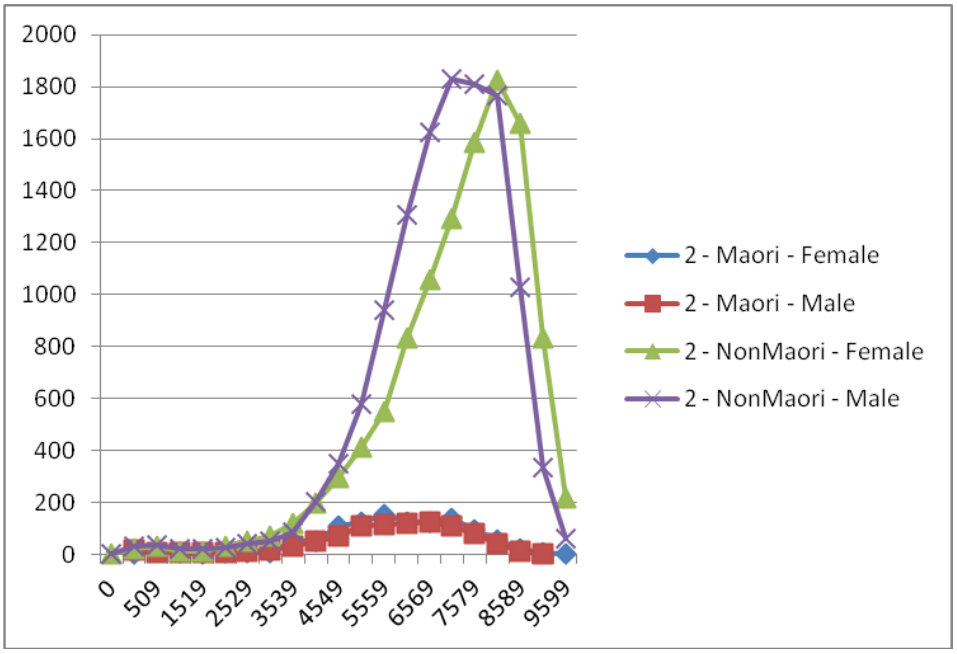


Figure S18: HS & OS prevalence counts in 2010

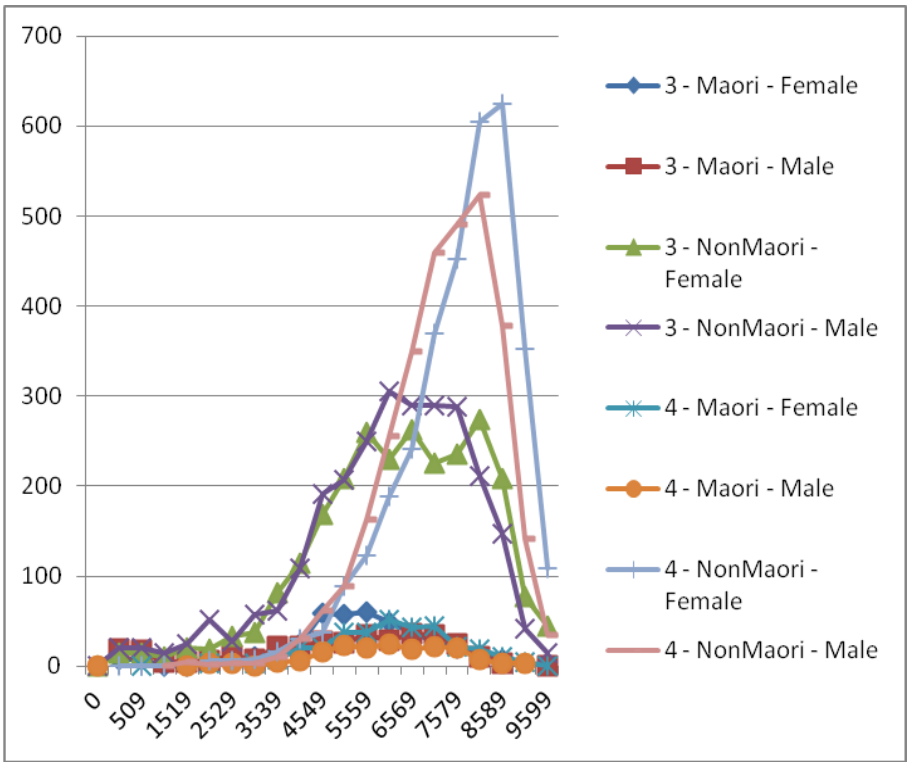


Table S11: CVD prevalence counts by age group, sex & ethnicity in 2010

Age group	CHD				IS				HS				OS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	50	95	280	464	51	30	119	86	17	22	82	62	8	4	16	11
40-44	163	264	542	1146	53	54	196	201	25	22	115	109	20	6	30	30
45-49	315	501	1059	2633	111	69	297	350	59	28	168	191	20	16	37	61
50-54	566	657	1914	4589	126	110	411	578	58	26	208	207	37	23	89	88
55-59	712	798	2813	6590	153	114	550	941	60	34	260	250	38	20	123	163
60-64	830	823	4408	9517	126	118	835	1309	49	29	230	305	51	25	188	255
65-69	799	770	5623	10345	126	124	1058	1624	37	36	263	290	43	19	241	350
70-74	692	697	7058	10656	138	109	1292	1828	27	34	225	289	44	22	370	460
75-79	459	395	8267	10680	98	82	1587	1809	21	25	236	288	22	21	452	491
80-84	314	192	8991	9117	55	40	1825	1766	13	11	274	211	19	8	604	523
85-89	121	64	7249	5012	23	12	1658	1031	8	3	209	147	11	3	624	378
90-94	35	15	3252	1492	8	1	832	335			78	42	5	3	353	141
95+	9	2	990	286	5		216	63		1	44	15	1		109	34
Grand Total	**5250**	**5453**	**53188**	**73306**	**1126**	**942**	**11114**	**12161**	**415**	**341**	**2542**	**2622**	**326**	**179**	**3259**	**2999**

