Supplementary Material – Additional Information and Results Tables

Supplementary material for ***Impact of five tobacco endgame strategies on future smoking prevalence, population health and health system costs: Two modelling studies to inform the tobacco endgame***

Table of Contents

Supplementary text around methods

Tables

Figures

Additional details around and discussion of intervention specification, rationale and assumptions

Annual tobacco tax increases

In New Zealand, tobacco tax has increased by 10% each year since 2010. The continuation of this strategy until at least 2020 was confirmed by the New Zealand Government in May 2016. For the taxation endgame strategy in this study, a further continuation of this strategy was assumed until 2025, after which the level of tax was held constant. This endgame strategy would result in an average retail price of a pack of 20 cigarettes of approximately NZ$40 by 2025. Age- and ethnicity-specific tobacco price elasticities were used to estimate changes in future smoking prevalence, and thence population health and health system costs.[1]

The TFG strategy

This strategy assumed a law change prohibiting the sale and supply of tobacco to individuals born from the year 1993 onwards, meaning that 18 year olds in 2011 (and all younger cohorts) would never be able to legally access tobacco. As such, annual smoking uptake rates were set to zero percent from 2011 onwards. A recent report by the Institute of Medicine [IOM] on the prevalence and health impacts of increasing the minimum age of legal access [MLA] to tobacco by a only a few years (ie, from 18 to 19, 21 or 25) suggested *illegal supply by retailers*, *delayed initiation*, and *social supply* may result in suboptimal impacts of such policies.[2] While the TFG strategy may share some similarities with policies that increase the MLA to tobacco by a few years, these three potential forms of 'leakages' were not considered in the base-case model of the TFG strategy (but were in a scenario analysis as described in the main manuscript) for a number of reasons.

First of all, research suggests that *illegal supply by retailers* in the context of changes in the MLA to tobacco does not have to be problematic as long as a comprehensive enforcement system is in place with regular surveillance and sufficiently high penalties for violation.[2] As such, it was assumed that the TFG strategy was implemented as part of a comprehensive enforcement system of which the costs were covered by annual surveillance fees paid by retailers (as per the current system in Finland).[3] Similarly, fines from prosecuted outlets could also contribute to funding the surveillance and enforcement system. But, even if such costs were covered by the government instead, the TFG strategy is likely to still yield substantive cost-savings for the health system. This is using estimates from the US on the yearly cost of four annual inspections per outlet and assuming increased enforcement from 2011 until 2025 (ie, US$350 per outlet[4] converted to 2011 NZ dollars = NZ$571 * 5979 outlets * 14 years = NZ$48 million). Where the TFG strategy was combined with outlet reduction (ie, in the combined strategy) – then the surveillance and enforcement costs would be reduced proportionately each year.

Secondly, *delayed initiation* was not considered for the model of the TFG strategy, as in theory the individuals covered by the TFG would never reach an age at which they would be legally able to access tobacco (this is in contrast with policies where the MLA to tobacco only increases by a few years). This modelling approach appears acceptable, given that delayed smoking initiation was also not considered in recent modelling work of the health impacts of increasing the MLA to tobacco from 18 to 25 (assuming somewhat more mature decision-making by that age).[2]

Finally, research suggests that channels of *social supply* for tobacco predominantly occur among friends, acquaintances, and siblings who are of similar ages.[5-7] As such, only increasing the MLA to tobacco by a few years may still allow for easy social access to tobacco. However, the TFG strategy should progressively widen the age gap between those who are legally able to access tobacco and those who are not, which reduces the likelihood of young people being in the same social networks as people who have legal access to tobacco.[8] Moreover, as outlined elsewhere,[9] the new TFG law would make it illegal for anyone to supply tobacco to those in the TFG targeting both illegal supply by retailers and social supply. As such, it was deemed acceptable to assume minimal leakage through social supply in the base-case scenario of the TFG strategy. However, in a scenario analysis the possibility of continued smoking uptake among young people through either illegal sales or illegal social supply was considered (at 20% of the BAU smoking uptake rates).

A sinking lid on tobacco supply

To model the sinking lid on tobacco supply strategy we followed the approach as outlined when it was first proposed in the published literature.[10,11] That is, new legislation would involve government-mandated set percentage point reductions in the annual commercial tobacco supply to the market sufficient to achieve zero commercial sales within the next 10 to 15 years. The original proposal suggested a 10% reduction in the supply of tobacco each year for a period of 10 years. However, this 10-year strategy was proposed before the adoption of the Smokefree 2025 goal by the New Zealand Government. For the current modelling which used New Zealand as a case study, it was most logical to line up the end date of commercial sales of tobacco with New Zealand's 2025 goal (ie, a sinking lid over a period of 14 years). As such, the first five years of the intervention followed the proposed annual supply reduction of 10% per year to provide a strong signal by the Government that it was serious about achieving the 2025 goal, with a 5.6% annual reduction in the remaining nine years (50%/9) and commercial sales of tobacco ending by 2025. It was thereby assumed that each year tobacco companies would bid for the newly reduced tobacco import quotas in an auction (overseen by the Government or an independent non-profit agency with legal mandate (as per suggested in the regulated market model[12]).

A strong rationale for the implementation of a sinking lid on supply strategy as part of the tobacco endgame is that it is an intervention with a clear time-table and end target. That said, the success of a sinking lid on supply strategy would depend on a well-organised and implemented enforcement system to prevent an increase in the illicit tobacco market and potential undesirable behaviours by the tobacco industry (eg, attempts to bribe politicians to stop the policy etc). In addition, the enforcement of a sinking lid strategy is likely to be more successful in jurisdictions that already have lower levels of smoking prevalence, are geographically isolated (eg, islands), have strong border controls, a well-functioning government, low levels of corruption, and a well-controlled or no tobacco manufacturing sector.[13] New Zealand substantially meets all of these criteria being an island nation with relatively low levels of tobacco smoking prevalence, strong border controls, low levels of corruption,[14] and no commercial grown tobacco.

