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Tobacco endgame intervention impacts on health gains and Māori:non-Māori health inequity: a simulation study of the Aotearoa/New Zealand Tobacco Action Plan

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ABSTRACT

Background The Aotearoa/New Zealand Government is aiming to end the tobacco epidemic and markedly reduce Māori:non-Māori health inequalities by legislating: (1) denicotinisation of retail tobacco, (2) 95% reduction in retail outlets and (c) a tobacco free-generation whereby people born after 2005 are unable to legally purchase tobacco. This paper estimates future smoking prevalence, mortality inequality and health-adjusted life year (HALY) impacts of these strategies.

Methods We used a Markov model to estimate future yearly smoking and vaping prevalence, linked to a proportional multistate life table model to estimate future mortality and HALYs.

Results The combined package of strategies (plus media promotion) reduced adult smoking prevalence from 31.8% in 2022 to 7.3% in 2025 for Māori, and 11.8% to 2.7% for non-Māori. The 5% smoking prevalence target was forecast to be achieved in 2026 and 2027 for Māori males and females, respectively. The HALY gains for the combined package over the population's remaining lifespan were estimated to be 594 000 (95% uncertainty interval (UI): 443 000 to 738 000; 3% discount rate). Denicotinisation alone achieved 97% of these HALYs, the retail strategy 19% and tobacco-free generation 12%.

By 2040, the combined package was forecast to reduce the gap in Māori:non-Māori all-cause mortality rates for people 45+ years old by 22.9% (95% UI: 19.9% to 26.2%) for females and 9.6% (8.4% to 11.0%) for males.

Conclusion A tobacco endgame strategy, especially denicotinisation, could deliver large health benefits and dramatically reduce health inequities between Māori and non-Māori in Aotearoa/New Zealand.

INTRODUCTION

Despite unequivocal evidence about the harm caused by commercial tobacco, it continues to be a leading cause of avoidable morbidity and mortality.¹ Smoking prevalence in high-income countries with colonial histories has steadily decreased, but prevalence among Indigenous peoples is often substantially higher² and is a significant contributor to health inequities.³

Indigenous peoples' experiences of colonisation include imposition of alien societal institutions,

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Modelling of health gains and health inequality reductions for some tobacco endgame strategies has been undertaken internationally, and specifically in Aotearoa, such as tobacco-free generation policy, substantial reductions in the number of tobacco outlets, including a sinking lid that gradually phased out all tobacco supply between 2011 and 2025 and restricting tobacco sales to pharmacies only with brief cessation advice provided to consumers. All modelling suggested that these interventions improved equity, of varying magnitude, in either smoking prevalence or health gain for Māori compared with non-Māori.
- ⇒ Endgame modelling of denicotinisation has not been undertaken, alone or in combination with other interventions. The interplay of tobacco smoking and vaping has not been explicitly included in endgame modelling. The package of endgame strategies in the Aotearoa/New Zealand Government's Smokefree Action Plan (December 2021) has not been modelled.

appropriation of economic resources and exposure to racism. Referred to as 'basic causes',^{4 5} these affect access to social determinants of health (eg, income, housing) and, via health behaviours such as smoking rates, ultimately leading to racialised health inequities. In many instances, this has been compounded by the use of tobacco as a trade commodity. Since the late 19th century, tobacco companies have actively exploited and promoted commercial tobacco to Indigenous peoples.^{2 6 7}

In 2021–2022, 19.9% of Māori (the Indigenous peoples of Aotearoa/New Zealand (A/NZ)), 18.2% of Pacifica, 2.6% of Asian and 7.2% of European/Other aged 15 years and older smoked at least daily.⁸ Over the last 2 years, the decline in smoking prevalence accelerated from 11.9% (95% CI 11.1% to 12.7%) for all ethnic groups combined in 2019–2020 to 8.0% (95% CI 7.0% to 9.0%) in 2021/2022. Over the same period, daily vaping prevalence increased from 3.5% (95% CI 3.0% to 4.1%) in 2019–2020 to 8.3% (95% CI 7.1% to 9.7%) in 2021–2022. Vaping prevalence was highest for people 18–28 years old (22.9%)

WHAT THIS STUDY ADDS

- ⇒ The government's package (denicotinisation of retail tobacco, 95% reduction in the number of tobacco retail outlets and a tobacco-free generation), if implemented in 2023, is forecast to achieve less than 5% smoking prevalence by 2025 for non-Māori and by 2027 for Māori.
- ⇒ Denicotinisation is estimated to achieve the majority of the health gains.
- ⇒ A 95% retail outlet reduction and a tobacco-free generation, on their own, are unlikely to achieve a 5% smoking prevalence for any sex by ethnic groups until at least 2040.
- ⇒ The combined package, compared with business as usual, is estimated to reduce the Māori:non-Māori gap in all-cause mortality of those aged 45+ years old in 2040 by 22.9% (95% uncertainty interval (UI) 19.9% to 26.2%) for females and 9.6% (95% UI: 8.4% to 11.0%) for males.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ No high-income country, particularly those with colonial histories, has yet implemented a comprehensive tobacco endgame strategy that includes both process and outcome measures with the goal of dramatically reducing health inequities. As such, modelling how the Aotearoa/New Zealand Government's endgame legislation is implemented and the outcomes it might achieve will provide important empirical evidence to inform policy action in other countries.

and among Māori (2.09 times non-Māori). The reasons for the recent acceleration of decline in tobacco smoking, and increase in vaping, may be due to a mix of: ongoing tobacco control efforts; relative ease of access to vaping products and economic pressures that favour lower-cost vaping over smoking; impacts of the pandemic; and possibly anticipatory changes due to the policies modelled in this paper that have received much media coverage.

Similar to other high-income countries, A/NZ's tobacco control programme includes: restricting the promotion of tobacco products, providing cessation support, mass media campaigns, regular increases in excise tax and smoke-free areas.⁹ Many of these measures rely on individual capacity and access to the resources needed to quit cigarettes. These resources are inequitably distributed across the A/NZ population, likely explaining a failure of A/NZ's tobacco control programme to address smoking disparities in the past. Concern about the slow progress in reducing smoking prevalence among Māori led Māori political and tobacco control leaders to propose a tobacco endgame in the mid-2000s. Instead of focusing on people who smoke, they argued that the tobacco industry and the products they sell should be targeted. In 2011, the A/NZ Government committed to achieving a smoke-free country by 2025¹⁰ (commonly interpreted as less than 5% smoking prevalence among both Māori and non-Māori). Achieving this goal required a radical departure from business-as-usual (BAU) approaches,¹¹ but actual tobacco control policy remained relatively unchanged. The 2010s coincided with the proliferation of alternative nicotine delivery devices (e-cigarettes in particular) and introduced a discourse about 'harm minimisation' to the endgame debate.¹² A more holistic notion of 'harm' expressed among many Māori includes addiction as well as health harm, meaning that achieving an end to both nicotine addiction as well as tobacco smoking is the desired endgame.

The A/NZ Government launched an Action Plan in late 2021 to achieve the country's endgame objective.¹³ This plan focused on smoked tobacco and sought to bring about rapid and profound reductions in smoking prevalence, and to do so equitably such that all population groups (in particular Māori) achieve minimal smoking prevalence by 2025. Three key ('endgame') strategies were identified in the Action Plan to achieve this goal: denicotinising retail tobacco to non-addictive levels (eg, ≤ 0.4 mg nicotine/cigarette),¹⁴ markedly reducing retail access to tobacco and creating a 'tobacco-free generation'. The latter would be achieved by progressively raising the legal age at which tobacco can be sold to young people. These measures do not directly address basic causes or social determinants of smoking-related inequities. However, they substantively circumvent the role of agency (eg, individual access to necessary social or economic resources) in being able to quit smoking or resisting initiation. As such, they have strong potential to bring equitable change in smoking behaviour.¹⁵ A challenge of these types of measures is that they would act against Indigenous aspirations of empowerment and self-determination¹⁶ if they were enacted by a predominantly non-Indigenous government 'on' Māori. The Action Plan has sought to address this issue by seeking Māori engagement throughout the planning and policy development stages, including establishing a Māori Governance group.

Internationally, there is a growing interest in tobacco endgame goals and strategies. Scotland, for example, has included a strong focus on equity within their endgame goals and strategies,¹⁷ but, other than in A/NZ, a focus on Indigenous health inequities has not been a key objective of endgame strategies. To date, the implementation of endgame interventions has been minimal and, consequently, the evidence base of their potential effects is weak.¹⁸ For example, none of the endgame interventions included in the A/NZ Action Plan have been implemented at country level, with the possible exception of substantial reductions in retail supply in Hungary.

This paper aimed to estimate the future tobacco smoking prevalence, mortality and health-adjusted life year (HALY) impacts (including changes in Māori/non-Māori inequities) of tobacco endgame strategies outlined in the A/NZ Government's proposed Action Plan. Specific research questions were:

1. Which endgame strategies have the potential to reduce smoking prevalence to less than 5% for all sex and ethnic groups by 2025?
2. Which endgame strategies maximally reduce Māori/non-Māori health inequities?

We used simulation modelling to calculate these estimates, using a range of data inputs from trial evidence (eg, for very low nicotine cigarettes) to observational evidence (eg, people who smoke responses to what they would do in the face of policies proposed) to expert knowledge elicitation when required. Forecasting the future is uncertain. Accordingly, all input parameters have uncertainty related to them that the reader can inspect, all outputs incorporate uncertainty due to the propagated input parameter uncertainty in Monte Carlo simulation and we tease apart which input parameter drives most of the output uncertainty. A key principle of this study is that even if as a research community we do not have ideal data, decision-makers and society need the best estimates we can produce, with appropriate depiction and caveats about inevitable uncertainty.

METHODS

We used an existing tobacco simulation model^{19–21} (rated as best of 25 tobacco models globally²²) and expanded its capabilities to

create a new model called Scalable Health Intervention Evaluation (SHINE) tobacco, which includes a Markov smoking and vaping life history model and functionality for outputting packages of interventions and mortality rates by time.

Smoking and vaping life history model

We developed a Markov model to simulate population smoking and vaping behaviours, based on seven states (online supplemental figure S1 and table S1): never smoker (NS), current smoker (CS), never smoker current vaper (NSCV), dual user (DU), former smoker current vaper (FSCV), former smoker and/or former vaper (FSFV), never smoker former vaper (NSFV). Movement between states is determined by transition probabilities, which reflect BAU and the potential effects of interventions (below). Initiation of smoking (transition from NS to CS or DU) and vaping (transition from NS to NSCV) was assumed to occur at age 20 years. From the age of 20 years onwards, any quitting of smoking was assumed permanent, parameterised as a 'net' cessation rate from CS and DU to either FSCV or FSFV. For proportions of the cohort in the FSCV state, there was an annual net transition probability to FSFV, but no return flow from FSFV to FSCV. The FSFV, FSCV and NSFV states were additionally modelled as 20-year tunnel states that the cohort

progressed through each year, allowing the model to identify how many years each cohort was from quitting so as to incorporate decaying impacts of smoking on disease incidence by time since quitting (see below).

To specify the transition probabilities under BAU, we first estimated future daily smoking (and vaping) rates by extrapolating trends in the 2013–2014 to 2019–2020 NZ Health Survey data, using a two-step regression approach: (1) a best fit regression model to historical data; and (2) a regression model on the former predictions by sex, age and ethnicity to generate annual net cessation rates by cohort as they age, and annual trends in initiation. We elected to not incorporate 2020–2021 and 2021–2022 data in the calibration for three reasons: (a) the exceptional circumstances of the COVID-19 pandemic and the likely impact on smoking; (b) the accelerating decline in smoking prevalence in the last 2 years may partially reflect anticipatory effects of people who smoke realising the endgame policy package is imminent; (c) if incorporating the last 2 years of data, it is unclear whether to only use the last 3 years of data to forecast future smoking prevalence (which is too little data for forecasting), or some average of the trend from 2013 to 2014 to 2021–2022.

Table 1 Baseline and business-as-usual (BAU) parameters

Parameter	Data source	Trend, uncertainty and scenario analyses
Demography		
Population	Statistics New Zealand (SNZ) population estimates for 2018 by sex, age group and ethnicity	Uncertainty: nil
BAU—epidemiological parameters		
All-cause mortality rates (ACMRs)	SNZ mortality rates by sex, age and ethnicity for 2020	Trends in ACMR were estimated using data from the GHDx database IHME. The annual percentage change in the age-standardised all-cause mortality rates from 1990 to 2019 was –1.9% for sexes combined. Retaining the original BODE3 model assumption of a 0.5% point greater APC for Māori (due to long run trends of closing ethnic inequalities in mortality), we arrived at APCs for ACMR from 2020 to 2035 of: Māori=–2.0%; non-Māori=–1.5%. They were uniform by age. No trends applied beyond 2035. Uncertainty: nil.
All-cause morbidity rates	NZ Burden of Disease Study (NZBDS) ²⁵	Data on years of life lived with disability (YLD) were obtained from the NZBDS for each sex and age group in 2016 ²⁵ and divided by the population in each sex by age by ethnic group to generate morbidity rates. No time trend was allowed.
Disease-specific incidence, prevalence and case fatality rates (CFRs)	NZBDS ²⁵	For each tobacco-related disease, coherent sets (by sex, age and ethnicity) of incidence rates, prevalence, CFRs and remission rates (zero for non-cancers, the complement of the CFR for cancers to give the expected 5-year relative survival) were estimated using the software DisMod II. Cancer incidence and CFR APC trend using Poisson regression historical trends of incidence and CFRs of diseases. The APCs included as inputs to the PMSLT model out to year 2035 and held constant beyond (future prevalence changes dynamically with model). It was assumed that the APCs were constant by ethnicity. Uncertainty: starting in 2020, rates all $\pm 5\%$ SD, correlations 1.0 between four sex by ethnic group categories for all diseases. APC all $\pm 0.5\%$ SD normal, correlations 1.0 between four sex by ethnic groups for all diseases.
Disease-specific morbidity	NZBDS ²⁵	The sex and age-specific disability rates were calculated as disease's YLD obtained divided by the prevalent cases. The same disability rate was assumed by ethnicity (ie, those with disease are assumed to have same severity distribution across ethnicity). Uncertainty: $\pm 5\%$ SD (beta distribution).
Tobacco smoking and vaping		
Smoking (daily)	NZ Health Survey	Logistic regression of NZ Health Survey data for years 2011–2019 was undertaken to 'predict' the prevalence of daily smoking (at least one cigarette per day) for years 2020–2040. This 'prediction file' was then reanalysed from a sex by ethnicity by 5-year age group perspective (ie, 72 separate sex by age by ethnicity cohorts) to generate future BAU smoking prevalence—and a yearly (cohort ageing) rate of decline—that was then used in the exposure model.
Vaping (daily e-cigarette use)	NZ Health Survey	Same as above for smoking, but for 'vaping' at least daily.
Association of smoking and vaping with disease incidence rates		
Smoking–disease incidence rate ratios	Relative risks of disease incidence for the association of current (or ex-smoker) with never smoker were sourced from NZ linked census cancer ³³ and census mortality ³⁴ (censuses include smoking question) and data from the Cancer Prevention Study II for respiratory diseases. ³⁵ Attenuation over time since quitting for ex-smokers was modelled using equations and coefficients from Hoogenveen <i>et al.</i> ³⁶	Standard errors of regression coefficients as described in online supplemental appendix C and tables S20 and S21.
APC, annual percentage change; BODE3, Burden of Disease Epidemiology, Equity and Cost-Effectiveness; GHDx, Global Health Data Exchange; IHME, Institute of Health Metrics and Evaluation; PMSLT, proportional multistate life table.		