All causes background mortality counts and rates, 2007-2010

Figure S19: Background death counts by age group, sex & ethnicity in 2007-2010

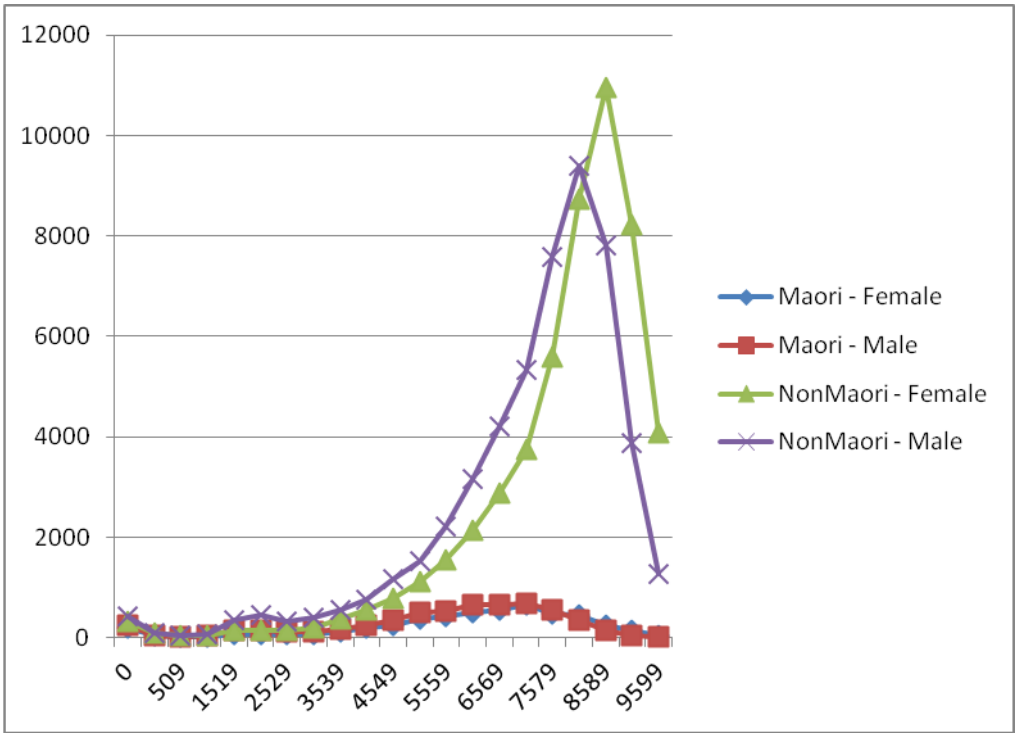


Figure S20: Background death counts by age group, sex & ethnicity in 2010

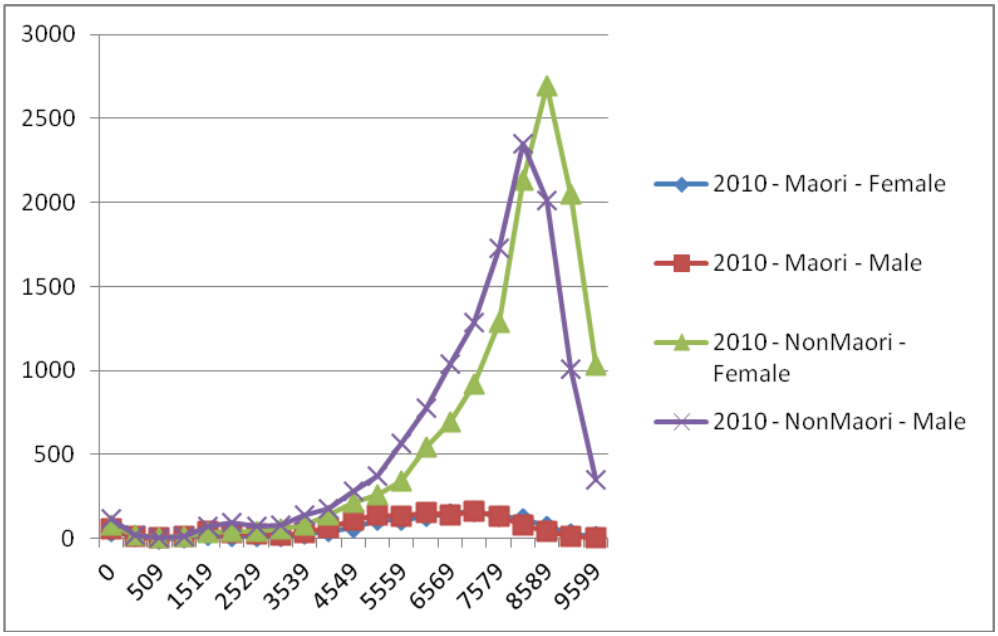


Table S12: Background death counts by age group, sex & ethnicity in 2007-2010

Age group	2007				2008				2009				2010		
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-M
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
35-39	34	52	99	151	29	31	107	151	25	51	89	120	24	37	81
40-44	44	64	162	197	58	58	119	200	45	55	142	188	42	62	142
45-49	56	100	183	304	66	67	178	308	69	88	211	274	67	107	217
50-54	77	131	272	392	85	101	268	384	99	127	308	395	110	136	263
55-59	108	135	414	564	122	154	444	569	92	118	361	518	113	132	341
60-64	135	150	483	768	133	173	559	811	117	178	553	804	129	151	547
65-69	124	186	743	1015	155	157	732	1105	130	180	707	1048	145	141	697
70-74	154	164	924	1384	158	165	987	1361	182	186	927	1313	162	162	915
75-79	115	139	1497	1990	116	140	1485	2002	123	136	1317	1867	129	129	1282