A substantial tobacco outlet reduction strategy

This strategy assumed a new law that mandated a tobacco retail licensing system as well as a reduction in the number of licences. It was thereby assumed that those outlets envisaging the largest turnover/demand (ie, those located in the most densely populated areas), would be most likely to be successful bidders for a licence in the auction. This appears to be a reasonable assumption based on Australian and Finnish evidence suggesting that typically

only outlets with the highest demand for tobacco products apply for a tobacco retail licence if a tobacco retail licensing scheme with fees is introduced or if such fees are increased.[15,16]

Our previous two modelling studies published in the journal "*Tobacco Control*" suggested that a larger than 95% reduction in the number of outlets would most likely be required to significantly alter access to tobacco retail outlets in New Zealand.[17] As such, the outlet reduction strategy modelled in this tobacco endgame modelling study featured a more substantial reduction in the number of outlets (ie, 99.7%) than previously modelled [17,18] over a longer period of time with the final reduction in 2025 (in line with New Zealand's Smoke-free 2025 goal). To allow for comparison of prevalence reductions and health and cost impacts under this more substantial outlet reduction strategy with our previously modelled tobacco retail outlet reduction strategies, the first nine years followed the same approach as our previous modelling work. That is, in the first year the number of outlets was reduced by 50% within each of the 66 local government areas (territorial local authority [TLA]), and by a further 5% per year thereafter (ie, a 90% reduction in the baseline number tobacco retail outlets from 5979 outlets in 2011 to 593 in 2020).

In the final five years of the intervention, nearing the year 2025, remaining licences within each TLA were reduced more substantially. The published literature was searched to find out what methods have been used in other countries/international settings to substantially reduce the number of outlets. To date, Hungary has been the only country to have substantially reduced the number of outlets at the country level (ie, 83% reduction in one year).[19] The quota of licences was thereby linked to the population size of municipalities (ie, one licence per 2,000 residents in a municipality). The same logic model was applied to the final five years of this substantial outlet reduction strategy albeit to a different (more substantial) degree, keeping the Smokefree 2025 goal and our previous modelling findings in mind (ie, a larger than 95% reduction would be required to substantially alter access to tobacco). As such, in the final five years, TLAs with a population size of 10,000 or above were granted one licence (in all other TLAs all remaining licences expired). Each year, the minimum population size required to keep a licence incrementally increased by 10,000 until this equalled 50,000 in 2025. In other words, in 2021 the number of outlet reduced further from 593 to 55 outlets, to 42 outlets in 2022, to 35 outlets in 2023, to 29 outlets in 2024, and to 18 outlets in 2025.

Combined tobacco endgame strategy

For this intervention, the effects of 10% tobacco tax increases, the TFG strategy, and the substantial tobacco outlet reduction strategy were combined with all beginning in the same 2011 year. As such for this combined endgame strategy, the annual smoking uptake rates were first of all set to zero (TFG strategy). The incremental travel cost increases (arising from people having to travel further to purchase tobacco under the substantial outlet reduction strategy) were together with the price rises incurred by the annual tax increases added to the price of tobacco, and modelled directly onto the (TFG strategy induced) reduced smoking prevalence via ethnicity- and age-specific tobacco price elasticities.

Table 1 Baseline model input parameters for the tobacco forecasting model

Parameter	Data source	Description	Trend/Uncertainty Analyses
Population counts	Statistics New Zealand population estimates for 2011 by sex, age-group and ethnicity[20]	Population counts by single year of age, sex and ethnicity for 2011.	No uncertainty.
Birth projections	National population projections from 2011 to 2061[20]	Median estimate from national population projections for 2011 to 2061.	No uncertainty.
Mortality	New Zealand Census Mortality Study[21,22]	Mortality by single year of age, sex, and ethnicity from 2006 to 2011 from New Zealand Māori and non-Māori life tables.	No uncertainty. Mortality projected forward assuming a 1% decline per year in mortality for never smokers and an annual decline in smoker mortality rate ratios of 2.75% for Māori and 2.0% for non-Māori populations (see [21,22] for derivation of trends).
Relative risks of mortality	New Zealand Census Mortality Study[21,22]	Relative risks of dying for current, former, and never smokers by 5-year age-group, sex and ethnicity (see [23]). Future risks in current smokers were adjusted according to mortality projections as per described above.	Uncertainty: Normal distribution corrected for bootstrap bias in sampling from the log of the relative risk (see[24]).
Tobacco smoking prevalence	As per the 2013 New Zealand Census of Population and Dwellings,[25] back-estimated to 2011 (the baseline year for all modelling).	Prevalence of current, former, and never smokers by age-group, sex, and ethnicity for 2006 and 2013 derived from the following census question for those who were aged 15+ years: "Do you smoke cigarettes regularly (that is, one or more a day)?" Business-as-usual trends in annual smoking uptake and cessation rates were estimated in the baseline model. *Annual proportionate reduction in smoking uptake age 20*: -Non-Māori: male 0.0339, female 0.0276 -Māori: male 0.0288, female 0.0322 *Annual net cessation rates:* 20–34 y of age: -Non-Māori: male 0.0414, female 0.0554 -Māori: male 0.0393, female	*Annual proportionate reduction in smoking uptake age 20*: Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between the four sex by ethnicity groups. *Annual net cessation rates:* Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between 12 sex by age by ethnicity groups.