Table 2 Intervention input parameter table

Parameter	Description
Denicotinisation	
NS→CS (age 20 only)	90% (SD 5%) of BAU initiation at age 20 by 5 years after implementation ($X=\beta$ (32.4, 3.6), median 90.7%, 95% UI: 78.5% to 97.4%). Implemented as $1-(1-X)^{(t/5)}$ scalar applied to the BAU initiation rates in years t (1–5) after introduction of the policy, then held at $1-X$ thereafter.
NS→DU (age 20 only)	
CS→FSFV CS→FSCV DU→FSFV DU→FSCV	Using an expert knowledge elicitation (see online supplemental appendix D), the reduction in smoking prevalence 5 years after the low nicotine policy compared with BAU in 5 years, due to quitting or switching to vaping, was mean 84.4% (SD 7.84%, $X=\beta$ (17.78, 3.19), median 85.9%, 95% UI: 67.1% to 96.3%). Implementation was as $1-(1-X)^{(t/5)}$ scalar applied to BAU CS and DU prevalence, where t is the 1–5 years after intervention. For the sixth and subsequent years, the transition probabilities were twice those in BAU (due to an ongoing higher NCR, given non-addictive levels of nicotine in tobacco).
NS→NSCV	No change.
Denicotinisation plus mass media	
NS→CS (age 20 only)	As above for low nicotine.
NS→DU (age 20 only)	As above for low nicotine.
NS→NSCV (age 20 only)	No change.
CS→FSFV CS→FSCV DU→FSFV DU→FSCV	As above for low nicotine from year 1 to 5+ twice the absolute contribution of the routine media/Quitline campaign added to background net cessation (ie, $1.055\% \times 2 = 2.1\%$) ³⁰ Subsequent years: transition to quitting or vaping was twice those in BAU.
Retail outlet restriction to about 300 outlets (about 5% of current outlets; assumed supply of e-cigarettes reduces commensurately)*	
NS→CS	As per the increase in cessation probabilities (CS→FSFV, etc, below), we reduced the initiation rate by $X=\beta$ (23.4, 97.2), median 19.2%, 95% UI: 12.9% to 26.9%. Applies in 2023 onwards (as youth contemplating initiating in the future confront lesser retail availability as well).
NS→DU	As above for NS→CS.
CS→FSFV CS→FSCV DU→FSFV DU→FSCV	As a low estimate of one-off quitting, we used that from studies modelling reducing retail outlets in terms of increased travel costs ³⁷ : a reduction in the prevalence of 15.6% for Māori, and 16.0% for non-Māori—or 15.8% overall. As a high estimate, we used that from the New Zealand - International Tobacco Control study where—in response to a question whether they would quit in response to a 95% reduction in retail outlets—23.0% said they would quit (half quitting→FSFV, half switching to FSCV). ³⁸ Placing the mean at 19.4% (average of above 15.8% and 23%) and using 15.8% and 23% as one SD either side of the mean (SD=3.6%), we parameterised the one-off increase in smoking net cessation as $X=\beta$ (23.4, 97.2), median 19.2% (ie, percentage point increase), 95% UI: 12.9% to 26.9%. Note this increase was on top of BAU transition probabilities and halved over CS→FSFV and CS→FSCV and halved over DU→FSFV and DU→FSCV. For example, if the CS→FSFV was 5%, the intervention CS→FSFV transition probability was $5\% + (1-5\%) \times 0.5 \times X\%$. This effect was in the year of intervention only—in years after the retail outlet restriction, the transition probabilities out of CS and DU reverted to BAU.
NS→NSCV	Unchanged.
Tobacco-free generation	
Smoking initiation rate (NS→CS; occurs only at age 20)	For two reasons, a tobacco-free generation proposal will not immediately achieve zero uptake at age 20; (1) our model for parsimony assumes all uptake at age 20, but the minimum legal age of purchasing is 18 years; (2) social supply will allow some young people to keep initiating. We therefore assumed that initiation at age 20 in our model (essentially an average of all initiation by (say) age 25) will asymptote to a mean of $X=10\%$ (SD 5%) of BAU in 10 years (β (3.6, 32.4), median 9.3%, 95% UI: 2.6% to 21.5%), with the scalar of BAU initiation rate of $X^{(t/10)}$ for $t=1-10$ years after the tobacco-free generation policy is implemented, then X of BAU initiation thereafter.
NS→DU	As above for NS→CS.
NS→NSCV	Unchanged.*
Combined: denicotinisation+retail+tobacco-free	
NS→CS (age 20 only)	Cumulative impact. If the % reduction in initiation in year t for denicotinisation, retail and tobacco-free was A%, B% and C%, then the reduction in the combined intervention was $1-(1-A)(1-B)(1-C)$.
NS→DU (age 20 only)	As above for NS→CS.
CS→FSFV CS→FSCV DU→FSFV DU→FSCV	Cumulative impact. If the % increase in quitting or switching in year t for denicotinisation, media and retail was A% and B%, then the increase in the combined intervention was $1-(1-A)(1-B)(1-C)$.
NS→NSCV	Unchanged.

*If the availability of alternative nicotine delivery systems (ANDS, for example, e-cigarettes) does not reduce commensurately with these policy interventions, one would expect larger switched to ANDS which would reduce smoking prevalence further (but increase DU, FSCV and possibly NSCV state prevalence). We do not model this explicitly but consider it in the Discussion section.
BAU, business as usual; CS, current smoker (but not a dual user); DU, dual user; FSCV, former smoker current vaper; FSFV, former smoker and/or former vaper; NCR, net cessation rate; NS, never smoker; NSCV, never smoker current vaper; NZ, New Zealand; UI, uncertainty interval.

We then calculated annual transition probabilities to achieve these projections, starting with transition probabilities between the seven states from the UK as reported by Doan *et al*²³ (online supplemental table S2), modifying them as required (with mathematical optimisation using Excel Solver) to meet the above projections. We performed this operation by sex and ethnicity for three age cohorts (20–24, 40–44 and 60–64 years), and interpolated other age cohorts.

Proportional multistate life table model

A proportional multistate life table (PMSLT) was used to estimate health impacts of smoking and vaping under BAU and intervention scenarios (key input parameters in table 1), with detailed description provided elsewhere.²⁴ Briefly, the PMSLT is composed of a

main cohort life table, which simulates the entire A/NZ population alive in 2020 until death using projected all-cause mortality and morbidity rates by sex, age and ethnicity (Māori, non-Māori). Thus, for the youngest people, we are estimating HALYs as far out as 2131; however, we focus on the next 20 years in much of the results. In parallel, proportions of the cohort also reside in 16 subsidiary tobacco-related disease life tables according to prevalence at baseline (ie, start of model), and in future years based on BAU disease-specific incidence, case fatality and remission rates. Within each disease life table, morbidity estimates (ie, disability rates from the NZ Burden of Disease Study²⁵) are attached to prevalent cases. Tobacco-related diseases included in the model are: coronary heart disease, stroke, chronic obstructive pulmonary disease, lower respiratory tract infection and 12 cancers (lung,

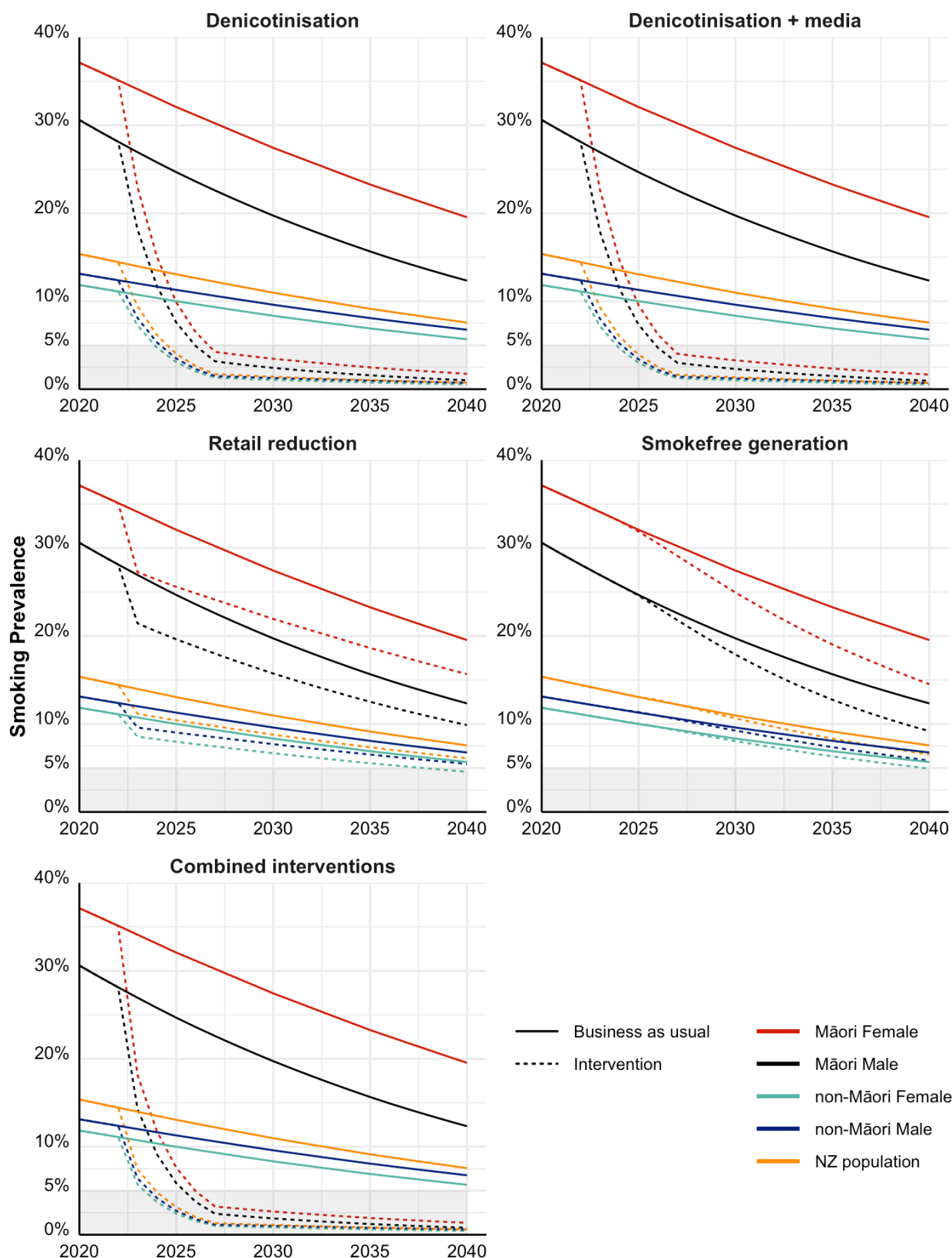


Figure 1 Smoking prevalence (daily, 20+ year population) in Aotearoa New Zealand (NZ) under business as usual and interventions. Prevalences are not age standardised and are calculated for the projected age structure of each sex by ethnic group in future years.

oesophageal, stomach, liver, head and neck, pancreas, cervical, bladder, kidney, endometrial, melanoma and thyroid).

Within each disease life table, an intervention is run in parallel to BAU with different disease incidence rates given changes in

smoking and vaping life histories (see the next section). Each disease life table estimates the difference between intervention and BAU in disease mortality and morbidity rates that are then added to matching entities in the main life table.

Table 3 Deaths averted* during 2020–2030 and 2031–2040, in Aotearoa New Zealand by strategy

Population	Year	Denicotinisation		Denicotinisation+media		Retail reduction		Smoke-free generation		Combined interventions	
		Est	95% UI	Est	95% UI	Est	95% UI	Est	95% UI	Est	95% UI
Female Māori (n=428 948 in 2020)	2020–2030	261	183 to 339	265	188 to 341	87	58 to 123	1	0.39 to 0.77	300	233 to 368
	2031–2040	1780	1360 to 2210	1800	1380 to 2220	441	285 to 643	14	10 to 17	1890	1500 to 2300
	2020–2040	2040	1540 to 2550	2060	1570 to 2560	528	344 to 764	14	10 to 18	2200	1740 to 2650
Female non-Māori (n=2 132 141 in 2020)	2020–2030	281	196 to 367	285	201 to 370	97	64 to 138	0	0.31 to 0.62	324	252 to 401
	2031–2040	1940	1450 to 2430	1960	1480 to 2440	496	321 to 729	9	6.1 to 12	2070	1620 to 2530
	2020–2040	2220	1650 to 2800	2240	1680 to 2810	594	384 to 867	9	6.4 to 12	2390	1870 to 2920
Male Māori (n=425 740 in 2020)	2020–2030	140	97 to 183	142	101 to 184	49	32 to 69	0	0 to 0.01	163	127 to 200
	2031–2040	864	651 to 1070	873	661 to 1080	221	145 to 321	4	2.6 to 4.8	921	726 to 1120
	2020–2040	1000	747 to 1260	1010	765 to 1260	270	176 to 389	4	2.6 to 4.8	1080	851 to 1310
Male non-Māori (n=2 099 493 in 2020)	2020–2030	329	229 to 431	333	236 to 433	113	75 to 160	0	0.12 to 0.28	380	298 to 468
	2031–2040	1970	1500 to 2440	1990	1520 to 2450	504	330 to 734	4	2.6 to 5	2110	1670 to 2540
	2020–2040	2300	1730 to 2860	2320	1760 to 2870	617	405 to 892	4	2.7 to 5.3	2490	1980 to 3000
All (n=5 086 322 in 2020)	2020–2030	1010	707 to 1320	1020	728 to 1320	346	230 to 491	1	0.84 to 1.6	1170	911 to 1430
	2031–2040	6560	4990 to 8160	6620	5060 to 8190	1660	1080 to 2420	30	22 to 37	6990	5520 to 8470
	2020–2040	7570	5680 to 9440	7640	5780 to 9490	2010	1310 to 2900	31	23 to 39	8150	6450 to 9890

*Deaths averted over the period, that is, total deaths over each 10-year period in BAU minus intervention.
BAU, business as usual; UI, uncertainty interval.

Connecting the smoking–vaping life history model to the PMSLT: using population impact fractions

For each sex by age by ethnic group, and each annual time step into the future, a population impact fraction (PIF) is calculated for each tobacco-related disease. The generic formula²⁶ is:

$$PIF_{idt} = \frac{\sum_{j=1}^n P_{ijt} RR_{idj} - \sum_{j=1}^n P'_{jt} RR_{idj}}{\sum_{j=1}^n P_{ijt} RR_{idj}}$$

where: i subscripts each sex by age by ethnic group, d subscripts each disease, t subscripts each time step or yearly cycle, j subscripts n states in the smoking–vaping life history model, RR is the incidence rate ratio for disease d and smoking–vaping state j , and possibly varying by demographics (eg, by sex and age, but not by ethnic group (note the RR does not vary by time step t), and P (P') is the proportion of the demographic cohort (i) in each of j states in each time step t . These PIFs are the percentage change in incidence rates for each smoking-related disease inputted to the PMSLT.

The source and values of the tobacco-related disease incidence rates and rate ratios are given in online supplemental appendices A and B and tables S3–S19. Harm from vaping was modelled as 5%–20% of tobacco harm following Mendez and Warner²⁷ (beta distribution with median 11% and 95% uncertainty interval (UI) of 5% to 20%).

Interventions

To parameterise the intervention scenarios, we considered initial estimates of potential effects based on A/NZ-specific and international literature.²⁸ This information, along with consideration of other more recent literature, was used in an expert knowledge elicitation process for the impact of denicotinised cigarettes on net cessation (above BAU cessation) in the A/NZ context (see online supplemental appendix D). The intervention specifications are shown in table 2; below we give key parameters and their UIs that are sampled from in Monte Carlo simulation. Briefly:

- Denicotinisation: initiation was estimated to be reduced by 90% (95% UI: 78.5% to 97.4%) compared with that in BAU by 5 years after implementation; cessation transition probabilities were increased so that over 5 years, the

smoking prevalence in CS and DU states was reduced by 84.8% (95% UI: 67.1% to 96.3%) compared with that in BAU, and from the sixth year onward, cessation transition probabilities were doubled (see online supplemental appendix D for details).

- Denicotinisation plus mass media: as above, plus an extra increase in cessation rates in the first 5 years of 2.1% (equivalent to twice the impact of past Quitline media campaigns in A/NZ on net cessation rates).
- Retail outlet reduction: we used the average of two inputs: (a) previous modelling²⁹ of increasing travel time, converted to cost and then through price elasticities that estimate a 15.8% reduction in smoking prevalence in the year of implementation, (b) 23.0% of respondents (people who smoke) to the NZ International Tobacco Collaboration Study saying they would quit if outlets reduced by 95%. We used the average of these two (19.4%; 95% UI: 12.9% to 26.9%) as the one-off increase in net cessation in the year of the policy implementation. The same magnitude reduction in initiation was included in the year of implementation and all subsequent years.
- Tobacco-free generation: in theory, initiation will reduce to zero. In practice, social supply is likely. The exact reduction is uncertain, so we specified that future initiation rates will be 10% of BAU, or a 90% reduction compared with BAU with wide uncertainty (95% UI: 78.5% to 97.4%), achieved 10 years after the policy is introduced.