80-84	96	74	2167	2370	117	86	2267	2408	118	114	2164	2282	117	83	2132
85-89	49	33	2703	1803	57	33	2789	2002	71	37	2765	1991	72	39	2691
90-94	33	15	2034	909	47	9	2114	976	41	10	2032	978	29	12	2052
95+	8	3	981	293	11	2	1060	290	4	4	1018	339	13	1	1030
Grand Total	**1197**	**1484**	**12963**	**12700**	**1296**	**1377**	**13407**	**13151**	**1271**	**1494**	**12871**	**12675**	**1277**	**1411**	**12674**

Total NZ population 2010 – counts

Figure S21: Population counts by age group, sex & ethnicity in 2010

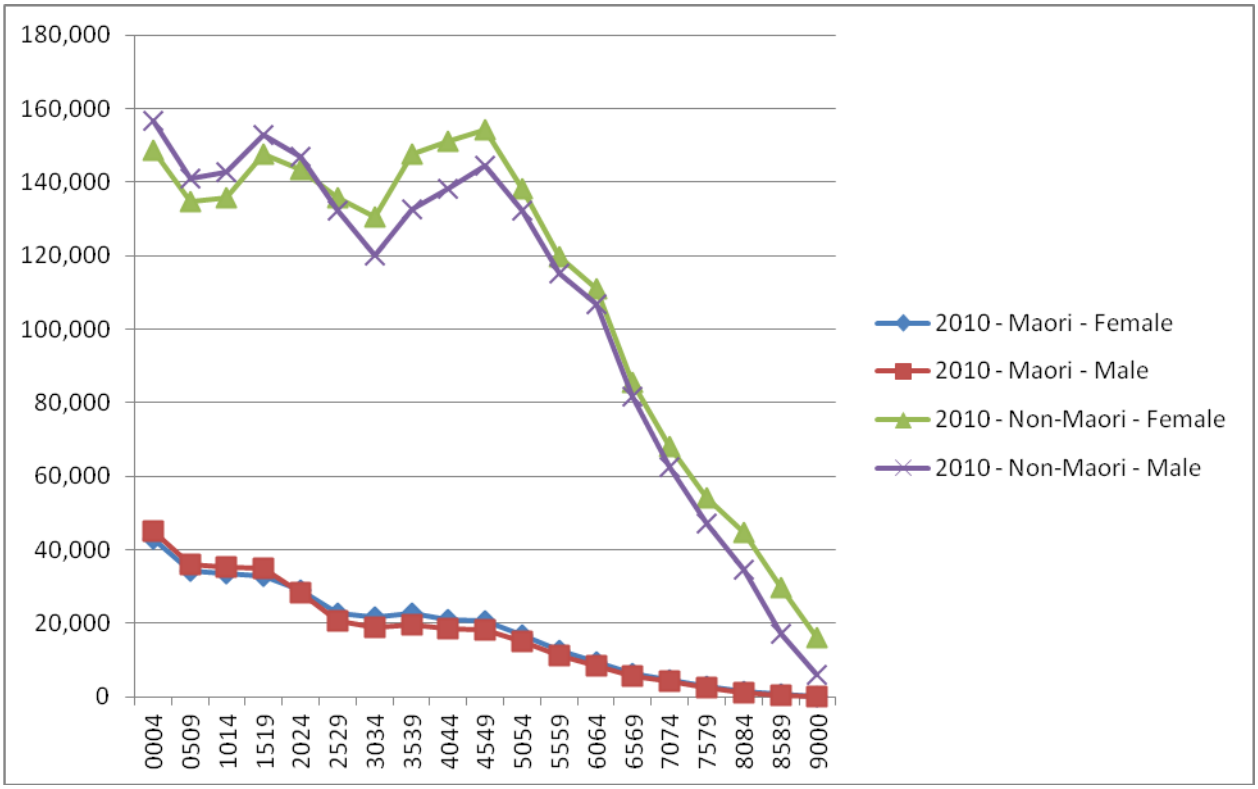


Table S13: Population counts by age group, sex & ethnicity in 2010

Age group	Maori		Non-Maori	
	Female	Male	Female	Male
35-39	22,362	19,428	132,148	120,904
40-44	21,712	19,034	142,444	131,514
45-49	20,118	17,832	142,874	135,320
50-54	16,946	15,146	132,214	127,280
55-59	12,652	11,534	116,894	113,410
60-64	9,552	8,634	106,016	102,794
65-69	6,466	5,802	83,308	79,706
70-74	4,836	4,270	68,226	62,862
75-79	2,956	2,362	53,610	46,504
80-84	1,606	1,116	44,426	33,744
85-89	654	366	29,090	17,074
90-100	282	98	16,014	6,530
Grand Total	**120,142**	**105,622**	**1,067,264**	**977,642**