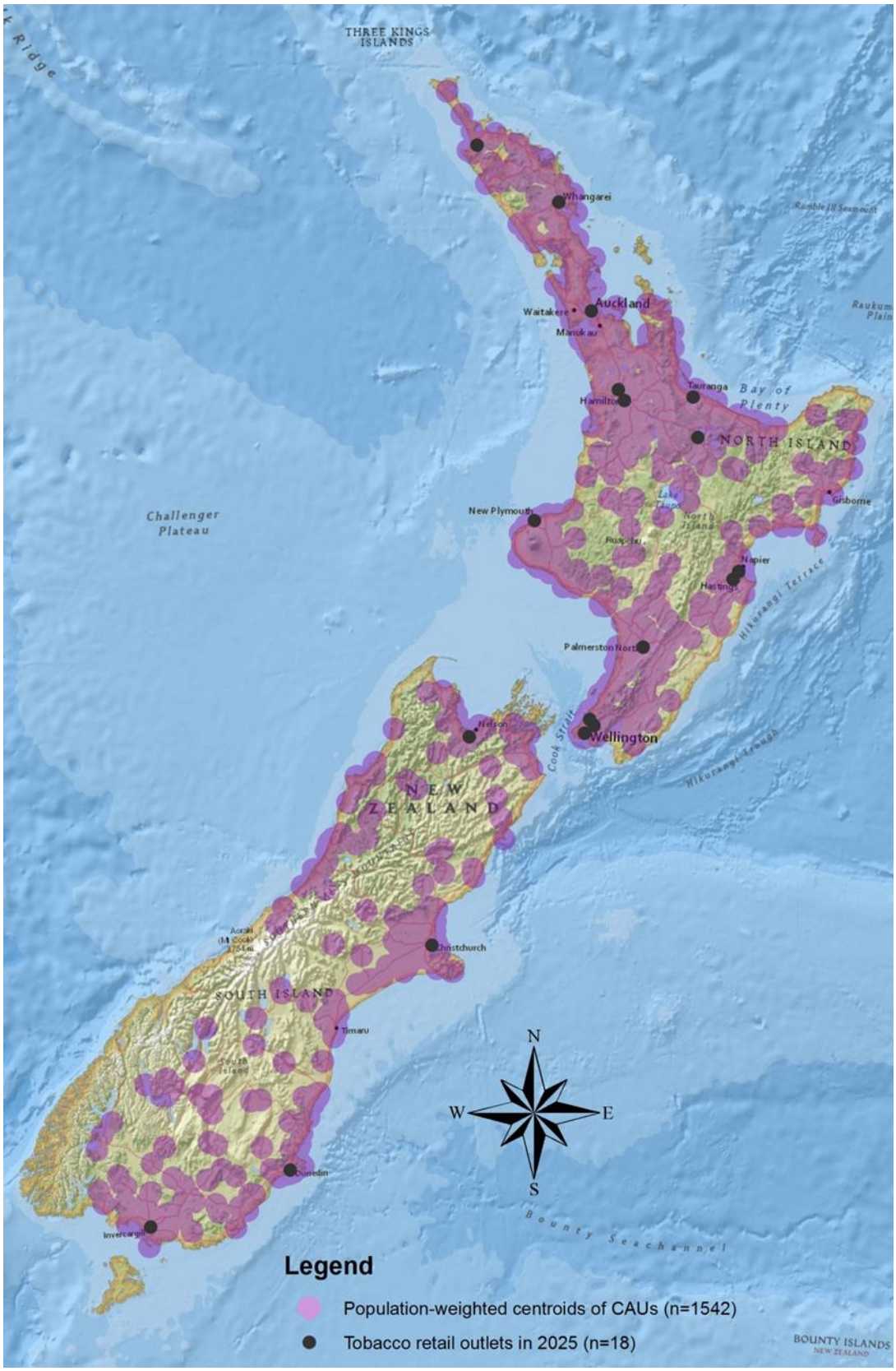
Parameter	Data source	Description	Trend/Uncertainty Analyses
		0.0451 35–54 y of age: -Non-Māori: male 0.0384, female 0.0431 -Māori: male 0.0369, female 0.0472 55+ y of age: -Non-Māori: male 0.0722, female 0.0714 -Māori: male 0.0769, female 0.0699	

Table 2 Baseline model input parameters for the tobacco multi-state life-table model

Parameter	Data source	Trend/Uncertainty Analyses*
Population counts	Statistics New Zealand population size estimates for 2011 by sex, age-group and ethnicity.[20]	Nil uncertainty.
All-cause mortality rates	All-cause mortality rates for 2011 were derived from Statistics New Zealand life-tables for period 2010 to 2012.[26]	Trend: The future trend in all-cause mortality rates was determined by the weighted sum of trends of each of the 16 tobacco-related diseases. For each of these diseases, the weights were proportion of deaths in 2011 by sex, age, and ethnicity. The remaining causes of death (non-tobacco related) were consistent with long-run mortality trends (eg, annual 2.25% decline for Māori, and 1.75% decline for non-Māori).[27] These trends were modelled out to 2026, with 0% per annum decline after that year. Nil uncertainty.
Tobacco-related disease-specific incidence, prevalence, case-fatality rates, and remission rates (the latter for cancers only)	Raw incidence, prevalence, case-fatality and remission rates data came from different sources such as NZBDS,[28] Health Tracker[29] (linked health data source in NZ), and other Ministry of Health data.[30] For each of the 16 tobacco-related diseases included in the modelling, coherent sets (by sex, age and ethnicity) of final incidence, prevalence, case-fatality, and remission rates (for cancers only) were produced by using DISMOD II.[31]	Trend: Tobacco-related incidence rates and case-fatality annual percentage change trends were based on historic trends.[32,33] These trends were projected out to 2026, then held constant. Future prevalence changes dynamically with the model. Uncertainty: Starting in 2011, rates all +/- 5% SD, correlations 1.0 between four sex by ethnicity group categories (eg, non-Māori women, non-Māori men, Māori women, and Māori men) for all diseases. Annual percentage change all +/- 0.5% SD, normal, correlations 1.0 between the four sex by ethnicity groups.
All-cause morbidity rates per capita in 2011 ('pYLD rates'')	Total prevalent years lived with disability (pYLDs) for all different disease causes were taken from NZBDS,[28] and combined. These were then calculated per capita resulting in age-, sex-, and ethnicity-specific 'pYLD rates'. The pYLD rates were used to adjust full life-years lived by the NZ population cohort for spent in suboptimal health.	No trend. Assumed to be constant into the future. Uncertainty: +/- 10% SD log-normal.
Disability rates per capita for each tobacco-related disease	Each disease was assigned with an age-, sex- and ethnicity-specific disability rate equal to YLDs for that disease (scaled down to adjust for comorbidities) from the NZBDS[28] projected forward to 2011, divided by the disease prevalence. The disability rate was assigned to the proportion of the cohort in each disease life-table.	No trend. Uncertainty: +/- 10% SD normal.
Relative risks for smoking and tobacco-related disease incidence	Relative risks of disease incidence for the association of current (or former smoker) with never smoker were sourced from: NZ linked census-cancer data for cancers,[34] census-mortality data for cardiovascular diseases[35] (censuses	Uncertainty: Using probability density functions about RRs for current compared to never smokers of tobacco-related diseases. For RRs since time of cessation for former smokers, standard errors of regression coefficients were used as published (see

Parameter	Data source	Trend/Uncertainty Analyses*
	include smoking question), and CPS II data for respiratory diseases.[36] Reduction in relative risks over time since quitting for former smokers was modelled using equations and coefficients from Hoogenveen et al (2008).[37] With the exception of lower respiratory tract infection, where no excess risk was assumed immediately after smoking cessation. Relative risks were assumed to be 1 for IHD and stroke until age 35, for COPD until age 30, and until age 20 for LRTI and all cancers.	supplementary information S2 of Blakely et al[1]).
Health system costs	Linked health data (hospitalisations, inpatient procedures, outpatients, pharmaceuticals, laboratories, and expected primary care usage) for each individual in New Zealand (NZ) for the period from 2006 to 2010 had unit costs assigned to each disease event. From this data, five types of health system costs (in NZ$2011; by strata of sex and age) were estimated. These types of costs are explained in more detail in the text.	No trend. Uncertainty: +/- 10% SD, log-normal.
Tobacco smoking prevalence	As per the 2013 New Zealand Census of Population and Dwellings,[25] back-estimated for 2011 (the baseline year for all modelling).	Business-as-usual trends were estimated using the baseline smoking uptake and cessation rates from the BODE[3] Tobacco Forecasting Model. *Annual proportionate reduction in smoking uptake age 20*: -Non-Māori: male 0.0339, female 0.0276 -Māori: male 0.0288, female 0.0322 Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between the four sex by ethnicity groups. *Annual net cessation rates:* 21–34 y of age: -Non-Māori: male 0.0414, female 0.0554 -Māori: male 0.0393, female 0.0451 35–54 y of age: -Non-Māori: male 0.0384, female 0.0431 -Māori: male 0.0369, female 0.0472 55+ y of age: -Non-Māori: male 0.0722, female 0.0714 -Māori: male 0.0769, female 0.0699 Uncertainty: +/- 20% SD, beta, correlations 1.0 between 12 sex by age by ethnicity groups.