Analyses and parameter uncertainty

We produced the following outputs. First, all and premature (before the age of 75 years) deaths averted by time period. Second, HALYs (3% annual discount rate) gained from each intervention, both the total number and age standardised (using Māori population 2020) per 1000 people. Third, we calculated the age-standardised all-cause mortality rate differences between Māori and non-Māori (by sex) for those aged 45+ years old (by age in the future), under BAU and each intervention, and presented the percentage difference in the rate difference for each intervention compared with BAU.

The BAU and each intervention scenario were simulated 2000 times using Monte Carlo simulation, drawing from the probability density functions specified in [table 2](#).

To help understand the uncertainty in our modelling, we also used univariate sensitivity analyses to depict which input parameter uncertainty generates the most uncertainty in lifetime HALY gains for all sex and ethnic groups combined for the combination endgame policy package compared with BAU. The result is presented as a 'tornado plot' showing the changes in model outputs for selecting the 2.5th and 97.5th percentile of each input parameter in turn (holding all other inputs at their expected value).

RESULTS

Achieving <5% prevalence

The modelled combined package achieves a profound and rapid reduction in smoking prevalence ([figure 1](#) and online supplemental table 23). In 2022, the year before policy implementation, Māori age 20+ years smoking prevalence is 31.8%, falling to 28.7% (95% UI: 25.5% to 30.4%) under BAU by 2025 (the year targeted to have smoking prevalence less than 5% by the A/NZ Parliament). Under the combined package, Māori smoking prevalence decreases to 7.3% (95% UI: 3.9% to 9.2%) in 2025 (females: 8.2%, 95% UI: 4.3% to 10.5%; males: 6.3%, 95% UI: 3.4% to 7.9%). For non-Māori, the smoking prevalence is 11.8% in 2022, falling to 10.8% (95% UI: 9.6% to 11.2%) in 2025 under BAU and decreasing to 2.7% (95% UI: 1.4% to 3.5%) under the combined package (females: 2.5%, 95% UI: 1.3% to 3.3%; males: 2.9%, 95% UI: 1.5% to 3.8%). The combined package achieves the under 5% smoking prevalence target in 2026 and 2027 for Māori males and females, respectively.

Denicotinisation causes the majority of forecasted decreases in smoking. Retail outlet reduction has a strong impact in its year of implementation (due to a large cessation impact), but it then tracks largely as in BAU (as no ongoing increases in cessation are assumed, and reductions in initiation take years to accrue). Neither the retail reduction nor the tobacco-free generation strategies achieve less than 5% smoking prevalence by 2025 for any sex by ethnic group.

Deaths averted

Under the combined policy package, deaths up to 2040 were 8150 (95% UI: 6450 to 9890) less than under BAU, with 27%–30% of these averted deaths among each of female Māori, female non-Māori and male non-Māori ([table 3](#)). Premature deaths averted (ie, deaths occurring before 75 years) up to 2040 were 8540 (95% UI: 6780 to 10 400), a 0.97% (95% UI: 0.77 to 1.17) reduction compared with BAU (online supplemental tables S24–S25).

HALYs gained

For the combined intervention compared with BAU, by sex and ethnic group, 28%–30% of all HALYs gained by the combined package were among female Māori, female non-Māori and male non-Māori, with a lesser 14% among male Māori. For sexes and ethnic groups combined, and for the remainder of the lifespan of the population alive in 2020, there was an estimated 594 000 HALYs gained (95% UI: 443 000 to 738 000: bottom right of [table 4](#)). The majority (90%) of these HALYs gained were after 2040.

The denicotinisation strategy alone achieves 97% of the HALYs of the combined package, retail outlet reduction alone 18% and the tobacco-free generation alone 13%. For the tobacco-free

generation, the vast majority (98%) of HALYs gained over the lifespan of the population occurred after 2040. Online supplemental figure S3 provides a comparison in terms of health gains from the endgame strategies evaluated in this paper with other large-scale public health policies (modelled or already in place) in A/NZ.

Inequality impacts

[Figure 2](#) shows the ratio of age-standardised per capita HALY gains for Māori compared with non-Māori. For the combined package, Māori females gained 4.75 times as many HALYs per capita as non-Māori females, and Māori males gained 2.15 times as many as non-Māori males. The Māori:non-Māori ratio of per capita HALY gains was similar for other interventions, except it was higher for the tobacco-free generation (noting that the absolute gains were less for this strategy—see online supplemental table S26).

Mortality rates of Māori aged 45+ years in 2040 are 11.6% and 5.2% lower under the combined package than under BAU, for females and males, respectively. For non-Māori, these reductions are less at 2.8% and 2.3%, for females and males, respectively. The impact of the combined endgame strategies on the Māori compared with non-Māori 'gap' (absolute difference) in mortality rates by 2040 is shown in [figure 3](#). The rate difference is 23.4% (95% UI: 19.1% to 27.6%) less for females for the combined package compared with BAU, and 9.5% (95% UI: 7.5% to 11.3%) less for males. The denicotinisation policy alone achieves most of this mortality rate inequality reduction, and the retail reduction strategy about a quarter of that for the combination strategy.

Sensitivity analyses for the denicotinisation policy at the lower end of effectiveness (ie, 97.5th percentile values of: the percentage reduction in smoking prevalence due to increased cessation over and above BAU of 67.1%, and the percentage reduction in initiation of 78.5%), and retail outlet reduction and the tobacco-free generation set to their expected or median input values, the total HALY gains for the combined package reduced by 13.6% to 513 000 compared with expected values for all inputs. The contribution of retail outlet reduction and the tobacco-free generation alone compared with the combined package was 19% and 29%, respectively, a higher relative contribution compared with 18% and 13% in the main model (see online supplemental table S27).

[Figure 4](#) shows a tornado plot of how much variation in lifetime HALYs gained (combined endgame policy; 3% discount rate) resulted from univariate sensitivity analyses about the key intervention parameters. Uncertainty about the cessation rate due to denicotinisation was clearly the major source of overall uncertainty in HALYs gained: the 97.5th percentile value of increased cessation leading to 32.9% of BAU smoking prevalence (or conversely a 67.1% reduction in smoking prevalence due to increased cessation) led to 545 000 HALYs gained (end of blue bar in [figure 4](#)) compared with 653 000 HALYs gained (end of red bar) for the 2.5th percentile value of 3.7% of BAU smoking prevalence due to cessation (or conversely a large 96.3% reduction in smoking prevalence due to increased cessation). Uncertainty about other key input parameters generates considerably less uncertainty in the HALYs gained.

DISCUSSION

In A/NZ, a post-colonial country with a high smoking rates among the Māori, we found that tobacco endgame strategies outlined in the December 2021 A/NZ Smokefree Plan,¹³ in particular

Table 4 Health gain (in HALYs gained) for people alive in 2020 (base year, N=5 086 322) in Aotearoa New Zealand by the modelled policies, by timeline into the future (3% discount rate)

Population	Year	Denicotinisation			Denicotinisation+media			Retail reduction			Smoke-free generation			Combined interventions		
		Estimate	95% UI		Estimate	95% UI		Estimate	95% UI		Estimate	95% UI		Estimate	95% UI	
Female Māori	2020–2030	955	679 to 1260		971	699 to 1260		335	221 to 475		23	16 to 31		1130	884 to 1380	
	2031–2040	10600	7990 to 13 100		10700	8160 to 13 100		2800	1830 to 3990		325	242 to 406		11 500	9370 to 13 700	
	2041–2131	151 000	111 000 to 188 000		151 000	112 000 to 189 000		24800	15 900 to 36 700		29900	19 400 to 40 600		157 000	116 000 to 195 000	
	All	162 000	120 000 to 202 000		163 000	121 000 to 203 000		27 900	18 000 to 41 100		30 300	19 700 to 41 000		170 000	127 000 to 210 000	
Female non-Māori	2020–2030	1450	1030 to 1940		1470	1050 to 1950		525	346 to 745		23	16 to 32		1710	1330 to 2130	
	2031–2040	14 700	11 000 to 18 300		14 800	11 200 to 18 400		3990	2610 to 5770		334	239 to 443		16 000	12 800 to 19 200	
	2041–2131	142 000	104 000 to 182 000		143 000	105 000 to 182 000		28 200	17 800 to 42 800		15 300	9950 to 22 400		149 000	109 000 to 189 000	
	All	159 000	116 000 to 201 000		160 000	117 000 to 202 000		32 700	20 800 to 49 200		15 600	10 300 to 22 900		166 000	124 000 to 209 000	
Male Māori	2020–2030	596	423 to 786		606	436 to 792		214	141 to 303		17	12 to 22		707	554 to 871	
	2031–2040	6080	4570 to 7520		6140	4670 to 7560		1640	1070 to 2350		230	171 to 291		6650	5360 to 7940	
	2041–2131	70 100	49 400 to 90 600		70 500	49 600 to 91 000		12 400	7990 to 18 800		12 800	8220 to 18 100		73 600	52 100 to 94 200	
	All	76 700	54 800 to 98 300		77 200	55 300 to 98 800		14 300	9240 to 21 400		13 000	8450 to 18 300		80 800	58 200 to 103 000	
Male non-Māori	2020–2030	1620	1140 to 2150		1640	1170 to 2160		585	384 to 830		24	16 to 33		1910	1500 to 2360	
	2031–2040	15 900	12 000 to 19 700		16 000	12 200 to 19 800		4300	2810 to 6180		345	249 to 455		17 300	14 000 to 20 800	
	2041–2131	151 000	112 000 to 193 000		152 000	112 000 to 193 000		29 500	18 900 to 44 400		16 300	10 800 to 23 800		158 000	119 000 to 199 000	
	All	168 000	126 000 to 214 000		169 000	127 000 to 214 000		34 400	22 100 to 51 400		16 700	11 100 to 24 300		177 000	134 000 to 221 000	
All population	2020–2030	4630	3260 to 6140		4690	3360 to 6170		1660	1090 to 2360		88	60 to 118		5460	4280 to 6740	
	2031–2040	47 400	35 700 to 58 500		47 800	36 400 to 58 700		12 700	8300 to 18 300		1230	909 to 1590		51 500	41 500 to 61 600	
	2041–2131	514 000	378 000 to 650 000		517 000	380 000 to 653 000		94 800	60 900 to 143 000		74 200	49 000 to 104 000		537 000	396 000 to 673 000	
	All	566 000	421 000 to 711 000		569 000	424 000 to 714 000		109 000	70 200 to 163 000		75 500	50 200 to 105 000		594 000	443 000 to 738 000	
HALYs, health-adjusted life years; UI, uncertainty interval.																

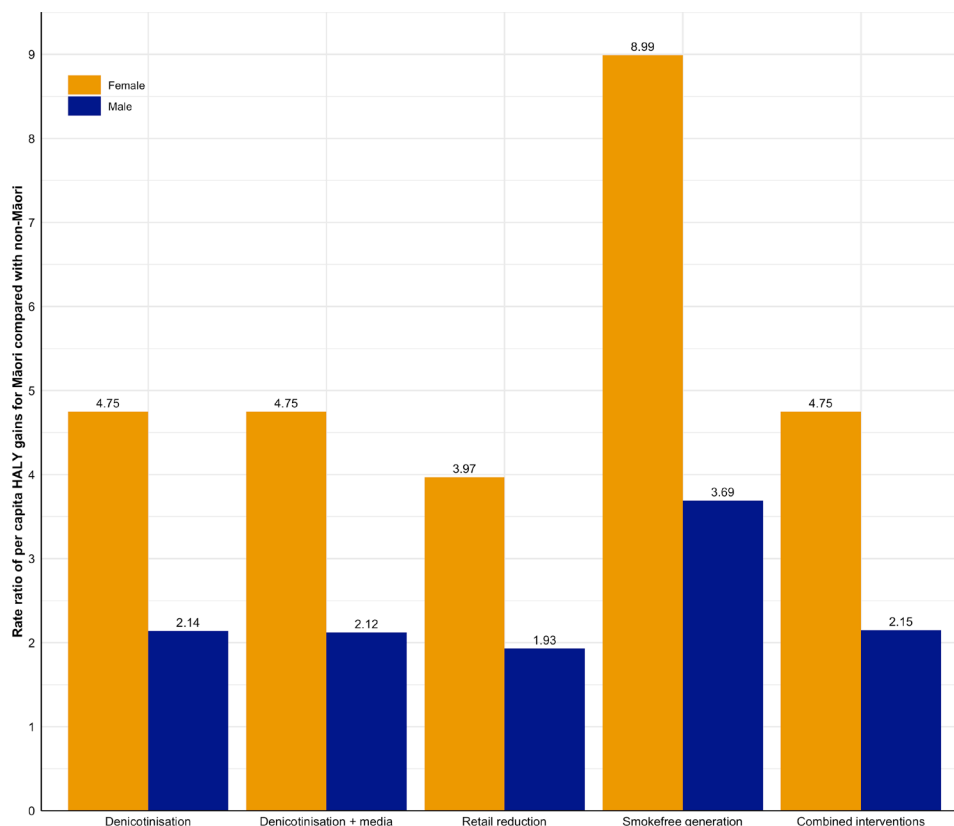


Figure 2 Ratios of per capita HALY gains over the remainder of the 2020 Aotearoa/New Zealand population's lifespan, for Māori compared with non-Māori. Calculated using cohorts defined by age in 2020, age standardised using the 2020 Māori population. HALY, health-adjusted life year.

denicotinisation of commercial tobacco, could have a profound positive impact on the health of Māori and notably reducing health inequity between Māori and non-Māori. For example, by 2040, a combined package including denicotinisation plus media, 95% reduction in retail outlets and a tobacco-free generation would—we estimate—reduce the gap in the mortality rate of people aged 45 years and older by 23.4% (95% UI: 19.1% to 27.6%) for females and 9.5% (95% UI: 7.5% to 11.3%) for males, compared with ongoing BAU. It is unlikely that any other feasible health intervention would reduce ethnic inequalities in mortality by as much.

Our forecasts suggest mandating denicotinisation would have an immediate, marked and enduring impact on smoking prevalence in A/NZ. Importantly, the impacts of this measure would make a significant contribution towards eliminating smoking prevalence inequities between Māori and non-Māori populations. Reducing retail access would have a lesser impact on overall prevalence and inequities and introducing a tobacco-free generation alone would take many years to take full effect with impact on smoking prevalence and then health gains. Nevertheless, the impacts of both of these measures are on par with tobacco tax increases,¹⁹ greater than interventions such as mass media and quit programmes alone,³⁰ and a tobacco-free generation will be relatively more important in terms of health benefits if the impact of the denicotinisation policy is at the lower end of our uncertainty range (see sensitivity analyses above).

The profound impact of tobacco endgame strategies on ethnic health inequities in A/NZ shown in the model is due to higher smoking rates among Māori (especially females), but also because the smoking-related disease rates are higher among Māori (for both tobacco and non-tobacco-related reasons). Such patterning by indigeneity, ethnicity and socioeconomic position occurs in many other countries, suggesting tobacco endgame strategies will notably

reduce health inequities in other countries—as well as improving the health of all citizen groups.

Tackling tobacco is not only a health issue, it has also a social and economic priority for Indigenous peoples.³¹ While not presented in this paper, modelling we conducted for the A/NZ Government to underpin the Action Plan estimated income gains of US\$1.42 billion by 2040 (3% discount rate) due to the income gains occurring among those not dying prematurely or developing chronic disease, a fillip to the A/NZ productivity and Gross Domestic Product (GDP) overall but also a pro-equity economic boost for Māori communities.

Colonisation is an underlying driver of ethnic inequalities in smoking behaviour. Māori engagement and leadership throughout the process of developing and subsequent implementation of A/NZ's Action Plan have been essential to ensure the plan itself is not a further expression of coloniality. Legislation for the actual implementation of the plan is expected to happen during 2022 with different measures coming into force over the next few years.