Background mortality rates average over 2007-2010

Table S14: Background mortality rates (all causes) average over 2007-2010

Age group	Background mortality rates			
	Maori		Non-Maori	
	Female	Male	Female	Male
35-39	0.0012	0.0021	0.0006	0.0010
40-44	0.0022	0.0032	0.0009	0.0014
45-49	0.0032	0.0051	0.0013	0.0020
50-54	0.0059	0.0087	0.0021	0.0030
55-59	0.0092	0.0124	0.0033	0.0049
60-64	0.0149	0.0208	0.0052	0.0079
65-69	0.0222	0.0290	0.0087	0.0134
70-74	0.0371	0.0440	0.0146	0.0227
75-79	0.0439	0.0625	0.0256	0.0404
80-84	0.0772	0.0939	0.0495	0.0716
85-89	0.1083	0.1183	0.0965	0.1251
90+	0.2325	0.1400	0.2037	0.2308

Note: Of note is that the mortality rates for NZ non-Maori versus Australia are fairly similar, albeit with NZ mortality rates tending to be higher in older age groups. This is consistent with higher life expectancy in Australia than NZ.

Non-CVD background mortality counts and rates, 2007-2010

Figure S22: Non-CVD death counts by age, sex & ethnicity in 2010

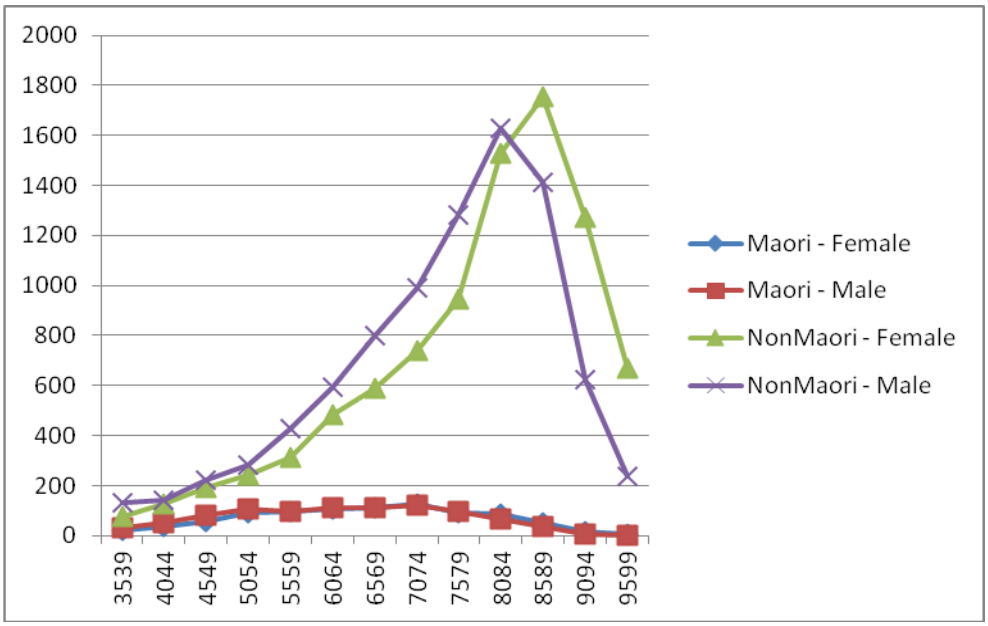


Table S15: Non-CVD death counts by age, sex & ethnicity in 2010

Age group	Background death counts excluding CHD & strokes (but including HF)			
	Maori		Non-Maori	
	Female	Male	Female	Male
35-39	21	33	74	130
40-44	36	52	129	144
45-49	58	80	193	224
50-54	89	105	240	284
55-59	98	97	311	430
60-64	104	110	481	593
65-69	111	113	591	800
70-74	126	120	741	993
75-79	92	98	945	1281
80-84	85	66	1527	1629
85-89	50	34	1752	1411
90-94	15	6	1273	626
95-99	8	1	668	236
Grand Total	**893**	**915**	**8925**	**8781**