Figure 1 Geographic location of population-weighted centroids of census area units and the 18 remaining tobacco retail outlets in 2025*



*Tobacco retail outlets that appear to be located close to each other are in fact located in different TLAs. For example, Hamilton appears to have two tobacco retail outlets. However, one is located in the TLA "Hamilton City" and the other is located in "Waikato District (both TLAs > 50,000 residents in 2013).

Table 3 Projected future tobacco smoking prevalence for 2025 by ethnicity under scenario analyses around intervention parameters of selected tobacco endgame strategies

Tobacco endgame strategy	Demographic group	Smoking prevalence in 2025 (smoke-free NZ goal
Business-as-usual		
	Non-Māori	8.1%
	Māori	20.5%
Substantial outlet reduction strategy		
Base-case model	Non-Māori	7.3%
	Māori	17.8%
50% lower price elasticities for all†	Non-Māori	7.7%
	Māori	18.2%
Same price elasticities Māori/non-Māori†	Non-Māori	7.3%
	Māori	18.2%
No growth in the illicit market share†	Non-Māori	7.3%
	Māori	17.7%
Annual tobacco tax increases		
Base-case model	Non-Māori	6.8%
	Māori	16.0%
20% annual tax increases†	Non-Māori	5.7%
	Māori	12.5%
Same price elasticities Māori/non-Māori†	Non-Māori	6.8%
	Māori	16.7%
No growth in the illicit market share†	Non-Māori	6.7%
	Māori	15.9%
Tobacco-free generation strategy		
Base-case model	Non-Māori	5.6%
	Māori	11.2%
Still 20% youth smoking uptake†	Non-Māori	6.1%
	Māori	13.1%
Increased cessation among adults†	Non-Māori	5.3%
	Māori	10.8%
Combined tobacco endgame strategy		
Base-case model	Non-Māori	4.8%
	Māori	9.3%
20% annual tax increases†	Non-Māori	4.3%
	Māori	8.1%
Still 20% youth smoking uptake†	Non-Māori	5.1%
	Māori	10.4%
50% lower price elasticities for all†	Non-Māori	5.2%
	Māori	10.2%
Same price elasticities Māori/non-Māori†	Non-Māori	4.8%
	Māori	9.5%
Increased cessation among adults†	Non-Māori	4.6%
	Māori	8.9%
No growth in the illicit market share†	Non-Māori	4.8%

Tobacco endgame strategy	Demographic group	Smoking prevalence in 2025 (smoke-free NZ goal
	Māori	9.2%
Sinking lid on supply strategy		
Base-case model	Non-Māori	0.0%
	Māori	0.0%
Ratio quitting/reducing number of cigarettes remains 50/50†	Non-Māori	0.0%
	Māori	0.0%
Ratio quitting/reducing number of cigarettes starts at 70/30 and shifts to 100% quitting†	Non-Māori	0.0%
	Māori	0.0%
Illicit market grows as a function of the % reduction in tobacco supply†	Non-Māori	0.11%
	Māori	0.25%

† All other intervention input parameters are as per the 'base-case model'.

Table 4 QALYs gained and net health system costs averted from substantial reducing the number of outlets selling tobacco from 2011 to 2025, among the New Zealand population alive in 2011 (at 3% discounting)

	Non-Māori		Māori			Ethnic groups combined	
Sex and age (in 2011)	**QALYs**	**Cost savings (million)**	**QALYs**	**QALYs – equity†**	**Cost savings (million)**	**QALYs**	**Net cost savings (million) ‡**
Sex and age-groups combined	15,700 (8640 to 26,500)	$376 ($208 to $641)	13,200 (7,520 to 22,400)	18,400 (9890 to 31,200)	$212 ($117 to $356)	28,900 (16,500 to 48,200)	$584 ($328 to $985)
Men							
0-14 year olds	2430	$77	2490	3430	$61	4920	$137
15-24 year olds	2020	$59	1410	1950	$32	3430	$91
25-44 year olds	2760	$64	1160	1710	$22	3920	$86
45-64 year olds	1330	$21	330	550	$4.5	1650	$26
65+ year olds	93	$0.78	9	17	$0.07	100	$0.85
All ages	8630	$222	5400	7660	$119	14,000	$341
Women							
0-14 year olds	2040	$54	3460	4560	$46	5500	$100
15-24 year olds	1510	$38	1940	2590	$24	3450	$62
25-44 year olds	2200	$46	1850	2630	$18	4050	$64
45-64 year olds	1170	$16	560	940	$3.9	1730	$20
65+ year olds	103	$0.60	19	39	$0.08	122	$0.68
All ages	7030	$154	7800	10,800	$92	14,900	$246
Per capita (QALYs/1000 people & $)	4.2	$101	19.6 (ratio Māori/non-Māori 4.7)	27.3	$314	6.6	$133

†Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.
‡Includes both the cost offsets and intervention cost, the latter being the cost of a law (NZ$3.5 million, 95% UI NZ$2.0 to NZ$6.2 million) to reduce the number of tobacco retail outlets from 5979 at baseline to 18 outlets in 2025, distributed pro-rata across all people alive in 2011. The cost of a law was not partitioned by age, sex, and ethnicity.