Other than a temporary ban on tobacco sales in Bhutan, no country has implemented any of the endgame interventions proposed in the A/NZ Action Plan. This lack of evidence about the real-world impacts of endgame strategies means that modelling studies' assumptions about likely impact are based on theory, logic, expert views and simulation studies. It is therefore imperative that where endgame strategies are implemented, robust evaluations are conducted to better inform decision-making and improve modelled estimates such as the current study. Second, such evaluations should thoroughly investigate equity issues, exploring intended and unintended impacts on Indigenous peoples. Third, the striking equity impacts of endgame interventions estimated here, future tobacco control modelling studies should explore impacts on inequities in smoking prevalence and smoking-related disease.

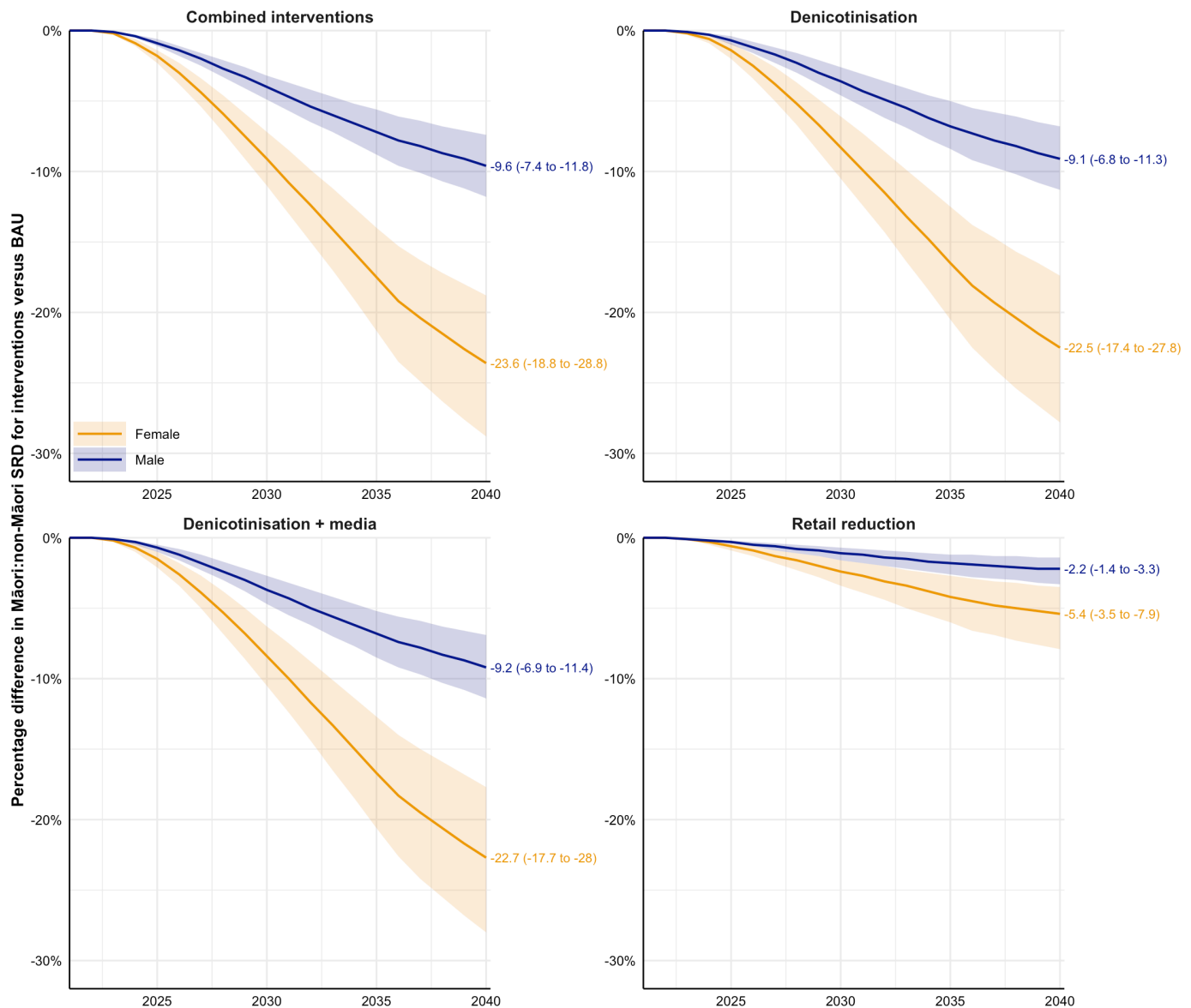


Figure 3 Projected percentage changes in age-standardised all-cause mortality rate differences (≥ 45 years) between Māori and non-Māori, for endgame strategies* compared with BAU. *We do not show the tobacco-free generation as there is no change in mortality rates of those aged 45 plus years old in this timeline. Rates are standardised to the Māori population. BAU, business as usual; SRD, standardised rate difference.

Limitations

Given data limitations, expert judgement and estimates from scenario studies were used in specifying the impacts of endgame policies. We specified substantial uncertainty about most of these inputs (table 2), then used Monte Carlo simulations to generate uncertainty about the outputs of HALYs gained and mortality impacts. The UIs of the HALYs, for example, are non-overlapping between the denicotinisation and retail interventions, and with BAU, suggesting a strong degree of confidence in the ranking of health gains and inequity impacts. Univariate sensitivity analyses for the combined interventions policy package (figure 4) clearly show that input uncertainty about how much denicotinisation will reduce cessation drives much of the uncertainty in the outputs of our modelling. That said, even for this cessation impact varying widely from a 67.1% to 96.3% reduction in prevalence, the lifetime HALY gains were always substantial (range: 545 000–653 000).

Our BAU scenario of future smoking prevalence was based on trends from 2013 to 2014 to 2019–2020. The 2020–2021 Health Survey results showed a notable downturn in smoking

prevalence—that has continued in the 2021–2022 prevalence estimates (see the Introduction section). If the drops in the last 2 years are not partially anticipatory effects of the Action Plan policies, then one could argue that the BAU we used is too high in future smoking prevalence, the corollary of which is that the health gains due to the endgame policies in this paper are overestimated (as some of the gains we attribute to the policies were already occurring under BAU).

Our model assumes that all smoking uptake occurred at age 20 years, and reports smoking prevalence for those aged 20+ years old; had we used 15+ years old as our denominator, the smoking prevalence results reported would have been lower. Our modelling quantified the separate effects of each policy, and their combined effect by simply adding them simultaneously to the modelling. Estimating impacts of temporal ordering of policies (eg, whether to implement denicotinisation or retail outlet reduction first) was beyond the scope of our modelling.

Contextual variations for A/NZ compared with other countries (strong border controls, likely minor illicit tobacco market, ready

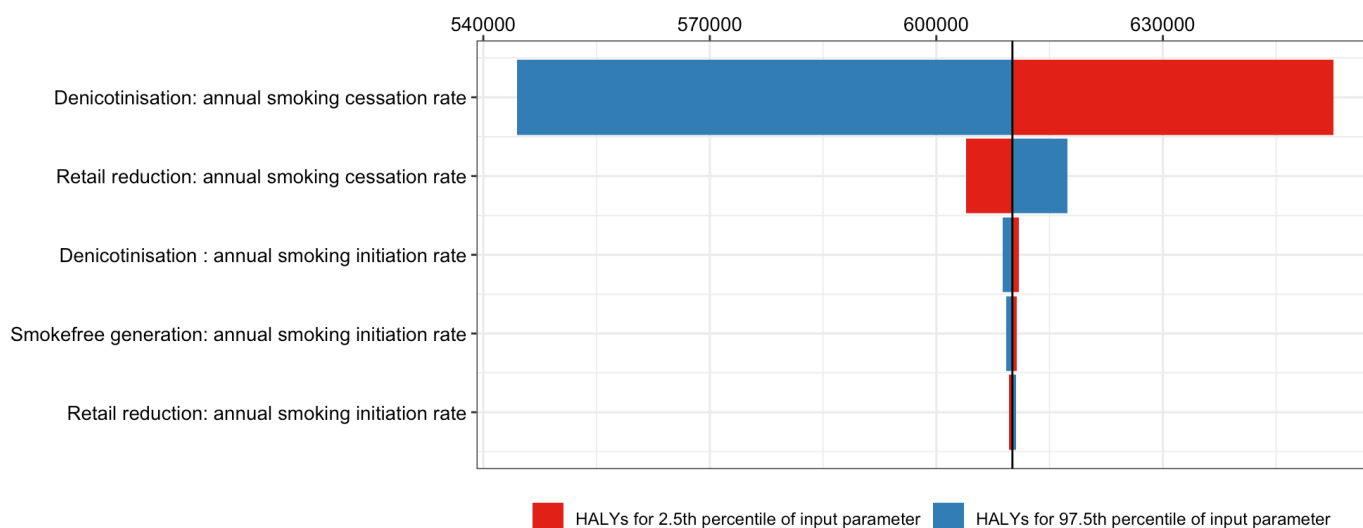


Figure 4 Tornado plots of total HALYs (3% discount, lifetime) showing the ranking of smoking initiation and cessation parameters by how much uncertainty their 2.5th and 97.5th percentiles cause for the combined intervention policy package compared with BAU, for: percentile values for sensitivity analyses (taken from table 2): *Denicotinisation: annual smoking cessation rate*. Cessation rates in first 5 years after policy implementation set to achieve 3.7% (2.5th percentile) or 32.9% (97.5th percentile) of BAU smoking prevalence (median=14.1%). *Retail reduction: annual smoking cessation rate*. One-off (in year of implementation) increase in cessation rate of 12.9 percentage points (2.5th percentile) or 26.9 percentage points (97.5th percentile) (median=19.2 percentage points). Note: when combined with denicotinisation (above), it acts on top of the 'new' (not BAU) denicotinisation cessation rate. *Denicotinisation: annual smoking initiation rate*. Initiation rate 5 years after policy implementation reduced to 2.6% (2.5th percentile) or 21.5% (97.5th percentile) of BAU initiation rates (median=9.3%). *Smoke-free generation: annual smoking initiation rate*. Initiation rate 5 years after policy implementation reduced to 2.6% (2.5th percentile) or 21.5% (97.5th percentile) of BAU initiation rates (median=9.3%). Note: when combined with denicotinisation (above), it acts on top of the 'new' (not BAU) denicotinisation cessation rate. *Retail reduction: annual smoking initiation rate*. Permanent decrease in initiation rate of 12.9% (2.5th percentile) or 26.9% (97.5th percentile) (median=19.2%). Note: when combined with denicotinisation and smoke-free generation (above), it acts on top of the 'new' (not BAU) initiation rate. Note: the vertical black line of 610 073 HALYs is for the median value of all input parameters. It differs modestly from the 594 000 central estimate of HALYs in the main analyses, which is the median across all iterations of the Monte Carlo analyses. BAU, business as usual; HALYs, health-adjusted life years.

access to vaping as a lower-cost substitute) may have contributed to the expert parameterisation of the cessation and initiation impacts in this modelling paper being more optimistic than a previous Food and Drug Administration (FDA) expert knowledge elicitation for the USA³² (online supplemental appendix D). Those estimates of cessation due to mandatory denicotinisation ranged from 20.6% to 99.9% (average across experts 77.2%). Our experts ranged from 78.5% to 95% in their 'most likely' estimates of quitting after 5 years and averaged 65.8% and 96.6% for their pessimist and optimistic estimates, respectively. However, our assumption of a 90% (95% UI: 78.5% to 97.4%) reduction in initiation due to mandatory denicotinisation was higher than the FDA experts (range: 45%–95% across experts).

The paper did not explicitly model the impact of the illicit market. However, homegrown tobacco is uncommon in A/NZ due to a non-ideal environment for growing. Furthermore, tight border security in an island nation with no land borders reduces the potential of an illicit market. Nevertheless, we may have modestly overestimated health gains and smoking prevalence reductions if—say—smoking prevalence was to asymptote to something like 1%–3%, rather than 0%. An important corollary is that achieving the health gains and health inequity reductions modelled in our paper will require strong border control, and comprehensive support for people who smoke to quit (or use alternative nicotine delivery products as a substitute).

We have highlighted the importance of Māori and Indigenous engagement in the development and implementation of the A/NZ's Action Plan. The plan also draws attention to the need for research and evaluation to provide an accountability mechanism to Māori. In this paper, we attempted to uphold Indigenous Data Sovereignty

principles, including Māori and First peoples contributors (AW, RM and RL), providing data analysed against Indigenous population norms and including Indigenous interpretations. But more should be done in the future to engage Maori governance of research alongside the implementation of the Action Plan, facilitating Māori researchers undertaking that research where practicable, and prioritising dissemination of findings to Māori communities first.

CONCLUSION

Many countries have Indigenous, ethnic and socioeconomic inequalities in tobacco use. This modelling study suggests that tobacco endgame strategies could have major impacts both on improving overall health status and on reducing inequities in health.

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Contributors Our team brings Māori lived experience (AW), Indigenous lived experience (RM, RL) and experience in research on tobacco inequalities (AW, RM, CEG, RL, RE, NW, TB). DAO, JAS, NW and TB led the conceptualisation of the computer simulation modelling with data and other input specified by TW, HA and SRM. DAO and TW led the analyses and production of outputs, tables and figures. All authors contributed to data interpretation. AW, RM and RL initiated the drafting of the Introduction and Discussion sections; TB led the Methods and Results sections; and DAO led the appendices. All authors revised the draft manuscript critically for important intellectual content. DAO is guarantor of the study and accepts full responsibility for its conduct and overall content.

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initial analyses, but did not contribute to drafting this paper, did contribute to conceptualisation of the interventions, as they are integral to the NZ Action Plan, did provide New Zealand Health Survey data to parameterise the smoking–vaping life history Markov model.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplemental information. All data used in the model are publicly available and their references provided in the manuscript.

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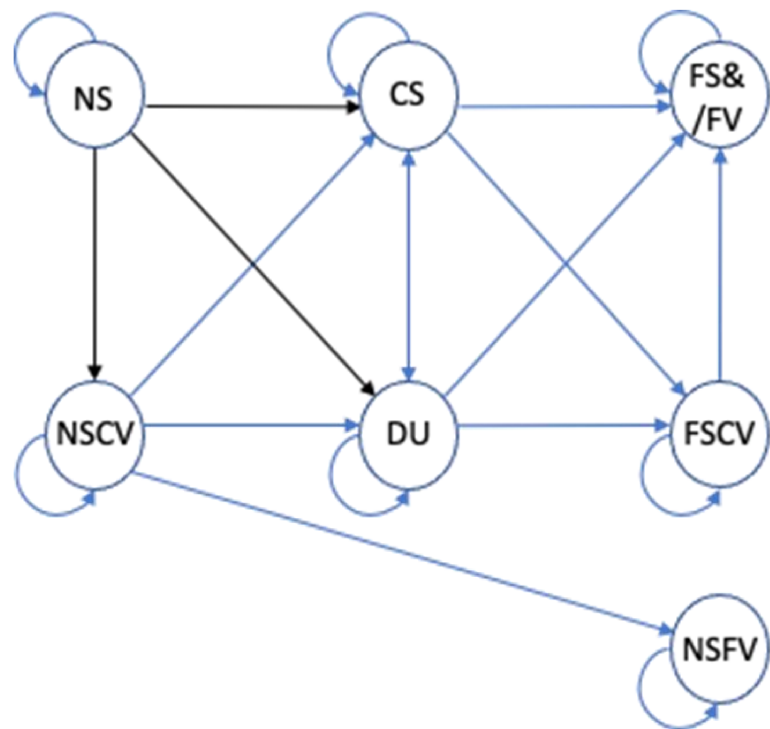
Supplementary material

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Figure S1. Tobacco and vaping life history Markov model



NS = never smoker, CS = current smoker, FS & FV = former smoker and former vaper; NSCV = never smoker current vaper; DU = dual user; FSCV = former smoker current vaper; NSFV = never smoker former vaper.