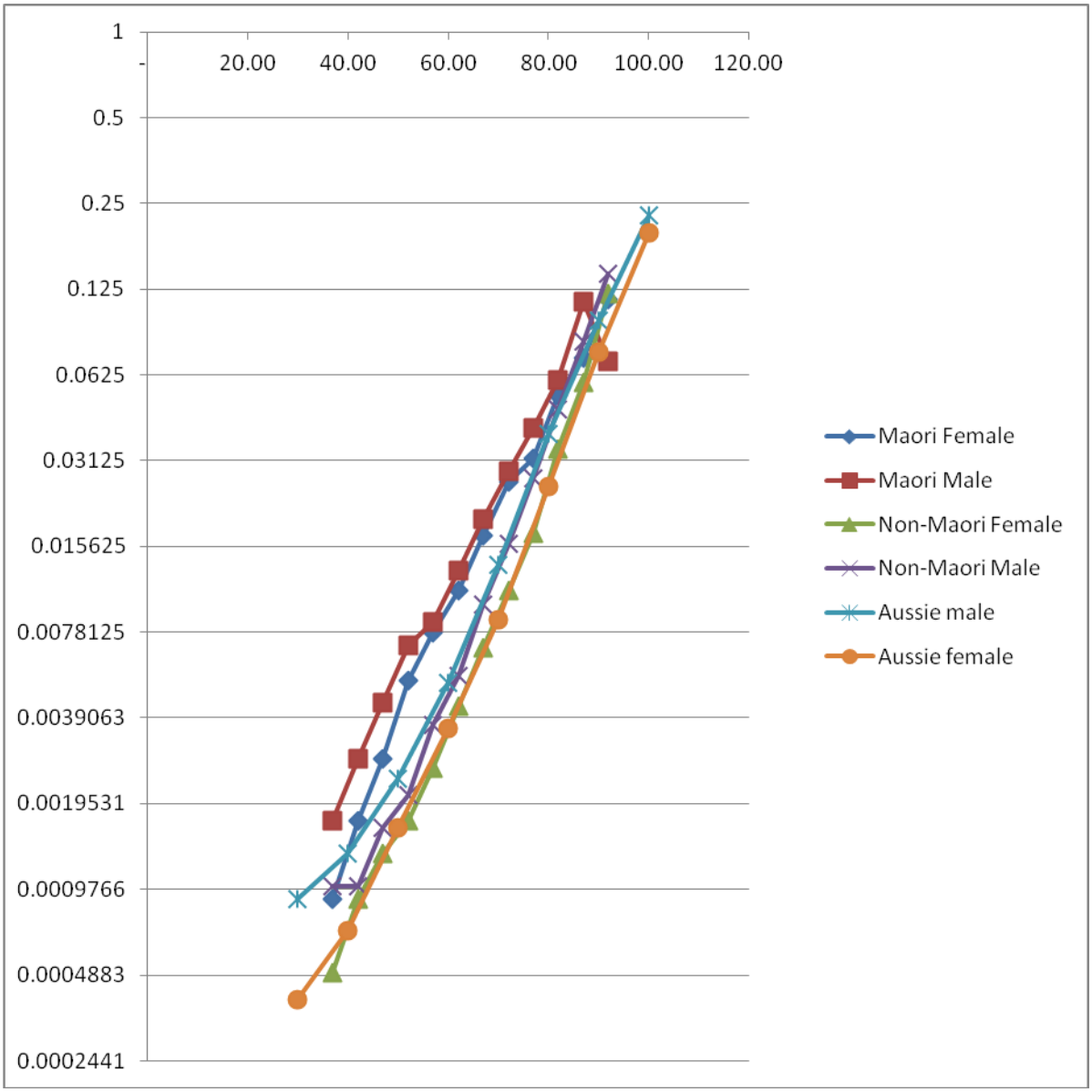
Table S16: Non-CVD mortality rate by age, sex & ethnicity in 2010

Age group	Non-CVD background mortality rate 2010			
	Maori		Non-Maori	
	Female	Male	Female	Male
35-39	0.0008	0.0010	0.0004	0.0005
40-44	0.0013	0.0017	0.0007	0.0009
45-49	0.0021	0.0027	0.0011	0.0014
50-54	0.0034	0.0045	0.0018	0.0024
55-59	0.0057	0.0075	0.0030	0.0039
60-64	0.0094	0.0124	0.0049	0.0065
65-69	0.0155	0.0205	0.0081	0.0107
70-74	0.0256	0.0339	0.0134	0.0177
75-79	0.0423	0.0560	0.0221	0.0293
80-84	0.0699	0.0925	0.0366	0.0484
85-89	0.1156	0.1529	0.0604	0.0799
90-94	0.1911	0.2527	0.0999	0.1321
95-99	0.3158	0.4177	0.1651	0.2184

Table S17: Australia non-CVD mortality in 2003 for comparison purposes

Age group	Males	Females
25–34 years	0.0009	0.0004
35–44 years	0.0013	0.0007
45–54 years	0.0024	0.0016
55–64 years	0.0052	0.0036
65–74 years	0.0135	0.0086
75–84 years	0.0389	0.0254
85–94 years	0.0972	0.0754
95 years and over	0.2261	0.1965

Figure S23: Cross-comparison of mortality rates by age for different NZ population groups and for Australia (using the log of the mortality rate)



Case fatality rates for CVD

Case fatality rates over 2007-2010 by condition

Table S18: Case fatality rates (per person) pre 28 day first-ever CVD survivors in 2010

CFR pre28 2010	CHD				IS				HS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
Age group	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	0.006	0.007	0.002	0.003	0.043	0.031	0.015	0.011	0.147	0.123	0.146	0.122
40-44	0.008	0.011	0.003	0.004	0.052	0.038	0.018	0.013	0.170	0.142	0.169	0.142
45-49	0.012	0.016	0.005	0.006	0.062	0.046	0.022	0.016	0.197	0.165	0.196	0.164
50-54	0.018	0.024	0.007	0.010	0.075	0.055	0.026	0.019	0.228	0.191	0.227	0.190
55-59	0.027	0.035	0.011	0.014	0.091	0.067	0.032	0.023	0.264	0.221	0.263	0.220
60-64	0.040	0.052	0.016	0.021	0.109	0.080	0.038	0.028	0.305	0.256	0.304	0.255
65-69	0.059	0.078	0.024	0.031	0.132	0.097	0.046	0.034	0.354	0.296	0.352	0.295
70-74	0.088	0.116	0.036	0.047	0.159	0.117	0.056	0.041	0.409	0.343	0.407	0.341
75-79	0.131	0.172	0.053	0.069	0.192	0.141	0.068	0.050	0.474	0.397	0.472	0.395
80-84	0.194	0.255	0.078	0.103	0.232	0.170	0.082	0.060	0.549	0.459	0.546	0.457
85-89	0.288	0.379	0.116	0.153	0.280	0.206	0.098	0.072	0.635	0.532	0.632	0.529
90-94	0.428	0.562	0.173	0.227	0.338	0.248	0.119	0.087	0.736	0.616	0.732	0.613
95-99	0.635	0.835	0.257	0.337	0.408	0.300	0.143	0.105	0.852	0.713	0.848	0.710

Notes: Some of these CFRs are lower than used in the Australian CVD model. This is likely to be due to the milder disease states (eg, mild angina) that are being picked up in the CVD definitions being used in this NZ model. The highest CFR is for haemorrhagic stroke – which is consistent with the Australian data and also what we know about the relatively higher severity of haemorrhagic vs ischaemic stroke.