Table 5 QALYs gained and net health system costs averted from 10% annual tax increases from 2011 to 2025, among the New Zealand population alive in 2011 (at 3% discounting)

	Non-Māori		Māori			Ethnic groups combined	
Sex and age (in 2011)	**QALYs**	**Cost savings (million)**	**QALYs**	**QALYs – equity†**	**Cost savings (million)**	**QALYs**	**Net cost savings (million) ‡**
Sex and age-groups combined	29,700 (16,000 to 49,400)	$711 ($391 to $1180)	23,500 (12,900 to 37,800)	32,000 (18,000 to 54,000)	$374 ($209 to $609)	53,200 (29,200 to 86,300)	$1080 ($597 to $1780)
Men							
0-14 year olds	4100	$129	4080	5550	$99	8180	$228
15-24 year olds	3780	$112	2540	3490	$58	6310	$170
25-44 year olds	5280	$127	2220	3180	$42	7500	$169
45-64 year olds	2890	$48	700	1150	$9.7	3590	$57
65+ year olds	230	$1.93	19	39	$0.16	245	$2.09
All ages	16,300	$417	9560	13,400	$210	25,800	$627
Women							
0-14 year olds	3480	$92	5690	7410	$76	9170	$167
15-24 year olds	2860	$73	3500	4630	$44	6360	$117
25-44 year olds	4270	$92	3520	4910	$36	7790	$128
45-64 year olds	2540	$35	1200	1950	$8.57	3740	$44
65+ year olds	250	$1.53	43	87	$0.17	288	$1.71
All ages	13,400	$294	14,000	19,000	$164	27,300	$458
Per capita (QALYs/1000 people & $)	8.0	$190	34.9(ratio Māori/non-Māori 4.4)	48.1	$554	12.1	$245

†Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.
‡Includes both the cost offsets and intervention cost, the latter being the cost of a law (NZ$3.5 million, 95% UI NZ$2.0 to NZ$6.2 million) to introduce annual 10% tobacco tax increases until 2025, distributed pro-rata across all people alive in 2011. The cost of a law was not partitioned by age, sex, and ethnicity.

Table 6 QALYs gained and net health system costs averted from a tobacco-free generation strategy, among the New Zealand population alive in 2011 (at 3% discounting)

	Non-Māori		Māori			Ethnic groups combined	
Sex and age (in 2011)	**QALYs***	**Cost savings (million)***	**QALYs***	**QALYs – equity*†**	**Cost savings (million)***	**QALYs***	**Net cost savings (million) *‡**
Sex and age-groups combined	41,300 (26,700 to 61,000)	$1194 ($780 to $1766)	42,000 (28,900 to 58,000)	56,700 (38,400 to 81,800)	$747 ($521 to $1051)	83,200 (55,400 to 119,000)	$1940 ($1300 to $2810)
Men							
0-14 year olds	13,800	$434	11,900	16,500	$290	25,700	$724
15-24 year olds	8800	$270	5730	7940	$134	14,500	$404
25-44 year olds	0	$0	0	0	$0	0	$0
45-64 year olds	0	$0	0	0	$0	0	$0
65+ year olds	0	$0	0	0	$0	0	$0
All ages	22,600	$704	17,600	24,400	$424	40,200	$1,128
Women							
0-14 year olds	11,700	$307	16,600	21,900	$221	28,200	$528
15-24 year olds	7000	$183	7760	10,300	$101	14,800	$284
25-44 year olds	0	$0	0	0	$0	0	$0
45-64 year olds	0	$0	0	0	$0	0	$0
65+ year olds	0	$0	0	0	$0	0	$0
All ages	18,700	$490	24,300	32,300	$322	43,000	$812
Per capita (QALYs/1000 people & $)	11.1	$320	62.2 (ratio Māori/non-Māori 5.6)	84	$1,107	19	$440

*QALYs gained and net health system cost savings are zero for age-groups 25-44 year olds, 45-64 year olds, and 65+ year olds as the tobacco-free generation strategy only affects those who are aged o to 20 in 2011 (smoking uptake is modelled at age 20 only)

†Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.

‡Includes both the cost offsets and intervention cost, the latter being the cost of a law (NZ$3.5 million, 95% UI NZ$2.0 to NZ$6.2 million) to introduce a new law that prohibits tobacco sales to those born in 1993 or thereafter, distributed pro-rata across all people alive in 2011. The cost of a law was not partitioned by age, sex, and ethnicity.

Table 7 QALYs gained and net health system costs averted from a combined tobacco endgame strategy (outlet reduction, tax increases, tobacco-free generation), among the New Zealand population alive in 2011 (at 3% discounting)

	Non-Māori		Māori			Ethnic groups combined	
Sex and age (in 2011)	**QALYs**	**Cost savings (million)**	**QALYs**	**QALYs – equity†**	**Cost savings (million)**	**QALYs**	**Net cost savings (million) ‡**
Sex and age-groups combined	64,300 (43,200 to 96,000)	$1680 ($1113 to $2450)	54,900 (39,000 to 76,970)	75,000 (52,000 to 107,000)	$925 ($653 to $1268)	119,000 (82,700 to 173,000)	$2600 ($1760 to $3690)
Men							
0-14 year olds	13,900	$437	11,900	16,000	$292	25,800	$729
15-24 year olds	11,100	$338	7120	9830	$166	18,300	$503
25-44 year olds	6460	$155	2730	3950	$52.3	9190	$208
45-64 year olds	3520	$58	870	1420	$12.06	4390	$70
65+ year olds	282	$2.45	25	50	$0.22	307	$2.66
All ages	35,200	$991	22,700	32,000	$522	57,900	$1513
Women							
0-14 year olds	11,700	$309	16,600	22,000	$222	28,400	$531
15-24 year olds	8690	$226	9730	12,900	$125	18,400	$351
25-44 year olds	5220	$112	4330	6090	$44.1	9550	$156
45-64 year olds	3090	$43	1480	2410	$10.63	4570	$53.8
65+ year olds	303	$1.93	55	110	$0.23	358	$2.15
All ages	29,000	$692	32,200	43,000	$402	61,300	$1094
Per capita (QALYs/1000 people & $)	17	$451	81(ratio Māori/non-Māori 4.7)	111	$1,370	27	$591

†Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.
‡Includes both the cost offsets and intervention cost, the latter being the cost of a law (NZ$3.5 million, 95% UI NZ$2.0 to NZ$6.2 million), distributed pro-rata across all people alive in 2011. The cost of a law was not partitioned by age, sex, and ethnicity.

Table 8 QALYs gained and net health system costs averted from a sinking lid on the supply of tobacco to the commercial market between 2011 and 2025, among the New Zealand population alive in 2011 (at 3% discounting)

	Non-Māori		Māori			Ethnic groups combined	
Sex and age (in 2011)	**QALYs**	**Cost savings (million)**	**QALYs**	**QALYs – equity†**	**Cost savings (million)**	**QALYs**	**Net cost savings (million) ‡**
Sex and age-groups combined	177,000 (115,000 to 261,000)	$3890 ($2550 to $5790)	105,000 (73,300 to 143,000)	151,000 (100,000 to 220,000)	$1540 ($1094 to $2160)	282,000 (189,000 to 405,000)	$5430 ($3640 to $7960)
Men							
0-14 year olds	13,600	$424	11,800	16,300	$285	25,400	$709
15-24 year olds	18,400	$528	10,600	14,900	$237	29,000	$766
25-44 year olds	45,600	$1040	15,900	23,800	$292	61,600	$1,332
45-64 year olds	19,900	$309	3820	6650	$51	23,800	$360
65+ year olds	660	$3.44	23	69	$0.10	680	$3.54
All ages	98,000	$2310	42,100	61,700	$865	140,000	$3170
Women							
0-14 year olds	11,400	$299	16,400	21,700	$216	27,800	$515
15-24 year olds	13,400	$335	14,500	19,700	$177	28,000	$512
25-44 year olds	35,800	$721	24,700	36,100	$236	60,500	$957
45-64 year olds	17,600	$225	6680	11,700	$45	24,200	$270
65+ year olds	920	$3.04	119	291	$0.29	1040	$3.32
All ages	79,200	$1580	62,400	89,500	$675	142,000	$2260
Per capita (QALYs/1000 people & $)	48	$1040	155(ratio Māori/non-Māori 3.3)	220	$2280	64	$1230