Table S1: Seven smoking and Vaping States used in the Multistate Life-table Model

Smoking and/or Vaping State ^a	Definition
NS (never smoker)	‘A person who has never smoked at all or has never regularly smoked one or more manufactured or RYO tobacco cigarettes per day.’ ^{1,2}
NSCV (never smoker, current vaper)	‘As above for NS and currently vapes daily (i.e., “do you now use an e-cigarette every day, some days, or not at all?”)’ ^{1,3}
CS (current smoker)	‘A person who currently smokes one or more manufactured or RYO tobacco cigarettes per day.’ ¹
DU (dual user – both vaping and smoking)	‘As above for CS and who currently vapes daily (i.e., “Do you now use an e-cigarette every day, some days, or not at all?”)’ ^{1,3}
FS&/FV (former smoker and/or former vaper)	A person who currently neither smokes or vapes, but previously either smoked one or more manufactured or RYO tobacco cigarettes per day and/or previously vaped daily. ^{1,2}
FSCV (former smoker and current vaper)	‘A person who does not smoke currently, but previously smoked one or more manufactured or RYO tobacco cigarettes per day’ ^{1,2} and ‘currently vapes daily (i.e., “do you now use an e-cigarette every day, some days, or not at all?”)’ ¹⁻³
NSFV (never smoker and former vaper)	As above for NS and previously vaped daily.

^aAs per the definitions described in Petrović-van der Deen et al 2019.⁴ RYO: roll-your-own

Table S2. Baseline annual transition probabilities based on data reported by Doan et al. 2020⁵

Transitions	Age 20-44	Age 45+
CS=>DU (smokers adopting dual use)	8.4%	5.3%
CS=>FS (smokers quitting all nicotine)	8.6%	14.6%
CS=>FSCV (smokers becoming vapers)	3.5%	4.4%
NSCV=>CS (vapers becoming smokers)	13.8%	15.5%
NSCV=>DU (vapers adopting dual use)	15.4%	10.9%
NSCV=>NSFV (vapers quitting vaping)	22.1%	20.5%
DU=>CS (dual users becoming just smokers)	13.7%	16.2%
DU=> FS&/FV (dual users quitting all nicotine)	17.9%	20.0%
DU=>FSCV (dual users becoming just vapers)	14.8%	18.9%
FSCV=> FS&/FV (vapers quitting all nicotine)	22.1%	20.5%
FSCV=> CS (former smokers, who became exclusive vapers, who go back to exclusive smoking)	13.8%	15.5%

Appendix A: Tobacco-related disease models¹

There are many diseases associated with smoking, with varying evidence in terms of the contribution of tobacco use to their incidence. In principle, we prioritised inclusion in the model for: 1) diseases which were included as smoking-related in the New Zealand Burden of Disease Study⁶; 2) cancers that were found to have a significant association with smoking in the New Zealand CancerTrends study⁷; and 3) other smoking-related diseases that contributed to at least 0.5% of the total disease burden in New Zealand in 2006 (as measured in DALYs in the NZBDS). Diseases needed to meet criteria 1 and 3 or criteria 2 to be included in the model. Most of the included diseases were chronic diseases (e.g. various cancers) with the exception of acute lower respiratory tract infections.

Some diseases with relatively high relative risks (RRs) were excluded such as age-related macular degeneration (ARMD) and peripheral vascular disease, as these each make up <0.5% of the total disease burden in New Zealand (and therefore would contribute negligible health gains in a smoking intervention model). Also, data availability and reliability were poor for the following conditions: gum disease, impotence, female infertility, hip fracture risk, fire-related injuries and other injuries, and mental health effects such as depression, anxiety, and for the psychological state of being “addicted” to tobacco. We did not include diseases from second-hand smoke and smoking in pregnancy as this was deemed too complex for our macro-simulation modelling – thus there is an inherent bias in our modelling to underestimate health gains from tobacco reduction (albeit probably slightly). Regarding female breast cancer IARC states “limited” evidence for the association with smoking⁸, therefore we did not include it. Last, we did not include “ovary mucinous” cancer, as this was not included in the NZBDS and would be a minor contributor to total health gains (even though IARC states that there is sufficient evidence for an association with smoking). Also of note, we included three diseases for which smoking appears to have protective effects: melanoma, thyroid cancer and endometrial cancer (based on the Cancer Trends study)⁷.

¹ The text presented in this section was reproduced from the supplementary material provided in Blakely et al. 2015. The full methodological appendix is available at: <https://doi.org/a0.1371/journal/pmed/10011856.s006>

Appendix B: Epidemiological inputs

The tables below present the tobacco-related diseases baseline epidemiological inputs into the multistate life table models

Table S3. CHD input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.0	0.105
		5-9	0.0	0.000	0.0	0.105
		10-14	0.0	0.000	0.0	0.105
		15-19	0.2	0.000	0.0	0.105
		20-24	8.8	0.000	0.2	0.105
		25-29	27.5	0.006	1.1	0.105
		30-34	44.7	0.026	2.6	0.105
		35-39	125.4	0.029	5.9	0.105
		40-44	250.4	0.030	13.8	0.105
		45-49	487.0	0.038	27.6	0.108
		50-54	846.3	0.040	52.0	0.108
		55-59	1249.4	0.035	88.2	0.100
		60-64	1796.2	0.034	138.1	0.100
		65-69	2333.5	0.032	200.8	0.083
		70-74	2769.0	0.034	269.6	0.083
		75-79	3009.7	0.041	331.9	0.069
		80-84	2793.6	0.050	375.6	0.069
		85-89	2676.4	0.071	386.8	0.061
		90-94	4368.9	0.111	385.1	0.061
		95+	6671.4	0.168	392.6	0.061
Female	Māori	0-4	0.0	0.000	0.0	0.096
		5-9	0.0	0.000	0.0	0.096
		10-14	0.0	0.004	0.0	0.096
		15-19	0.9	0.085	0.0	0.096
		20-24	13.9	0.165	0.3	0.096
		25-29	30.4	0.089	1.1	0.096
		30-34	29.8	0.033	2.2	0.096
		35-39	46.6	0.027	3.6	0.096
		40-44	130.0	0.027	6.9	0.096
		45-49	290.3	0.020	15.9	0.112
		50-54	459.2	0.017	32.3	0.112
		55-59	650.4	0.017	54.8	0.124
		60-64	1053.5	0.023	87.2	0.124
		65-69	1401.6	0.027	130.0	0.110
		70-74	1690.4	0.031	176.7	0.110
		75-79	2245.6	0.045	224.2	0.101
		80-84	2870.6	0.069	268.4	0.101
		85-89	2999.2	0.103	289.6	0.090
		90-94	3085.3	0.176	262.8	0.090
		95+	3996.0	0.339	171.9	0.090
Male	non-Māori	0-4	0.0	0.000	0.0	0.079
		5-9	0.0	0.000	0.0	0.079
		10-14	0.0	0.002	0.0	0.079
		15-19	0.4	0.038	0.0	0.079
		20-24	8.5	0.074	0.2	0.079

Female	non-Māori	25-29	21.7	0.040	0.8	0.079
		30-34	29.3	0.018	1.9	0.079
		35-39	75.9	0.012	4.1	0.079
		40-44	165.8	0.013	9.6	0.079
		45-49	302.9	0.016	19.8	0.088
		50-54	500.5	0.015	37.0	0.088
		55-59	763.1	0.015	63.1	0.088
		60-64	1109.7	0.017	99.7	0.088
		65-69	1570.9	0.018	148.7	0.086
		70-74	2071.5	0.020	209.4	0.086
		75-79	2683.9	0.026	277.5	0.083
		80-84	3562.0	0.042	348.3	0.083
		85-89	4498.6	0.079	405.2	0.072
		90-94	4944.0	0.151	410.1	0.072
		95+	5201.0	0.301	296.2	0.072
		0-4	0.0	0.000	0.0	0.069
		5-9	0.0	0.000	0.0	0.069
		10-14	0.0	0.000	0.0	0.069
		15-19	0.1	0.000	0.0	0.069
		20-24	7.0	0.000	0.1	0.069
		25-29	19.7	0.001	0.8	0.069
		30-34	16.4	0.002	1.8	0.069
		35-39	21.2	0.003	2.6	0.069
		40-44	50.4	0.006	4.2	0.069
		45-49	104.6	0.007	7.7	0.086
		50-54	198.9	0.005	14.7	0.086
		55-59	350.4	0.006	27.4	0.089
		60-64	551.5	0.010	47.4	0.089
		65-69	864.6	0.012	76.9	0.093
		70-74	1258.7	0.015	118.7	0.093
		75-79	1786.0	0.021	171.8	0.093
		80-84	2495.9	0.032	234.9	0.093
		85-89	3131.2	0.062	294.8	0.086
		90-94	3297.2	0.144	303.7	0.086
		95+	3388.0	0.344	187.0	0.086

Table S4. Stroke input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.0	0.396
		5-9	0.0	0.006	0.0	0.396
		10-14	0.0	0.067	0.0	0.396
		15-19	0.0	0.122	0.0	0.396
		20-24	0.0	0.089	0.0	0.396
		25-29	2.1	0.042	0.2	0.396
		30-34	15.1	0.089	0.4	0.396
		35-39	51.8	0.074	1.6	0.396
		40-44	81.2	0.035	4.4	0.396
		45-49	115.5	0.024	8.3	0.132
		50-54	168.0	0.023	14.1	0.132
		55-59	216.4	0.023	21.5	0.143
		60-64	297.6	0.020	31.0	0.143
		65-69	448.8	0.019	45.3	0.218
		70-74	625.7	0.035	64.0	0.218

Female	Māori	75-79	733.8	0.058	79.7	0.294
		80-84	788.9	0.083	87.6	0.294
		85-89	1013.0	0.168	82.2	0.534
		90-94	1645.2	0.399	57.6	0.534
		95+	2760.7	0.803	36.8	0.534
		0-4	0.0	0.000	0.0	0.431
		5-9	0.0	0.000	0.0	0.431
		10-14	0.0	0.000	0.0	0.431
		15-19	0.0	0.000	0.0	0.431
		20-24	0.0	0.000	0.0	0.431
		25-29	0.8	0.333	0.0	0.431
		30-34	4.2	1.476	0.0	0.431
		35-39	15.1	1.897	0.1	0.431
		40-44	75.9	1.017	0.6	0.431
		45-49	163.9	0.126	4.2	0.137
		50-54	226.0	0.029	12.5	0.137
		55-59	274.1	0.027	22.4	0.130
		60-64	353.9	0.030	33.7	0.130
		65-69	463.0	0.034	47.0	0.164
		70-74	586.2	0.042	61.9	0.164
		75-79	721.5	0.055	76.6	0.258
		80-84	1041.1	0.096	88.4	0.258
		85-89	1650.4	0.229	87.5	0.559
		90-94	2168.2	0.481	60.5	0.559
		95+	2670.8	0.770	37.1	0.559
Male	non-Māori	0-4	0.0	0.004	0.0	0.373
		5-9	0.0	0.028	0.0	0.373
		10-14	0.0	0.043	0.0	0.373
		15-19	0.0	0.044	0.0	0.373
		20-24	0.0	0.050	0.0	0.373
		25-29	5.1	0.051	0.3	0.373
		30-34	5.1	0.028	0.5	0.373
		35-39	19.9	0.012	1.0	0.373
		40-44	44.5	0.012	2.5	0.373
		45-49	72.9	0.014	5.1	0.132
		50-54	116.6	0.012	9.3	0.132
		55-59	188.1	0.013	15.9	0.122
		60-64	288.9	0.015	26.0	0.122
		65-69	447.7	0.017	41.0	0.150
		70-74	656.4	0.020	62.5	0.150
		75-79	921.0	0.029	90.1	0.158
		80-84	1255.7	0.048	120.5	0.158
		85-89	1589.6	0.097	142.8	0.166
		90-94	1876.4	0.219	127.9	0.166
		95+	2773.8	0.472	73.9	0.166
Female	non-Māori	0-4	0.0	0.000	0.0	0.415
		5-9	0.0	0.000	0.0	0.415
		10-14	0.0	0.000	0.0	0.415
		15-19	0.0	0.002	0.0	0.415
		20-24	0.0	0.136	0.0	0.415
		25-29	3.4	0.354	0.1	0.415
		30-34	10.9	0.172	0.2	0.415
		35-39	23.4	0.039	0.9	0.415
		40-44	39.1	0.024	2.3	0.415
		45-49	57.6	0.019	4.3	0.180
		50-54	78.8	0.015	7.2	0.180
		55-59	111.4	0.009	11.3	0.166

60-64	182.0	0.011	17.7	0.166
65-69	299.4	0.017	27.6	0.164
70-74	483.1	0.024	42.7	0.164
75-79	775.5	0.033	64.8	0.180
80-84	1223.1	0.054	94.2	0.180
85-89	1739.5	0.080	116.5	0.242
90-94	2120.5	0.124	124.7	0.242
95+	2777.6	0.182	109.2	0.242

Table S5. Lung cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.00	0.000	0.0	0.323
		5-9	0.0	0.00	0.000	0.0	0.323
		10-14	0.0	0.00	0.000	0.0	0.323
		15-19	0.0	0.00	0.000	0.0	0.323
		20-24	0.1	0.00	0.000	0.0	0.323
		25-29	0.5	0.03	0.005	0.0	0.323
		30-34	1.3	0.14	0.023	0.0	0.323
		35-39	3.4	0.30	0.046	0.1	0.323
		40-44	7.9	0.29	0.063	0.1	0.323
		45-49	21.8	0.27	0.065	0.4	0.323
		50-54	56.5	0.51	0.058	0.9	0.323
		55-59	132.3	0.79	0.055	1.3	0.323
		60-64	268.6	0.80	0.048	2.7	0.323
		65-69	378.4	0.83	0.052	4.1	0.281
		70-74	447.6	0.95	0.056	4.5	0.281
		75-79	504.9	1.31	0.052	3.9	0.281
		80-84	552.0	1.67	0.046	3.2	0.281
		85-89	545.2	1.59	0.044	3.4	0.281
		90-94	469.1	1.62	0.043	2.9	0.281
		95+	404.5	1.77	0.043	2.3	0.281
Female	Māori	0-4	0.0	0.00	0.000	0.0	0.396
		5-9	0.0	0.00	0.000	0.0	0.396
		10-14	0.0	0.00	0.000	0.0	0.396
		15-19	0.0	0.00	0.000	0.0	0.396
		20-24	0.3	0.00	0.000	0.0	0.396
		25-29	1.5	0.10	0.010	0.0	0.396
		30-34	3.9	0.53	0.061	0.1	0.396
		35-39	8.2	1.14	0.155	0.1	0.396
		40-44	15.3	1.00	0.186	0.1	0.396
		45-49	42.1	0.57	0.138	0.4	0.396
		50-54	105.0	0.56	0.092	1.3	0.396
		55-59	208.8	0.63	0.080	2.6	0.396
		60-64	353.0	0.85	0.069	3.7	0.396
		65-69	443.6	0.99	0.067	4.1	0.313
		70-74	502.0	1.02	0.060	4.5	0.313
		75-79	549.3	0.98	0.045	5.2	0.313
		80-84	557.2	0.99	0.037	5.7	0.313
		85-89	502.3	1.23	0.035	4.2	0.313
		90-94	432.5	1.43	0.034	3.1	0.313
		95+	378.7	1.64	0.034	2.4	0.313
Male	non-Māori	0-4	0.0	0.00	0.000	0.0	0.358
		5-9	0.0	0.00	0.000	0.0	0.358