Table S19: Case fatality rates post 28 day first-ever CVD survivors in 2007-2010 (using the population for the same period)

CFR post 28 days 2007-2010	CHD				IS				HS			
	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori	
Age group	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
35-39	0.007	0.007	0.003	0.003	0.014	0.013	0.008	0.008	0.033	0.035	0.020	0.021
40-44	0.009	0.009	0.004	0.004	0.018	0.017	0.010	0.010	0.041	0.044	0.024	0.026
45-49	0.013	0.013	0.006	0.006	0.023	0.023	0.014	0.013	0.051	0.054	0.030	0.032
50-54	0.019	0.019	0.008	0.008	0.030	0.030	0.018	0.018	0.064	0.067	0.038	0.040
55-59	0.026	0.026	0.012	0.012	0.040	0.039	0.024	0.023	0.079	0.083	0.047	0.049
60-64	0.037	0.037	0.017	0.017	0.052	0.051	0.031	0.030	0.098	0.104	0.058	0.061
65-69	0.052	0.053	0.024	0.024	0.068	0.067	0.040	0.040	0.122	0.128	0.072	0.076
70-74	0.074	0.074	0.033	0.033	0.090	0.088	0.053	0.052	0.151	0.159	0.089	0.094
75-79	0.104	0.105	0.047	0.047	0.117	0.115	0.069	0.068	0.187	0.197	0.111	0.117
80-84	0.146	0.148	0.066	0.067	0.154	0.151	0.091	0.089	0.232	0.245	0.137	0.145
85-89	0.206	0.208	0.093	0.094	0.201	0.198	0.119	0.117	0.288	0.304	0.170	0.180
90+	0.291	0.294	0.131	0.132	0.26367	0.25873	0.15563	0.15272	0.35673	0.37672	0.21088	0.22271

Disability weights (DW) used in the CVD modelling

Table S20: Disability weights used in the GBD 2010 and in other studies

Disease state	Disability weights [DW] from GBD 2010 ((Salomon *et al.*) (95%UI)	QALY utility weight (with values for our scenario analysis in bold italics)	1-DALY disability weight (used in previous work (Cobiac et al. 2012))	Summary DWs used in the NZ Burden of Disease Study (forthcoming) and based on the GBD 2010 Study DWs [1-DW]
Stroke	long-term consequences [LTC], mild 0·021 (0·011–0·037) LTC, moderate 0·076 (0·050–0·110) LTC, moderate plus cognition problems 0·312 (0·211–0·433) LTC, severe 0·539 (0·363–0·705) LTC, severe plus cognition problems 0·567 (0·394–0·738)	Meta-analysis: 0.52 for major, ***0.68*** for moderate, and 0.87 for minor stroke (Tengs & Lin 2003) 0.76 (Cadilhac *et al.* 2010)**	0.68 (Begg *et al.* 2008)	0.226 [0.774] (See next table for further details)
Angina	mild 0·037 (0·022–0·058) moderate 0·066 (0·043–0·095) severe 0·167 (0·109–0·234)	0.904 (Fryback *et al.* 1993; Hanmer *et al.* 2006)*	***0.896*** (Begg et al. 2008)	Coronary heart disease overall = 0.081 [0.919]
Congestive heart failure	mild 0·037 (0·021–0·058) moderate 0·070 (0·044–0·102) severe 0·186 (0·128–0·261)	0.863 (Fryback et al. 1993; Hanmer et al. 2006)*	0.809 (Begg et al. 2008)	
Myocardial infarction	days 1–2: 0.422 (0·284–0·566) days 3–28: 0·056 (0·035–0·082)	0.877 (Fryback et al. 1993; Hanmer et al. 2006)* #	***0.605*** (Begg et al. 2008) # (used for acute CHD event (6 weeks) in Cobiac et al (Cobiac et al. 2012))	

Notes:
* Beaver dam study utility weights (Quality of Well-being index) corrected for 'background disability' using US population norms (Quality of Well-being index) (Hanmer et al. 2006), combined multiplicatively, assuming the 'average' age for each condition is the same as in Australia (Begg et al. 2008)

** NEMESIS stroke study utility weights, corrected for 'background disability' using AQoL population quality of life norms (Cadilhac et al. 2010)
# QALY utility weights represent utility in those who experienced a myocardial infarction in the last year, while DALY disability weights reflect disability over the three months following myocardial infarction.