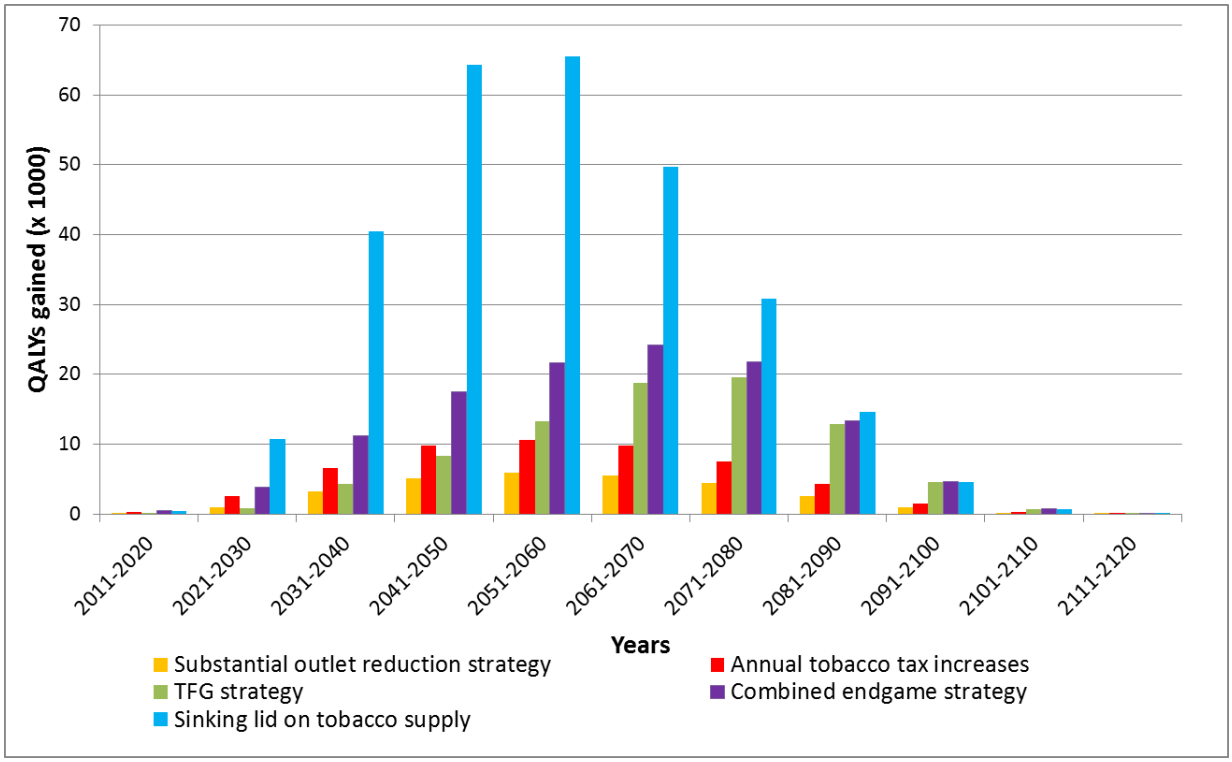
†Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.
‡Includes both the cost offsets and intervention cost, the latter being the cost of a law (NZ$3.5 million, 95% UI NZ$2.0 to NZ$6.2 million) to mandate a sinking lid on the supply of tobacco to the commercial market, distributed pro-rata across all people alive in 2011. The cost of a law was not partitioned by age, sex, and ethnicity.

Table 9 Expected values of total population health gains (in QALYs gained) and health system cost savings (in NZ$) for the five tobacco endgame interventions compared to BAU over the remainder of the 2011 NZ population's lifetime at 6% discounting*, and % QALYs gained and costs saved by 2025, 2040, 2055, and 2070

	Over the remainder of 2011 population's lives		By 2025		By 2040		By 2055		By 2070	
Endgame intervention	**QALYs gained**	**Net health system cost savings in NZ$ in millions**	**% QALYs gained**	**% Cost savings**	**% QALYs gained**	**% Cost savings**	**% QALYs gained**	**% Cost savings**	**% QALYs gained**	**% Cost savings**
6% discount rate										
Outlet reduction	7710	$193	4.1%	5.6%	29.1%	40.3%	63.7%	76.9%	87.1%	96.0%
Tax increases	14,600	$372	5.3%	9.1%	33.6%	45.9%	67.2%	80.0%	88.7%	96.7%
TFG strategy	17,200	$518	1.0%	0.7%	15.2%	17.7%	41.9%	57.9%	73.3%	91.6%
Combined strategy	29,400	$807	3.9%	6.1%	27.1%	34.8%	58.0%	71.3%	83.2%	94.7%
Sinking lid	82,100	$2020	2.5%	6.2%	31.6%	49.9%	71.0%	85.9%	92.2%	98.2%

Figure 2 QALY gains [a] and cost savings [b] accrued by decade into the future for the selected tobacco endgame strategy over the lifetime of the NZ population (at 3% discounting)

[a]



[b]