Female	non-Māori	10-14	0.0	0.00	0.000	0.0	0.358
		15-19	0.0	0.00	0.000	0.0	0.358
		20-24	0.1	0.00	0.000	0.0	0.358
		25-29	0.3	0.07	0.014	0.0	0.358
		30-34	0.6	0.29	0.062	0.0	0.358
		35-39	1.6	0.33	0.080	0.0	0.358
		40-44	3.6	0.35	0.082	0.1	0.358
		45-49	9.0	0.47	0.078	0.1	0.331
		50-54	20.9	0.55	0.066	0.3	0.331
		55-59	43.6	0.55	0.068	0.6	0.338
		60-64	85.6	0.61	0.066	1.1	0.338
		65-69	135.1	0.71	0.073	1.6	0.297
		70-74	199.0	0.83	0.082	2.1	0.297
		75-79	268.5	1.11	0.091	2.3	0.273
		80-84	309.2	1.55	0.105	1.9	0.273
		85-89	298.5	1.96	0.112	1.5	0.378
		90-94	275.5	2.23	0.105	1.2	0.378
		95+	245.2	2.46	0.100	1.0	0.378
		0-4	0.0	0.00	0.000	0.0	0.353
		5-9	0.0	0.00	0.000	0.0	0.353
		10-14	0.0	0.00	0.000	0.0	0.353
		15-19	0.0	0.00	0.000	0.0	0.353
		20-24	0.2	0.00	0.000	0.0	0.353
		25-29	0.6	0.03	0.019	0.0	0.353
		30-34	1.3	0.12	0.094	0.1	0.353
		35-39	2.7	0.15	0.179	0.1	0.353
		40-44	5.9	0.26	0.149	0.1	0.353
		45-49	11.9	0.39	0.079	0.2	0.355
		50-54	22.9	0.44	0.076	0.4	0.355
		55-59	42.6	0.50	0.079	0.6	0.367
		60-64	73.9	0.55	0.067	1.0	0.367
		65-69	106.9	0.68	0.063	1.4	0.305
		70-74	139.5	0.80	0.062	1.6	0.305
		75-79	162.6	0.97	0.058	1.6	0.290
		80-84	171.7	1.14	0.055	1.4	0.290
		85-89	169.9	1.13	0.053	1.5	0.122
		90-94	147.7	1.19	0.052	1.2	0.122
		95+	128.4	1.36	0.052	1.0	0.122

Table S6. Head and neck cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.000	0.0	0.319
		5-9	0.0	0.000	0.000	0.0	0.319
		10-14	0.0	0.000	0.000	0.0	0.319
		15-19	0.3	0.000	0.000	0.0	0.319
		20-24	0.9	0.001	0.000	0.0	0.319
		25-29	1.8	0.010	0.031	0.1	0.319
		30-34	3.1	0.033	0.132	0.1	0.319
		35-39	5.1	0.033	0.145	0.2	0.319
		40-44	8.4	0.035	0.084	0.3	0.319
		45-49	13.4	0.054	0.061	0.6	0.319
		50-54	20.1	0.075	0.097	0.9	0.319
		55-59	28.9	0.097	0.111	1.1	0.319

Female	Māori	60-64	37.9	0.144	0.086	1.4	0.319
		65-69	42.8	0.159	0.064	1.7	0.270
		70-74	44.7	0.181	0.052	1.9	0.270
		75-79	44.1	0.192	0.055	1.8	0.270
		80-84	45.4	0.177	0.065	1.8	0.270
		85-89	56.9	0.208	0.059	2.0	0.270
		90-94	73.4	0.282	0.056	2.1	0.270
		95+	88.3	0.344	0.060	2.2	0.270
		0-4	0.0	0.000	0.000	0.0	0.388
		5-9	0.0	0.000	0.000	0.0	0.388
		10-14	0.0	0.000	0.000	0.0	0.388
		15-19	0.1	0.000	0.000	0.0	0.388
		20-24	0.3	0.001	0.000	0.0	0.388
		25-29	0.9	0.013	0.092	0.0	0.388
		30-34	2.5	0.047	0.395	0.1	0.388
		35-39	3.8	0.047	0.452	0.1	0.388
		40-44	5.1	0.046	0.263	0.1	0.388
		45-49	6.9	0.073	0.142	0.2	0.388
		50-54	9.1	0.105	0.164	0.3	0.388
		55-59	12.2	0.142	0.151	0.4	0.388
	non-Māori	60-64	16.1	0.209	0.104	0.5	0.388
		65-69	19.0	0.235	0.086	0.5	0.196
		70-74	21.9	0.283	0.085	0.6	0.196
		75-79	24.1	0.312	0.123	0.6	0.196
		80-84	27.3	0.283	0.178	0.6	0.196
		85-89	35.7	0.322	0.169	0.7	0.196
		90-94	46.5	0.473	0.152	0.7	0.196
		95+	58.9	0.695	0.130	0.7	0.196
		0-4	0.0	0.000	0.000	0.0	0.280
		5-9	0.0	0.000	0.000	0.0	0.280
		10-14	0.0	0.000	0.000	0.0	0.280
		15-19	0.0	0.000	0.000	0.0	0.280
		20-24	0.7	0.001	0.000	0.0	0.280
		25-29	1.1	0.009	0.012	0.1	0.280
		30-34	1.8	0.026	0.051	0.1	0.280
		35-39	2.9	0.028	0.063	0.2	0.280
		40-44	4.9	0.030	0.037	0.3	0.280
		45-49	8.1	0.048	0.019	0.5	0.256
		50-54	12.9	0.067	0.040	0.7	0.256
Female	non-Māori	55-59	19.6	0.083	0.065	1.0	0.283
		60-64	27.8	0.115	0.054	1.3	0.283
		65-69	33.3	0.129	0.052	1.6	0.225
		70-74	37.4	0.153	0.057	1.7	0.225
		75-79	40.2	0.165	0.080	1.7	0.182
		80-84	44.4	0.152	0.108	1.7	0.182
		85-89	56.5	0.178	0.098	1.9	0.112
		90-94	71.2	0.249	0.101	2.0	0.112
		95+	81.3	0.332	0.115	2.0	0.112
		0-4	0.0	0.000	0.000	0.0	0.494
		5-9	0.0	0.000	0.000	0.0	0.494
		10-14	0.0	0.000	0.000	0.0	0.494
	non-Māori	15-19	0.0	0.000	0.000	0.0	0.494
		20-24	0.3	0.000	0.000	0.0	0.494
		25-29	0.6	0.010	0.051	0.0	0.494
		30-34	1.4	0.040	0.216	0.0	0.494
		35-39	2.1	0.043	0.245	0.1	0.494
		40-44	3.2	0.038	0.174	0.1	0.494

45-49	4.6	0.050	0.136	0.2	0.386
50-54	6.3	0.070	0.140	0.2	0.386
55-59	9.1	0.089	0.138	0.3	0.312
60-64	12.6	0.107	0.136	0.4	0.312
65-69	15.7	0.137	0.137	0.5	0.263
70-74	19.1	0.177	0.150	0.6	0.263
75-79	21.8	0.221	0.189	0.6	0.297
80-84	25.4	0.258	0.237	0.5	0.297
85-89	34.8	0.291	0.256	0.6	0.165
90-94	44.4	0.341	0.259	0.7	0.165
95+	49.3	0.389	0.264	0.8	0.165

Table S7. Esophageal cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.00	0.000	0.000	0.283
		5-9	0.0	0.00	0.000	0.000	0.283
		10-14	0.0	0.00	0.000	0.000	0.283
		15-19	0.0	0.00	0.000	0.000	0.283
		20-24	0.0	0.00	0.000	0.000	0.283
		25-29	0.0	0.08	0.009	0.000	0.283
		30-34	0.0	0.33	0.032	0.001	0.283
		35-39	0.5	0.38	0.023	0.007	0.283
		40-44	1.3	0.43	0.048	0.022	0.283
		45-49	2.9	0.60	0.129	0.036	0.283
		50-54	6.9	0.63	0.166	0.072	0.283
		55-59	15.7	0.53	0.114	0.195	0.283
		60-64	27.9	0.76	0.096	0.304	0.283
		65-69	39.4	0.73	0.075	0.438	0.283
		70-74	50.9	0.69	0.042	0.652	0.283
		75-79	62.3	0.82	0.021	0.736	0.283
		80-84	70.9	0.97	0.017	0.728	0.283
		85-89	72.6	1.22	0.016	0.619	0.283
		90-94	64.1	1.58	0.016	0.430	0.283
		95+	51.9	1.78	0.016	0.282	0.283
Female	Māori	0-4	0.0	0.00	0.000	0.000	0.271
		5-9	0.0	0.00	0.000	0.000	0.271
		10-14	0.0	0.00	0.000	0.000	0.271
		15-19	0.0	0.00	0.000	0.000	0.271
		20-24	0.0	0.00	0.000	0.000	0.271
		25-29	0.0	0.06	0.006	0.000	0.271
		30-34	0.0	0.24	0.021	0.000	0.271
		35-39	0.2	0.26	0.020	0.003	0.271
		40-44	0.4	0.28	0.017	0.010	0.271
		45-49	0.9	0.40	0.026	0.017	0.271
		50-54	1.8	0.45	0.030	0.029	0.271
		55-59	4.3	0.41	0.020	0.072	0.271
		60-64	8.7	0.51	0.019	0.138	0.271
		65-69	13.0	0.50	0.017	0.215	0.271
		70-74	17.8	0.50	0.012	0.314	0.271
		75-79	23.7	0.58	0.008	0.383	0.271
		80-84	28.0	0.66	0.008	0.416	0.271
		85-89	27.0	0.77	0.008	0.371	0.271
		90-94	22.1	0.93	0.008	0.262	0.271

Male	non-Māori	95+	17.4	1.07	0.008	0.162	0.271
		0-4	0.0	0.00	0.000	0.000	0.530
		5-9	0.0	0.00	0.000	0.000	0.530
		10-14	0.0	0.00	0.000	0.000	0.530
		15-19	0.0	0.00	0.000	0.000	0.530
		20-24	0.0	0.00	0.000	0.000	0.530
		25-29	0.0	0.11	0.024	0.000	0.530
		30-34	0.1	0.46	0.094	0.000	0.530
		35-39	0.5	0.50	0.084	0.006	0.530
		40-44	1.3	0.55	0.140	0.017	0.530
		45-49	2.7	0.84	0.250	0.023	0.530
		50-54	5.6	0.94	0.237	0.042	0.530
		55-59	11.8	0.76	0.128	0.113	0.530
		60-64	21.4	0.97	0.106	0.187	0.530
		65-69	31.8	0.96	0.107	0.275	0.295
		70-74	43.5	0.97	0.092	0.392	0.295
		75-79	56.2	1.15	0.079	0.450	0.295
		80-84	65.8	1.31	0.075	0.473	0.295
		85-89	65.9	1.55	0.072	0.420	0.295
		90-94	55.6	1.82	0.069	0.310	0.295
Female	non-Māori	95+	44.3	1.98	0.071	0.210	0.295
		0-4	0.0	0.00	0.000	0.000	0.367
		5-9	0.0	0.00	0.000	0.000	0.367
		10-14	0.0	0.00	0.000	0.000	0.367
		15-19	0.0	0.00	0.000	0.000	0.367
		20-24	0.0	0.00	0.000	0.000	0.367
		25-29	0.0	0.09	0.025	0.000	0.367
		30-34	0.0	0.39	0.099	0.000	0.367
		35-39	0.3	0.42	0.082	0.003	0.367
		40-44	0.6	0.42	0.068	0.010	0.367
		45-49	1.0	0.57	0.082	0.014	0.367
		50-54	1.9	0.61	0.063	0.023	0.367
		55-59	4.0	0.50	0.039	0.057	0.367
		60-64	7.8	0.62	0.040	0.103	0.367
		65-69	11.9	0.64	0.043	0.155	0.279
		70-74	17.1	0.68	0.045	0.221	0.279
		75-79	24.7	0.85	0.052	0.264	0.279
		80-84	31.8	1.04	0.058	0.289	0.279
		85-89	33.0	1.25	0.061	0.261	0.279
		90-94	29.1	1.53	0.058	0.194	0.279
		95+	24.1	1.73	0.058	0.133	0.279

Table S8. Stomach cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.000	0.0	0.262
		5-9	0.0	0.000	0.000	0.0	0.262
		10-14	0.0	0.000	0.000	0.0	0.262
		15-19	0.0	0.000	0.000	0.1	0.262
		20-24	0.7	0.000	0.000	0.1	0.262
		25-29	2.0	0.025	0.086	0.2	0.262
		30-34	3.4	0.126	0.347	0.1	0.262
		35-39	6.4	0.267	0.305	0.1	0.262
		40-44	11.5	0.477	0.176	0.2	0.262

Female	Māori	45-49	17.6	0.529	0.146	0.2	0.262
		50-54	24.6	0.410	0.153	0.4	0.262
		55-59	37.3	0.528	0.189	0.5	0.262
		60-64	60.1	0.828	0.162	0.6	0.262
		65-69	83.9	0.802	0.119	0.8	0.326
		70-74	103.7	0.665	0.099	1.3	0.326
		75-79	139.4	0.553	0.082	1.9	0.326
		80-84	185.0	0.464	0.064	3.1	0.326
		85-89	209.0	0.573	0.066	3.4	0.326
		90-94	250.4	0.777	0.060	3.1	0.326
		95+	280.6	0.949	0.057	2.9	0.326
		0-4	0.0	0.000	0.000	0.0	0.296
		5-9	0.0	0.000	0.000	0.0	0.296
		10-14	0.0	0.000	0.000	0.0	0.296
		15-19	0.0	0.000	0.000	0.1	0.296
		20-24	0.2	0.000	0.000	0.1	0.296
		25-29	0.9	0.111	0.011	0.1	0.296
		30-34	4.8	0.484	0.047	0.1	0.296
		35-39	8.2	0.605	0.058	0.1	0.296
		40-44	11.3	0.500	0.075	0.2	0.296
	non-Māori	45-49	15.7	0.406	0.079	0.3	0.296
		50-54	20.0	0.424	0.084	0.4	0.296
		55-59	24.1	0.496	0.142	0.4	0.296
		60-64	35.8	0.416	0.123	0.5	0.296
		65-69	48.6	0.307	0.100	1.0	0.281
		70-74	61.3	0.403	0.097	1.3	0.281
		75-79	61.2	0.518	0.090	1.1	0.281
		80-84	69.5	0.448	0.069	1.1	0.281
		85-89	123.1	0.404	0.050	2.2	0.281
		90-94	148.8	0.523	0.046	2.7	0.281
		95+	163.8	0.720	0.044	2.4	0.281
		0-4	0.0	0.000	0.000	0.0	0.304
		5-9	0.0	0.000	0.000	0.0	0.304
		10-14	0.0	0.000	0.000	0.0	0.304
		15-19	0.0	0.000	0.000	0.0	0.304
		20-24	0.2	0.000	0.000	0.0	0.304
		25-29	0.3	0.030	0.014	0.0	0.304
		30-34	0.7	0.136	0.065	0.0	0.304
		35-39	1.4	0.213	0.102	0.0	0.304
		40-44	2.5	0.266	0.138	0.1	0.304
Female	non-Māori	45-49	4.6	0.286	0.156	0.1	0.300
		50-54	8.5	0.298	0.163	0.2	0.300
		55-59	15.6	0.391	0.210	0.2	0.359
		60-64	26.4	0.500	0.254	0.3	0.359
		65-69	36.5	0.491	0.243	0.5	0.342
		70-74	52.4	0.561	0.223	0.6	0.342
		75-79	71.3	0.665	0.192	0.8	0.249
		80-84	87.4	0.660	0.147	1.0	0.249
		85-89	102.4	0.652	0.133	1.3	0.143
		90-94	114.0	0.683	0.131	1.4	0.143
		95+	115.8	0.724	0.132	1.4	0.143
		0-4	0.0	0.000	0.000	0.0	0.153
		5-9	0.0	0.000	0.000	0.0	0.153
		10-14	0.0	0.000	0.000	0.0	0.153
		15-19	0.0	0.000	0.000	0.0	0.153
		20-24	0.5	0.000	0.000	0.0	0.153
		25-29	0.3	0.032	0.019	0.0	0.153

30-34	0.4	0.148	0.086	0.0	0.153
35-39	0.8	0.249	0.118	0.0	0.153
40-44	1.7	0.302	0.134	0.0	0.153
45-49	2.9	0.289	0.133	0.1	0.312
50-54	4.5	0.265	0.121	0.1	0.312
55-59	6.6	0.345	0.147	0.1	0.239
60-64	9.4	0.457	0.172	0.1	0.239
65-69	14.6	0.425	0.167	0.2	0.317
70-74	23.1	0.446	0.156	0.3	0.317
75-79	33.0	0.522	0.137	0.5	0.231
80-84	41.5	0.512	0.110	0.6	0.231
85-89	47.4	0.491	0.101	0.8	0.107
90-94	51.3	0.516	0.100	0.8	0.107
95+	51.4	0.561	0.101	0.8	0.107