Also in GBD 2010 documentation (but not included here) were these other DWs:

- Cardiac conduction disorders and cardiac dysrhythmias: 0·145 (0·097–0·205)
- Claudication 0·016 (0·008–0·028).
- Generic uncomplicated disease: worry and daily medication 0·031 (0·017–0·050)
- Generic uncomplicated disease: anxiety about diagnosis 0·054 (0·033–0·082)

Table S21: DWs used in the NZ Burden of Disease Study (Appendix to Methodology Report) and approach taken in the current study (BODE[3])

NZBDS Code	NZBDS Description	ICD10 Codes	Effective DW (averaged over strata) used in the NZBDS	Constituent health states (NZBDS)	Health state DWs	Values used in BODE3 modelling (baseline)
E01	Coronary heart disease	I20-I25	0.081	Myocardial infarction Unstable angina Stable angina - Hospital case Stable angina - Community case Heart failure	0.082 0.082 0.076 0.066 0.109	**0.081** (same as NZBDS) – for initial weeks and subsequently. See next tables for age, sex and ethnicity distribution, and consideration of uncertainty.
E10	Stroke	G45-G46, I60-I69 (also separated into ischaemic and haemorrhagic types)	0.226	Acute event Partially recovered Dependent Institutionalised	0.082 0.172 0.312 0.567	**0.226** (same as NZBDS) – for initial weeks and subsequently. See next tables for age, sex and ethnicity distribution, and consideration of uncertainty.

DWs being used in this CVD model

Effective DWs by age, sex & ethnic were YLDs (year lost to disability) divided by prevalence cases. YLDs were calculated by multiplying prevalence cases for each health state with its corresponding DWs (as in Table S21). YLDs here were not adjusted for comorbidity.

Table S22: Age, sex and ethnicity distribution of disability weights used in this CVD modelling

BDS_Condition_codes	Coronary heart disease (E01)		Stroke (E10)	
Effective DWs	**Maori**	**Non-Maori**	**Maori**	**Non-Maori**
Males aged 35_39	0.078	0.075	0.159	0.159
M40_44	0.080	0.076	0.157	0.157
M45_49	0.080	0.077	0.158	0.158
M50_54	0.083	0.077	0.160	0.160
M55_59	0.084	0.078	0.162	0.162
M60_64	0.084	0.078	0.162	0.162
M65_69	0.085	0.079	0.199	0.199
M70_74	0.087	0.080	0.198	0.198
M75_79	0.087	0.082	0.235	0.235

BDS_Condition_codes	Coronary heart disease (E01)		Stroke (E10)	
Effective DWs	**Maori**	**Non-Maori**	**Maori**	**Non-Maori**
M80_84	0.091	0.084	0.235	0.235
M85plus	0.089	0.087	0.289	0.289
Females aged 35_39	0.077	0.072	0.185	0.185
F40_44	0.077	0.075	0.185	0.185
F45_49	0.078	0.075	0.186	0.186
F50_54	0.080	0.075	0.187	0.187
F55_59	0.080	0.076	0.188	0.188
F60_64	0.082	0.077	0.188	0.188
F65_69	0.083	0.078	0.202	0.202
F70_74	0.086	0.079	0.202	0.202
F75_79	0.088	0.081	0.263	0.263
F80_84	0.090	0.083	0.264	0.264
F85plus	0.090	0.086	0.376	0.376

Uncertainty around disability weights

DW relative confidence intervals were adapted from the GBD 2010 data. Absolute CIs then were calculated using DWs for middle age group (60-64) for non-Māori. According to the GBD 2010, DWs followed a logit-normal distribution. However, as TreeAge does not support for a logit-normal distribution, we approximated using a beta distribution with normal mean & SD, then rescaled the DWs so that they felt within the 95% UI.

Table S23: Examples of uncertainty distribution of disability weights for non-Maori aged 60-64

Condition	DW	Mean	LCI%	UCI%	LCI	UCI	SD
Coronary	Male	0.078	36	44	0.050	0.112	0.016
	Female	0.077	36	44	0.049	0.111	0.016
Stroke	Male	0.162	33	43	0.109	0.232	0.031
	Female	0.188	33	43	0.126	0.269	0.036

Health system costs for the CVD conditions

Selected comments on costs sourced from HealthTracker

The patterns in the tables below using HealthTracker data show the expected patterns with similar CHD and stroke costs for both sexes. Declines in the cost per person after the age of 50 years are also expected given maximal interventions occurring in the younger age groups. The steeper decline in costs in the oldest age-groups may reflect lower rates of surgical intervention (eg, bypass surgery).

The values are relatively high compared to UK data, are slightly higher than for the Australian data, and are similar to the Auckland stroke study data (see the tables below). This is likely to be due to: (i) HealthTracker data being more comprehensive than the approach taken in other costing studies; (ii) potentially extra costs around co-morbidities that people with CVD are more likely to have; (iii) some recent temporal trends that might have pushed up treatment costs eg, recent increase use in stents.

The higher costs for stroke (relative to CHD) was also expected as surgical interventions can be very expensive (eg, for haemorrhagic stroke), and stroke is typically much more disabling than CHD, with more expenditure required for rehabilitation etc.