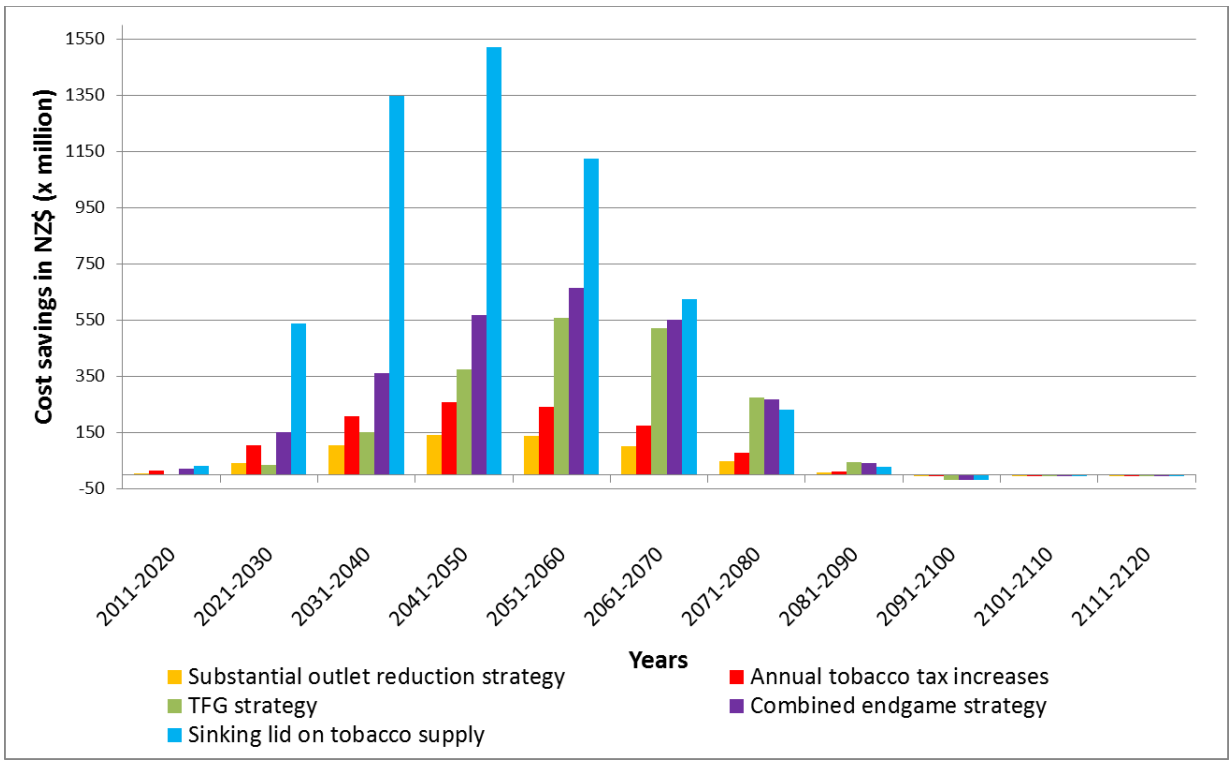


Table 10 Scenario analyses about QALY gains and health system cost savings (expected values) over the lifetime of the New Zealand population alive in 2011 by ethnic group for each of the selected tobacco endgame interventions

	non-Māori (sex and age=groups combined)			Māori (sex and age-groups combined)		
Scenario	**QALYs gained**	**Net health system cost savings in NZ$ (million)**	**Year <5% prevalence is achieved**	**QALYs gained**	**Net health system cost savings in NZ$ (million)**	**Year <5% prevalence is achieved**
Substantial outlet reduction strategy						
Base-case model (3% discount rate) †	15,400	$373	2035	13,400	$216	2059
0% per annum discount rate‡	73,200	$1330	2035	69,600	$752	2059
50% lower price elasticities for all‡	7900	$192	2036	6990	$113	2061
Price elasticities same for Māori/non-Māori‡	15,400	$373	2035	11,300	$182	2060
No growth in the illicit market share (remains stable at 1%)‡	15,800	$382	2035	13,800	$221	2059
10% tax increases until 2025						
Base-case model (3% discount rate) †	28,900	$699	2032	23,200	$372	2054
0% per annum discount rate‡	131,000	$2390	2032	113,000	$1230	2054
20% annual tax increases‡	55,000	$1320	2028	42,300	$673	2044
Price elasticities same for Māori/non-Māori‡	28,900	$699	2032	19,700	$317	2061
No growth in the illicit market share (remains stable at 1%)‡	29,600	$716	2032	23,700	$381	2054
Tobacco-free generation strategy						
Base-case model (3% discount rate) †	40,700	$1190	2027	41,800	$750	2035
0% per annum discount rate‡	255,000	$5270	2027	251,000	$2940	2035
Continued youth smoking uptake (at 20% of BAU trends)‡	32,500	$950	2029	33,200	$596	2040
Increased cessation among adults (BAU annual adult smoking cessation rates were increased by 10% for 20-34 year olds, by 5% for 35-54 year olds, and by 2·5% for 55+-year olds) ‡	48,400	$1350	2026	45,500	$798	2034
Combined tobacco endgame strategy						
Base-case model (3% discount rate) †	63,200	$1670	2025	54,500	$924	2032

	non-Māori (sex and age=groups combined)			Māori (sex and age-groups combined)		
Scenario	**QALYs gained**	**Net health system cost savings in NZ$ (million)**	**Year <5% prevalence is achieved**	**QALYs gained**	**Net health system cost savings in NZ$ (million)**	**Year <5% prevalence is achieved**
0% per annum discount rate‡	336,000	$6530	2025	296,000	$3350	2032
20% annual tax increases‡	78,500	$1990	2024	62,700	$1040	2031
Continued youth smoking uptake (at 20% of BAU trends) ‡	57,600	$1500	2026	49,200	$828	2035
Increased cessation among adults‡	70,000	$1810	2025	57,600	$964	2032
50% lower price elasticities for all‡	52,300	$1440	2026	48,400	$840	2033
Price elasticities same for Māori/non-Māori‡	63,200	$1670	2025	52,500	$897	2033
No growth in the illicit market share (remains stable at 1%)‡	63,800	$1680	2025	54,800	$928	2032
Sinking lid on tobacco supply strategy						
Base-case model (3% discount rate) †	175,000	$3910	2022	104,000	$1560	2024
0% per annum discount rate‡	734,000	$12300	2022	467,000	$4780	2024
Ratio quitting/reducing number of cigarettes remains 50/50‡	154,000	$3460	2024	95,300	$1430	2025
Ratio quitting/reducing number of cigarettes starts at 70/30 and then shifts to 100% quitting over time‡	188,000	$4170	2021	109,000	$1620	2024
An emerging illicit market driven by % reduction in supply of tobacco (every 10% reduction in supply equating to a 1% increase in the illicit market) ‡	166,000	$3710	2022	99,500	$1490	2024

† Presented results are expected values (running the model two times with uncertainty switched off) as such central estimates differ from results presented in tables from full-uncertainty model runs ‡All other parameters as per the 'base-case model'.