Table S9. Liver cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.00	0.000	0.000	0.148
		5-9	0.0	0.00	0.000	0.000	0.148
		10-14	0.0	0.00	0.000	0.000	0.148
		15-19	0.0	0.00	0.000	0.005	0.148
		20-24	0.7	0.00	0.000	0.027	0.148
		25-29	1.4	0.03	0.031	0.072	0.148
		30-34	2.9	0.14	0.133	0.100	0.148
		35-39	5.3	0.17	0.150	0.131	0.148
		40-44	9.8	0.26	0.109	0.216	0.148
		45-49	18.3	0.47	0.087	0.298	0.148
		50-54	32.4	0.63	0.086	0.409	0.148
		55-59	49.8	0.62	0.086	0.628	0.148
		60-64	59.4	0.55	0.083	0.867	0.148
		65-69	57.2	0.54	0.086	0.931	0.138
		70-74	52.6	0.56	0.103	0.832	0.138
		75-79	53.1	0.67	0.097	0.727	0.138
		80-84	54.2	1.16	0.072	0.512	0.138
		85-89	44.5	1.72	0.087	0.263	0.138
		90-94	23.7	1.18	0.117	0.192	0.138
		95+	13.3	0.48	0.141	0.187	0.138
Female	Māori	0-4	0.0	0.00	0.000	0.000	0.183
		5-9	0.0	0.00	0.000	0.000	0.183
		10-14	0.0	0.00	0.000	0.000	0.183
		15-19	0.0	0.00	0.000	0.000	0.183
		20-24	0.1	0.00	0.000	0.003	0.183
		25-29	0.6	0.13	0.041	0.017	0.183
		30-34	1.1	0.54	0.174	0.018	0.183
		35-39	1.8	0.62	0.200	0.020	0.183
		40-44	3.3	0.51	0.150	0.041	0.183
		45-49	4.2	0.48	0.122	0.065	0.183
		50-54	5.8	0.49	0.122	0.085	0.183
		55-59	10.4	0.50	0.123	0.144	0.183
		60-64	13.7	0.67	0.129	0.172	0.183
		65-69	18.3	0.92	0.115	0.175	0.183
		70-74	20.4	1.28	0.118	0.152	0.183
		75-79	19.5	1.31	0.102	0.136	0.183

Male	non-Māori	80-84	18.3	0.98	0.050	0.171	0.183
		85-89	16.1	0.89	0.039	0.177	0.183
		90-94	10.3	0.77	0.038	0.140	0.183
		95+	6.4	0.55	0.039	0.102	0.183
		0-4	0.0	0.00	0.000	0.000	0.147
		5-9	0.0	0.00	0.000	0.000	0.147
		10-14	0.0	0.00	0.000	0.000	0.147
		15-19	0.0	0.00	0.000	0.000	0.147
		20-24	0.1	0.00	0.000	0.002	0.147
		25-29	0.5	0.09	0.029	0.013	0.147
		30-34	0.9	0.42	0.126	0.017	0.147
		35-39	1.4	0.53	0.146	0.019	0.147
		40-44	2.4	0.42	0.103	0.036	0.147
		45-49	4.2	0.44	0.079	0.069	0.178
		50-54	7.4	0.59	0.092	0.098	0.178
		55-59	11.8	0.59	0.121	0.149	0.178
		60-64	15.8	0.65	0.157	0.190	0.178
		65-69	21.3	0.89	0.151	0.205	0.217
		70-74	28.8	1.35	0.159	0.196	0.217
		75-79	33.2	2.12	0.167	0.152	0.190
		80-84	34.3	2.56	0.136	0.126	0.190
		85-89	37.2	1.94	0.114	0.173	0.190
		90-94	33.0	1.43	0.123	0.211	0.190
		95+	27.8	1.17	0.145	0.206	0.190
Female	non-Māori	0-4	0.0	0.00	0.000	0.000	0.005
		5-9	0.0	0.00	0.000	0.000	0.005
		10-14	0.0	0.00	0.000	0.000	0.005
		15-19	0.0	0.00	0.000	0.000	0.005
		20-24	9.4	0.00	0.000	0.431	0.005
		25-29	2.2	0.77	0.246	0.341	0.005
		30-34	0.4	3.02	0.982	0.002	0.005
		35-39	0.5	2.04	0.752	0.002	0.005
		40-44	0.9	0.78	0.259	0.008	0.005
		45-49	1.5	0.76	0.109	0.015	0.262
		50-54	2.3	0.56	0.059	0.031	0.262
		55-59	3.9	0.58	0.105	0.052	0.262
		60-64	6.9	0.87	0.221	0.062	0.262
		65-69	9.6	1.27	0.257	0.063	0.174
		70-74	13.3	1.50	0.215	0.075	0.174
		75-79	17.1	1.71	0.241	0.087	0.183
		80-84	18.0	1.98	0.367	0.078	0.183
		85-89	14.8	1.82	0.491	0.065	0.183
		90-94	9.1	0.94	0.634	0.059	0.183
		95+	6.5	0.35	0.731	0.058	0.183

Table S10. Pancreatic cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.00	0.000	0.000	0.160
		5-9	0.0	0.00	0.000	0.000	0.160
		10-14	0.0	0.00	0.000	0.000	0.160
		15-19	0.0	0.00	0.006	0.000	0.160
		20-24	0.1	0.01	0.338	0.002	0.160
		25-29	0.1	0.08	0.865	0.001	0.160

Female	Māori	30-34	0.6	0.25	0.365	0.007	0.160
		35-39	1.3	0.41	0.049	0.021	0.160
		40-44	2.5	0.53	0.049	0.038	0.160
		45-49	4.8	0.61	0.075	0.062	0.160
		50-54	8.9	0.63	0.096	0.105	0.160
		55-59	16.3	0.63	0.065	0.199	0.160
		60-64	27.5	0.62	0.044	0.361	0.160
		65-69	41.0	0.69	0.033	0.524	0.160
		70-74	58.0	0.79	0.022	0.670	0.160
		75-79	76.5	0.83	0.014	0.853	0.160
		80-84	94.9	0.82	0.012	1.079	0.160
		85-89	114.3	0.79	0.012	1.357	0.160
		90-94	126.8	0.87	0.012	1.447	0.160
		95+	132.5	0.97	0.012	1.370	0.160
		0-4	0.0	0.00	0.000	0.000	0.183
		5-9	0.0	0.00	0.000	0.000	0.183
		10-14	0.0	0.00	0.000	0.000	0.183
		15-19	0.0	0.00	0.006	0.000	0.183
		20-24	0.1	0.03	0.335	0.001	0.183
		25-29	0.1	0.12	0.857	0.001	0.183
	non-Māori	30-34	0.4	0.25	0.355	0.005	0.183
		35-39	0.9	0.38	0.037	0.016	0.183
		40-44	2.2	0.53	0.039	0.031	0.183
		45-49	4.2	0.70	0.047	0.051	0.183
		50-54	7.2	0.79	0.050	0.077	0.183
		55-59	13.3	0.75	0.040	0.145	0.183
		60-64	23.1	0.70	0.031	0.274	0.183
		65-69	35.4	0.77	0.026	0.413	0.183
		70-74	50.3	0.87	0.020	0.538	0.183
		75-79	71.2	0.96	0.016	0.693	0.183
		80-84	94.7	1.13	0.018	0.812	0.183
		85-89	111.3	1.33	0.022	0.828	0.183
		90-94	120.8	1.48	0.023	0.808	0.183
		95+	124.4	1.65	0.023	0.753	0.183
Male	non-Māori	0-4	0.0	0.00	0.000	0.000	0.314
		5-9	0.0	0.00	0.000	0.000	0.314
		10-14	0.0	0.00	0.000	0.000	0.314
		15-19	0.0	0.00	0.006	0.000	0.314
		20-24	0.0	0.04	0.338	0.001	0.314
		25-29	0.0	0.15	0.868	0.000	0.314
		30-34	0.2	0.35	0.368	0.002	0.314
		35-39	0.5	0.57	0.054	0.007	0.314
		40-44	1.2	0.79	0.065	0.013	0.314
		45-49	2.5	0.98	0.170	0.020	0.314
		50-54	4.9	1.10	0.281	0.033	0.314
		55-59	9.4	1.10	0.220	0.065	0.314
		60-64	16.6	1.11	0.173	0.119	0.314
		65-69	25.4	1.32	0.138	0.168	0.192
		70-74	36.5	1.61	0.093	0.207	0.192
		75-79	47.9	1.77	0.065	0.254	0.192
		80-84	58.5	1.85	0.068	0.300	0.192
		85-89	70.3	2.06	0.076	0.327	0.192
		90-94	81.8	2.39	0.075	0.331	0.192
		95+	87.1	2.63	0.074	0.326	0.192
Female	non-Māori	0-4	0.0	0.00	0.000	0.000	0.369
		5-9	0.0	0.00	0.000	0.000	0.369
		10-14	0.0	0.00	0.000	0.000	0.369

15-19	0.0	0.00	0.006	0.000	0.369
20-24	0.0	0.07	0.327	0.001	0.369
25-29	0.0	0.22	0.837	0.000	0.369
30-34	0.2	0.30	0.352	0.002	0.369
35-39	0.4	0.45	0.045	0.006	0.369
40-44	1.0	0.76	0.054	0.011	0.369
45-49	2.2	1.15	0.087	0.017	0.369
50-54	4.2	1.40	0.116	0.025	0.369
55-59	8.3	1.40	0.105	0.050	0.369
60-64	15.2	1.38	0.095	0.095	0.369
65-69	24.0	1.60	0.088	0.138	0.230
70-74	34.6	1.87	0.071	0.173	0.230
75-79	47.3	2.00	0.060	0.223	0.230
80-84	60.4	2.13	0.067	0.270	0.230
85-89	70.5	2.41	0.079	0.282	0.230
90-94	78.0	2.65	0.081	0.285	0.230
95+	81.8	2.84	0.082	0.283	0.230

Table S11. Cervical cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Female	Māori	0-4	0.0	0.000	0.0	0.00	0.127
		5-9	0.0	0.000	0.000	0.00	0.127
		10-14	0.0	0.000	0.000	0.00	0.127
		15-19	0.0	0.000	0.000	0.00	0.127
		20-24	2.3	0.000	0.000	0.05	0.127
		25-29	7.7	0.004	0.000	0.29	0.127
		30-34	13.1	0.017	0.028	0.59	0.127
		35-39	18.9	0.024	0.131	0.71	0.127
		40-44	21.7	0.037	0.221	0.76	0.127
		45-49	21.1	0.050	0.236	0.79	0.127
		50-54	20.8	0.062	0.214	0.81	0.127
		55-59	22.3	0.090	0.183	0.91	0.127
		60-64	20.9	0.117	0.128	0.97	0.127
		65-69	17.3	0.135	0.098	0.92	0.093
		70-74	13.0	0.138	0.073	0.82	0.093
		75-79	9.6	0.099	0.045	0.77	0.093
		80-84	9.3	0.043	0.020	0.91	0.093
		85-89	11.4	0.033	0.006	1.23	0.093
		90-94	6.7	0.034	0.004	1.44	0.093
		95+	2.1	0.035	0.004	1.33	0.093
Female	non-Māori	0-4	0.0	0.000	0.000	0.00	0.209
		5-9	0.0	0.000	0.000	0.00	0.209
		10-14	0.0	0.000	0.000	0.00	0.209
		15-19	0.0	0.000	0.000	0.00	0.209
		20-24	1.7	0.001	0.000	0.04	0.209
		25-29	6.2	0.006	0.050	0.21	0.209
		30-34	10.1	0.018	0.230	0.37	0.209
		35-39	12.7	0.040	0.347	0.35	0.209
		40-44	13.2	0.034	0.352	0.33	0.209
		45-49	12.1	0.015	0.304	0.36	0.130
		50-54	10.8	0.025	0.242	0.39	0.130
		55-59	10.1	0.057	0.183	0.41	0.107
		60-64	9.8	0.085	0.157	0.41	0.107

	65-69	9.2	0.104	0.147	0.39	0.119
	70-74	8.5	0.149	0.126	0.35	0.119
	75-79	8.0	0.202	0.084	0.30	0.109
	80-84	8.0	0.212	0.049	0.29	0.109
	85-89	8.7	0.175	0.057	0.33	0.056
	90-94	8.7	0.123	0.088	0.38	0.056
	95+	8.1	0.082	0.117	0.40	0.056

Table S12. Bladder cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.000	0.000	0.232
		5-9	0.0	0.000	0.000	0.000	0.232
		10-14	0.0	0.000	0.000	0.000	0.232
		15-19	0.0	0.000	0.000	0.000	0.232
		20-24	0.3	0.000	0.000	0.005	0.232
		25-29	1.0	0.063	0.083	0.030	0.232
		30-34	1.6	0.262	0.349	0.031	0.232
		35-39	2.6	0.270	0.366	0.035	0.232
		40-44	4.2	0.192	0.273	0.071	0.232
		45-49	6.4	0.166	0.275	0.122	0.232
		50-54	9.6	0.182	0.314	0.173	0.232
		55-59	13.4	0.240	0.314	0.222	0.232
		60-64	18.9	0.267	0.274	0.305	0.232
		65-69	31.1	0.184	0.210	0.580	0.208
		70-74	45.4	0.175	0.160	1.077	0.208
		75-79	58.8	0.281	0.135	1.353	0.208
		80-84	67.7	0.324	0.123	1.444	0.208
		85-89	73.4	0.279	0.122	1.692	0.208
		90-94	98.9	0.377	0.121	1.932	0.208
		95+	132.3	0.554	0.117	2.079	0.208
Female	Māori	0-4	0.0	0.000	0.000	0.000	0.163
		5-9	0.0	0.000	0.000	0.000	0.163
		10-14	0.0	0.000	0.000	0.000	0.163
		15-19	0.0	0.000	0.000	0.000	0.163
		20-24	0.2	0.000	0.000	0.003	0.163
		25-29	0.6	0.054	0.000	0.020	0.163
		30-34	1.0	0.245	0.000	0.036	0.163
		35-39	1.5	0.347	0.007	0.038	0.163
		40-44	2.2	0.326	0.066	0.048	0.163
		45-49	3.2	0.291	0.168	0.064	0.163
		50-54	4.9	0.305	0.206	0.084	0.163
		55-59	7.7	0.343	0.163	0.131	0.163
		60-64	10.6	0.353	0.232	0.169	0.163
		65-69	14.6	0.265	0.200	0.256	0.163
		70-74	19.8	0.208	0.178	0.431	0.163
		75-79	26.2	0.262	0.251	0.511	0.163
		80-84	36.0	0.545	0.307	0.455	0.163
		85-89	50.1	1.130	0.264	0.369	0.163
		90-94	60.8	1.624	0.175	0.339	0.163
		95+	63.4	1.856	0.174	0.315	0.163
Male	non-Māori	0-4	0.0	0.000	0.000	0.000	0.145
		5-9	0.0	0.000	0.000	0.000	0.145
		10-14	0.0	0.000	0.000	0.000	0.145

Female	non-Māori	15-19	0.0	0.000	0.000	0.000	0.145
		20-24	0.2	0.000	0.000	0.008	0.145
		25-29	0.5	0.010	0.039	0.025	0.145
		30-34	1.1	0.044	0.176	0.041	0.145
		35-39	2.1	0.052	0.258	0.054	0.145
		40-44	4.0	0.043	0.225	0.098	0.145
		45-49	8.1	0.037	0.183	0.219	0.128
		50-54	15.7	0.040	0.197	0.438	0.128
		55-59	29.2	0.055	0.217	0.777	0.144
		60-64	51.9	0.071	0.249	1.263	0.144
		65-69	85.4	0.084	0.239	2.037	0.140
		70-74	127.5	0.089	0.208	3.306	0.140
		75-79	175.3	0.105	0.219	4.716	0.110
		80-84	220.5	0.158	0.269	5.213	0.110
		85-89	255.6	0.303	0.275	4.727	0.093
		90-94	291.7	0.591	0.184	3.959	0.093
		95+	309.9	0.812	0.145	3.351	0.093
		0-4	0.0	0.000	0.000	0.000	0.114
		5-9	0.0	0.000	0.000	0.000	0.114
		10-14	0.0	0.000	0.000	0.000	0.114
		15-19	0.0	0.000	0.000	0.000	0.114
		20-24	0.1	0.000	0.000	0.019	0.114
		25-29	0.3	0.033	0.065	0.029	0.114
		30-34	0.7	0.141	0.279	0.022	0.114
		35-39	1.2	0.154	0.333	0.021	0.114
		40-44	2.2	0.103	0.298	0.042	0.114
		45-49	3.8	0.067	0.281	0.082	0.155
		50-54	6.6	0.045	0.350	0.139	0.155
		55-59	11.2	0.022	0.504	0.191	0.134
		60-64	16.8	0.019	0.445	0.296	0.134
		65-69	23.8	0.050	0.287	0.531	0.150
		70-74	33.2	0.078	0.196	0.910	0.150
		75-79	44.9	0.121	0.216	1.234	0.107
		80-84	58.9	0.237	0.255	1.235	0.107
		85-89	72.6	0.434	0.215	1.152	0.068
		90-94	79.4	0.648	0.183	1.000	0.068
		95+	79.0	0.711	0.249	0.836	0.068