Background costing data from other studies (for comparison purposes)

Table S24: CVD costs - UK data for comparison (2003 Euros) – from Lamotte et al 2006 (aspirin study)

Cost item	Average	95%CI
MI	1593	(1326, 1976)
Ischaemic/haemorrhagic stroke	3385	(2795, 4060)
Fatal MI	1824	(1490, 2210)
Fatal stroke	5309	(3036, 8523)
GI bleed	1218	(1025, 1619)
In-hospital follow-up (per year)		
non-fatal MI	1234	(987, 1539)
non-fatal stroke	892	(654, 1189)
non-fatal MI + non-fatal stroke	1628	(1250, 2104)

Table S25: Treatment costs ($AUS) – from Cobiac et al 2012 CVD model (Table 6 in Supplementary file [S2])

	Ischaemic heart disease		Stroke		Gastrointestinal bleed
	First year	Subsequent years	First year	Subsequent years	
35 +	$12,921 (All)	$4,539 (All)	$23,581 (All)	$3,201 (All)	$430 to $2,114 depending on age-sex grouping

Table S26: Auckland study on stroke units (using NZ 2008$) (Te Ao *et al.* 2012)

Setting	First year	Lifetime
General ward	20,849	67,057
Stroke unit	24,275	77,313

Table S27: CVD excess treatment costs (NZD per year, excluding 'average citizen' costs) by age, sex and state in 2011 (including costs in the last year of life if death occurs)

Disease	Coronary heart disease (CHD)		Stroke	
Age group	Women	Men	Women	Men
35-39	18,412	17,515	23,669	24,195
40-44	18,545	17,314	23,869	23,894
45-49	18,388	17,064	23,635	23,520
50-54	17,086	18,614	21,796	18,573
55-59	16,745	18,161	21,285	17,895
60-64	16,258	17,569	20,553	17,006
65-69	16,448	19,733	15,565	15,866
70-74	15,777	18,784	14,558	14,442
75-79	15,138	18,053	13,600	13,346
80-84	9,921	13,303	10,560	11,594
85-89	9,636	12,955	10,133	11,071
90+	8,065	9,467	8,537	10,117

Note: These costs have all been scaled from those obtained in HealthTracker. First, to adequately cover private health expenditure, all costs across all age groups were multiplied by 1.2 (as 83% of health care is publically funded, giving 1/0.83 as a scaling factor to capture private expenditure). Costs are also multiplied by 1.1, 1.2, 1.3 for 65-74,75-84 and 85+ age groups respectively, to capture the estimated missing data of funding residential 'disability support services' care funded though Vote:Health but not yet captured in available data.

Table S28: CVD excess treatment costs (NZD per year) for second and subsequent years after diagnosed with CVD (and excluding 'average citizen' costs) by age, sex and state in 2011 (including costs in the last year of life if death occurs)

Disease	CHD		Stroke	
Age group	Women	Men	Women	Men
35-39	6,281	5,179	7,455	6,495
40-44	6,414	4,979	7,655	6,195
45-49	6,258	4,729	7,420	5,820
50-54	6,224	4,625	7,234	8,654
55-59	5,882	4,173	6,722	7,975
60-64	5,395	3,581	5,991	7,087
65-69	5,217	4,390	6,930	7,180
70-74	4,546	3,441	5,923	5,757
75-79	3,908	2,710	4,965	4,660
80-84	3,374	3,213	3,742	4,228
85-89	3,089	2,865	3,315	3,705
90+	2,426	3,047	2,516	2,968

Note: See Table S26 for details on scaling.

Health costs for the average NZ citizen without CVD

Below are the costs from HealthTracker for the 'average citizen' per year without CHD or stroke.

Table S29: "Average citizen costs" cost (all health costs in NZD per year, excluding CVD treatment costs) by age & sex in 2011 (including costs in the last year of life if death occurs)

Age group	Women	Men
35-39	863	1,368
40-44	1,021	1,214
45-49	1,197	1,330
50-54	1,483	1,552
55-59	1,835	1,828
60-64	2,381	2,251
65-69	3,167	2,955
70-74	4,204	3,535
75-79	5,049	4,027
80-84	5,598	4,679
85-89	6,411	5,116
90+	6,552	5,050

Note: See Table S26 for details on scaling.

References

Begg S, Vos T, Barker B, et al. (2008). Burden of disease and injury in Australia in the new millennium: measuring health loss from diseases, injuries and risk factors. *Medical Journal of Australia* **188**, 36-40.

Cadilhac DA, Dewey HM, Vos T, et al. (2010). The health loss from ischemic stroke and intracerebral hemorrhage: evidence from the North East Melbourne Stroke Incidence Study (NEMESIS). *Health and Quality of Life Outcomes* **8**.

Cobiac LJ, Magnus A, Lim S, et al. (2012). Which interventions offer best value for money in primary prevention of cardiovascular disease? *PLoS One* **7**, e41842.

Fryback DG, Dasbach EJ, Klein R, et al. (1993). The Beaver Dam Health outcomes study: Initial catalog of health state quality factors. *Medical Decision Making* **13**, 89-102.

Hanmer J, Lawrence WF, Anderson JP, et al. (2006). Report of nationally representative values for the noninstitutionalized US adult population for 7 health-related quality-of-life scores. *Medical Decision Making* **26**, 391-400.

Ministry of Health 2012. Ways and Means A report on methodology from the New Zealand Burden of Diseases, Injuries and Risk Factors Study, 2006–2016. Wellington: 83-84.

Salomon JA, Wang H, Freeman MK, et al. Healthy life expectancy for 187 countries, 1990-2010: a systematic analysis for the Global Burden Disease Study 2010. *Lancet* **380**, 2144-2162.

Te Ao BJ, Brown PM, Feigin VL, et al. (2012). Are stroke units cost effective? Evidence from a New Zealand stroke incidence and population-based study. *Int J Stroke* **7**, 623-630.

Tengs TO, Lin TH (2003). A meta-analysis of quality-of-life estimates for stroke. *Pharmacoeconomics* **21**, 191-200.