References

1. Blakely T, Cobiac LJ, Cleghorn CL, et al. Health, health inequality and cost impacts of annual increases in tobacco tax: Multistate lifetable modeling at a country level. *PLoS Med* 2015; *PLoS Med*; **12**(7): e1002232.
2. Committee on the Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products. Public Health Implications of Raising the Minimum Age of Legal Access to Tobacco Products. Washington (DC): Institute of Medicine, 2015.
3. CNN. What Finland's plan to be tobacco-free can teach the world. 2017. http://edition.cnn.com/2017/01/26/health/finland-tobacco-free-plan/ (accessed 26 January 2017).
4. DiFranza JR, Peck RM, Radecki TE, Savageau JA. What is the potential cost-effectiveness of enforcing a prohibition on the sale of tobacco to minors? *Prev Med* 2001; **32**(2): 168-74.
5. Gendall P, Hoek J, Marsh L, Edwards R, Healey B. Youth tobacco access: trends and policy implications. *BMJ Open* 2014; **4**(4): e004631.
6. Walton D, Newcombe R, Li J, White J, Guiney H. Research updates from HPA - Social supply. 2014. http://www.smokefree.org.nz/files/images/Latest%20findings%20from%20HPA%20Research.pdf (accessed 8 November 2016).
7. Marsh L, Dawson A, McGee R. "When you're desperate you'll ask anybody": young people's social sources of tobacco. *Aust N Z J Public Health* 2013; **37**(2): 155-61.
8. Nelson R. Hawaii raises legal age of smoking and buying tobacco. *Lancet (spotlight)* 2015; http://dx.doi.org/10.1016/S2213-2600(15)00366-5 (accessed 10 November 2016).
9. Berrick AJ. The tobacco-free generation proposal. *Tob Control* 2013; **22**(suppl 1): i22-i6.
10. Laugesen M. Snuffing out cigarette sales and the smoking deaths epidemic. *N Z Med J* 2007; **120**(1256): U2587.
11. Thomson G, Wilson N, Blakely T, Edwards R. Ending appreciable tobacco use in a nation: Using a sinking lid on supply. *Tob Control* 2010; **19**(5): 431-5.
12. Borland R. A strategy for controlling the marketing of tobacco products: a regulated market model. *Tob Control* 2003; **12**(4): 374-82.
13. Wilson N, Thomson GW, Edwards R, Blakely T. Potential advantages and disadvantages of an endgame strategy: a 'sinking lid' on tobacco supply. *Tob control* 2013; **22 Suppl 1**: i18-21.
14. Transparency International New Zealand. New Zealand public sector ranked number one as the least corrupt on the planet. Wellington: Transparency International New Zealand, 2017.
15. Bowden JA, Dono J, John DL, Miller CL. What happens when the price of a tobacco retailer licence increases? *Tob Control* 2014; **23**(2): 178-80.
16. Halonen JI, Kivimäki M, Kouvonen A, et al. Proximity to a tobacco store and smoking cessation: a cohort study. *Tob Control* 2014; **23**: 146-151.
17. Pearson AL, van der Deen FS, Wilson N, Cobiac L, Blakely T. Theoretical impacts of a range of major tobacco retail outlet reduction interventions: modelling results in a country with a smokefree nation goal. *Tob Control* 2015; **24**: e32-8.
18. Pearson AL, Cleghorn CL, van der Deen FS, et al. Tobacco retail outlet restrictions: health and cost impacts from multi-state life-table modelling in a national population. *Tob Control;* Online First 22 September 2016.
19. Caceres K, Chaiton M. Hungary: state licensing for tobacco outlets. *Tob Control* 2013; **22**(5): 292-3.
20. Statistics New Zealand. National Population Projections: 2011(base) – 2061. 2012. http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/NationalPopulationProjections_HOTP2011.aspx (accessed 19 July 2012).
21. Blakely T, Carter K, Wilson N, et al. If nobody smoked tobacco in New Zealand from 2020 onwards, what effect would this have on ethnic inequalities in life expectancy? *N Z Med J* 2010; **123**(1320): 26-36.
22. Carter KN, Blakely T, Soeberg M. Trends in survival and life expectancy by ethnicity, income and smoking in New Zealand: 1980s to 2000s. *N Z Med J* 2010; **123**(1320): 13-24.
23. Cobiac L, Ikeda T, Nghiem N, Blakely T, Wilson N. Modelling the implications of regular increases in tobacco taxation in the tobacco endgame. *Tob Control* 2015; **24**: e154-60.

24. Barendregt J. Ersatz User Guide: EpiGear International Pty Ltd (www.epigear.com), 2012.
25. Statistics New Zealand. Census. 2015. http://www.stats.govt.nz/Census.aspx (accessed 30 June 2015).
26. Statistics New Zealand. New Zealand Period Life Tables: 2010–12. 2013. http://www.stats.govt.nz/browse_for_stats/health/life_expectancy/NZLifeTables_HOTP10-12.aspx (accessed 16 April 2013).
27. Woodward A, Blakely T. The Healthy Country? A History of Life and Death in New Zealand. Auckland: University of Auckland Press; 2014.
28. Ministry of Health. Health Loss in New Zealand: A report from the New Zealand Burden of Diseases, Injuries and Risk Factors Study 2006–2016. Wellington: Ministry of Health, 2013.
29. Blakely T, Atkinson J, Kvizhinadze G, Nghiem N, McLeod H, Wilson N. Health system costs by sex, age and proximity to death, and implications for estimation of future expenditure. *N Z Med J* 2014; **127**: 12-25.
30. Ministry of Health. Mortality and Demographic Data 2010. 2013. http://www.health.govt.nz/publication/mortality-and-demographic-data-2010 (accessed 4 October 2013).
31. Barendregt J, Oortmarssen GJ, Vos T, Murray CJL. A generic model for the assessment of disease epidemiology: the computational basis of DisMod II. *Popul Health Metr* 2003; **1**(1): 4.
32. Blakely T, Costilla R, Soeberg M. Cancer excess mortality rates over 2006-2026 for ABC-CBA. Wellington: Department of Public Health, University of Otago, Wellington 2012.
33. Costilla R, Atkinson J, Blakely T. Incorporating Ethnic and Deprivation Variation to Cancer Incidence Estimates over 2006-2026 for ABC-CBA. Wellington: Department of Public Health, University of Otago, Wellington 2011.
34. Blakely T, Barendregt JJ, Foster RH, et al. The association of active smoking with multiple cancers: national census-cancer registry cohorts with quantitative bias analysis. *Cancer Causes Control* 2013; **24**: 1243-55.
35. Hunt D, Blakely T, Woodward A, Wilson N. The smoking-mortality association varies over time and by ethnicity in New Zealand. *Int J Epidemiol* 2005; **34**: 1020-8.
36. Thun M, Apicella L, Henley S. Smoking vs other risk factors as the cause of smoking-attributable deaths: confounding in the courtroom. *JAMA* 2000; **284**(6): 706-12.
37. Hoogenveen R, van Baal P, Boshuizen H, Feenstra T. Dynamic effects of smoking cessation on disease incidence, mortality and quality of life: The role of time since cessation. *Cost Eff and Resour Alloc* 2008; **6**: 1.