Table S13. Kidney cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.000	0.000	0.265
		5-9	0.0	0.000	0.000	0.000	0.265
		10-14	0.0	0.000	0.000	0.000	0.265
		15-19	0.1	0.000	0.000	0.002	0.265
		20-24	0.3	0.000	0.000	0.013	0.265
		25-29	0.7	0.003	0.039	0.033	0.265
		30-34	2.1	0.016	0.169	0.068	0.265
		35-39	4.1	0.044	0.210	0.115	0.265
		40-44	7.3	0.058	0.222	0.192	0.265
		45-49	12.7	0.093	0.240	0.304	0.265
		50-54	19.6	0.147	0.225	0.444	0.265
		55-59	27.3	0.153	0.204	0.634	0.265
		60-64	37.3	0.170	0.193	0.892	0.265

Female	Māori	65-69	45.1	0.230	0.216	1.009	0.111
		70-74	51.2	0.256	0.186	1.078	0.111
		75-79	48.6	0.257	0.130	1.240	0.111
		80-84	41.6	0.272	0.115	1.138	0.111
		85-89	40.1	0.274	0.111	1.080	0.111
		90-94	24.8	0.284	0.115	0.825	0.111
		95+	14.1	0.288	0.116	0.433	0.111
		0-4	0.0	0.000	0.000	0.000	0.199
		5-9	0.0	0.000	0.000	0.000	0.199
		10-14	0.0	0.000	0.000	0.000	0.199
		15-19	0.1	0.000	0.000	0.001	0.199
		20-24	0.2	0.000	0.000	0.008	0.199
		25-29	0.6	0.002	0.063	0.023	0.199
		30-34	1.9	0.012	0.266	0.047	0.199
		35-39	3.3	0.031	0.284	0.078	0.199
		40-44	5.2	0.040	0.243	0.134	0.199
		45-49	8.2	0.082	0.234	0.209	0.199
		50-54	12.3	0.140	0.211	0.294	0.199
		55-59	16.6	0.138	0.202	0.410	0.199
		60-64	20.6	0.165	0.163	0.549	0.199
	non-Māori	65-69	23.0	0.216	0.149	0.620	0.118
		70-74	24.8	0.235	0.115	0.661	0.118
		75-79	25.0	0.263	0.087	0.726	0.118
		80-84	23.0	0.379	0.093	0.587	0.118
		85-89	19.9	0.540	0.085	0.380	0.118
		90-94	14.4	0.608	0.113	0.234	0.118
		95+	9.4	0.658	0.145	0.131	0.118
		0-4	0.0	0.000	0.000	0.000	0.131
		5-9	0.0	0.000	0.000	0.000	0.131
		10-14	0.0	0.000	0.000	0.000	0.131
		15-19	0.0	0.000	0.000	0.000	0.131
		20-24	0.4	0.000	0.000	0.014	0.131
		25-29	0.7	0.002	0.023	0.039	0.131
		30-34	1.5	0.012	0.101	0.070	0.131
		35-39	3.2	0.027	0.129	0.119	0.131
		40-44	6.0	0.037	0.156	0.208	0.131
		45-49	11.1	0.055	0.189	0.333	0.146
		50-54	18.6	0.083	0.196	0.516	0.146
Female	non-Māori	55-59	28.4	0.093	0.208	0.758	0.164
		60-64	42.3	0.112	0.229	1.066	0.164
		65-69	54.5	0.162	0.302	1.186	0.207
		70-74	66.3	0.193	0.316	1.230	0.207
		75-79	72.5	0.233	0.308	1.352	0.170
		80-84	74.6	0.380	0.382	1.102	0.170
		85-89	78.2	0.602	0.475	0.775	0.172
		90-94	57.7	0.679	0.500	0.534	0.172
		95+	39.8	0.687	0.500	0.327	0.172
		0-4	0.0	0.000	0.000	0.000	0.144
		5-9	0.0	0.000	0.000	0.000	0.144
		10-14	0.0	0.000	0.000	0.000	0.144
		15-19	0.0	0.000	0.000	0.000	0.144
		20-24	0.2	0.000	0.000	0.009	0.144
		25-29	0.5	0.002	0.030	0.026	0.144
		30-34	1.2	0.010	0.128	0.048	0.144
		35-39	2.2	0.026	0.154	0.079	0.144
		40-44	3.8	0.036	0.170	0.130	0.144
		45-49	7.1	0.055	0.200	0.206	0.179

50-54	12.1	0.083	0.206	0.323	0.179
55-59	17.3	0.090	0.208	0.469	0.180
60-64	23.9	0.101	0.203	0.657	0.180
65-69	28.2	0.136	0.233	0.757	0.132
70-74	32.7	0.156	0.222	0.802	0.132
75-79	34.0	0.181	0.201	0.891	0.166
80-84	31.5	0.262	0.249	0.730	0.166
85-89	30.0	0.364	0.316	0.497	0.124
90-94	21.3	0.390	0.345	0.333	0.124
95+	14.8	0.395	0.356	0.201	0.124

Table S14. Endometrial cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Female	Māori	0-4	0.0	0.000	0.000	0.00	0.231
		5-9	0.0	0.000	0.000	0.00	0.231
		10-14	0.0	0.000	0.000	0.00	0.231
		15-19	0.0	0.000	0.000	0.00	0.231
		20-24	0.3	0.000	0.000	0.01	0.231
		25-29	1.6	0.007	0.031	0.05	0.231
		30-34	4.5	0.034	0.149	0.14	0.231
		35-39	8.2	0.058	0.260	0.22	0.231
		40-44	15.2	0.061	0.284	0.34	0.231
		45-49	29.1	0.058	0.237	0.67	0.212
		50-54	49.6	0.062	0.189	1.33	0.212
		55-59	69.4	0.062	0.186	2.17	0.212
		60-64	75.8	0.066	0.210	2.63	0.212
		65-69	72.3	0.096	0.216	2.53	0.161
		70-74	75.1	0.160	0.223	2.16	0.161
		75-79	79.7	0.210	0.206	1.94	0.102
		80-84	76.7	0.216	0.162	1.98	0.102
		85-89	69.8	0.210	0.149	2.00	0.102
		90-94	54.4	0.217	0.153	1.71	0.102
		95+	42.6	0.225	0.158	1.21	0.102
Female	non-Māori	0-4	0.0	0.000	0.000	0.00	0.176
		5-9	0.0	0.000	0.000	0.00	0.176
		10-14	0.0	0.000	0.000	0.00	0.176
		15-19	0.0	0.000	0.000	0.00	0.176
		20-24	0.1	0.000	0.000	0.01	0.176
		25-29	0.3	0.005	0.009	0.02	0.176
		30-34	1.8	0.019	0.050	0.06	0.176
		35-39	3.5	0.022	0.116	0.14	0.176
		40-44	6.7	0.024	0.128	0.25	0.176
		45-49	12.8	0.031	0.097	0.49	0.187
		50-54	22.5	0.035	0.093	0.92	0.187
		55-59	35.6	0.034	0.121	1.51	0.179
		60-64	46.8	0.041	0.159	1.99	0.179
		65-69	54.8	0.066	0.171	2.21	0.153
		70-74	59.0	0.096	0.203	2.14	0.153
		75-79	59.9	0.120	0.207	1.90	0.144
		80-84	58.0	0.139	0.180	1.87	0.144
		85-89	53.1	0.162	0.220	1.61	0.070
		90-94	47.8	0.201	0.253	1.21	0.070
		95+	43.6	0.130	0.168	0.56	0.070

Table S15. Melanoma input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.000	0.000	0.00	0.080
		5-9	0.0	0.000	0.000	0.00	0.080
		10-14	0.0	0.000	0.000	0.00	0.080
		15-19	0.0	0.000	0.000	0.00	0.080
		20-24	1.7	0.001	0.000	0.06	0.080
		25-29	3.0	0.008	0.044	0.17	0.080
		30-34	4.7	0.022	0.190	0.22	0.080
		35-39	6.1	0.035	0.229	0.22	0.080
		40-44	7.8	0.038	0.222	0.26	0.080
		45-49	10.6	0.036	0.216	0.34	0.080
		50-54	14.5	0.038	0.213	0.47	0.080
		55-59	19.8	0.047	0.277	0.57	0.080
		60-64	28.1	0.063	0.351	0.64	0.080
		65-69	37.0	0.089	0.368	0.75	0.061
		70-74	46.5	0.101	0.358	0.92	0.061
		75-79	57.6	0.107	0.363	1.14	0.061
		80-84	66.9	0.116	0.393	1.28	0.061
		85-89	67.0	0.102	0.444	1.26	0.061
		90-94	59.0	0.076	0.491	1.11	0.061
		95+	52.9	0.054	0.519	0.94	0.061
Female	Māori	0-4	0.0	0.000	0.000	0.00	0.181
		5-9	0.0	0.000	0.000	0.00	0.181
		10-14	0.0	0.000	0.000	0.00	0.181
		15-19	0.0	0.000	0.000	0.00	0.181
		20-24	1.6	0.001	0.000	0.06	0.181
		25-29	3.4	0.007	0.078	0.16	0.181
		30-34	7.0	0.020	0.335	0.20	0.181
		35-39	9.1	0.031	0.409	0.20	0.181
		40-44	10.7	0.033	0.368	0.24	0.181
		45-49	12.7	0.031	0.313	0.31	0.181
		50-54	14.9	0.033	0.258	0.43	0.181
		55-59	17.6	0.042	0.273	0.52	0.181
		60-64	21.3	0.056	0.284	0.58	0.181
		65-69	25.3	0.079	0.256	0.68	0.199
		70-74	29.5	0.089	0.221	0.84	0.199
		75-79	34.3	0.095	0.205	1.03	0.199
		80-84	37.3	0.110	0.227	1.12	0.199
		85-89	35.0	0.112	0.291	0.98	0.199
		90-94	29.8	0.096	0.346	0.77	0.199
		95+	25.6	0.080	0.388	0.58	0.199
Male	non-Māori	0-4	0.0	0.000	0.000	0.00	0.111
		5-9	0.0	0.000	0.000	0.00	0.111
		10-14	0.0	0.000	0.000	0.00	0.111
		15-19	0.0	0.000	0.000	0.00	0.111
		20-24	11.0	0.001	0.000	0.42	0.111
		25-29	14.8	0.006	0.021	1.07	0.111
		30-34	20.4	0.012	0.092	1.49	0.111
		35-39	27.8	0.017	0.119	1.69	0.111
		40-44	38.4	0.018	0.133	2.02	0.111
		45-49	54.9	0.018	0.139	2.56	0.150

Female	non-Māori	50-54	78.2	0.019	0.145	3.52	0.150
		55-59	109.9	0.024	0.207	4.30	0.161
		60-64	157.1	0.032	0.270	4.82	0.161
		65-69	205.2	0.045	0.285	5.60	0.170
		70-74	252.0	0.051	0.278	6.83	0.170
		75-79	301.5	0.055	0.280	8.22	0.129
		80-84	339.6	0.077	0.302	8.96	0.129
		85-89	340.2	0.126	0.335	8.08	0.137
		90-94	315.2	0.202	0.345	6.41	0.137
		95+	292.1	0.278	0.354	4.84	0.137
		0-4	0.0	0.000	0.000	0.00	0.166
		5-9	0.0	0.000	0.000	0.00	0.166
		10-14	0.0	0.000	0.000	0.00	0.166
		15-19	0.0	0.000	0.000	0.00	0.166
		20-24	11.6	0.001	0.000	0.41	0.166
		25-29	20.3	0.005	0.046	1.16	0.166
		30-34	32.0	0.011	0.197	1.52	0.166
		35-39	42.3	0.015	0.246	1.52	0.166
		40-44	53.2	0.017	0.238	1.80	0.166
		45-49	66.3	0.016	0.211	2.31	0.167
		50-54	80.5	0.017	0.176	3.20	0.167
		55-59	96.9	0.021	0.202	3.91	0.128
		60-64	117.5	0.028	0.215	4.38	0.128
		65-69	137.5	0.039	0.193	5.12	0.126
		70-74	155.8	0.044	0.166	6.24	0.126
		75-79	172.2	0.048	0.151	7.50	0.098
		80-84	179.5	0.056	0.169	8.14	0.098
		85-89	167.7	0.059	0.236	7.00	0.096
		90-94	145.2	0.055	0.300	5.10	0.096
		95+	127.1	0.051	0.347	3.51	0.096

Table S16. Thyroid cancer input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Remission rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.0000	0.00	0.000	0.135
		5-9	0.0	0.0000	0.00	0.000	0.135
		10-14	0.0	0.0000	0.00	0.000	0.135
		15-19	0.6	0.0000	0.00	0.014	0.135
		20-24	1.5	0.0001	0.00	0.070	0.135
		25-29	1.4	0.0000	0.02	0.138	0.135
		30-34	2.2	0.0000	0.10	0.176	0.135
		35-39	3.3	0.0002	0.14	0.196	0.135
		40-44	4.3	0.0018	0.14	0.236	0.135
		45-49	5.4	0.0100	0.15	0.284	0.135
		50-54	6.9	0.0190	0.18	0.318	0.135
		55-59	8.8	0.0160	0.23	0.342	0.135
		60-64	10.7	0.0110	0.29	0.361	0.135
		65-69	12.4	0.0122	0.44	0.312	0.135
		70-74	13.4	0.0129	0.53	0.254	0.135
		75-79	12.5	0.0105	0.64	0.215	0.135
		80-84	11.6	0.0099	0.72	0.161	0.135
		85-89	13.5	0.0127	0.49	0.227	0.135
		90-94	14.3	0.0151	0.48	0.286	0.135
		95+	14.6	0.0137	0.57	0.259	0.135

Female	Māori	0-4	0.0	0.0000	0.00	0.000	0.169
		5-9	0.0	0.0000	0.00	0.000	0.169
		10-14	0.0	0.0000	0.00	0.001	0.169
		15-19	1.5	0.0000	0.00	0.033	0.169
		20-24	3.8	0.0000	0.00	0.172	0.169
		25-29	4.9	0.0000	0.05	0.354	0.169
		30-34	10.6	0.0000	0.22	0.444	0.169
		35-39	14.7	0.0001	0.28	0.479	0.169
		40-44	17.1	0.0011	0.25	0.584	0.169
		45-49	19.4	0.0063	0.24	0.702	0.169
		50-54	22.3	0.0138	0.25	0.783	0.169
		55-59	24.5	0.0150	0.26	0.846	0.169
		60-64	24.5	0.0094	0.28	0.874	0.169
		65-69	25.7	0.0100	0.38	0.752	0.145
		70-74	26.3	0.0105	0.43	0.625	0.145
		75-79	24.5	0.0089	0.55	0.521	0.145
		80-84	23.1	0.0188	0.80	0.321	0.145
		85-89	25.6	0.0399	0.91	0.271	0.145
		90-94	27.0	0.0429	1.05	0.252	0.145
		95+	27.6	0.0342	1.27	0.217	0.145
	non-Māori	0-4	0.0	0.0000	0.00	0.000	0.137
		5-9	0.0	0.0000	0.00	0.000	0.137
		10-14	0.0	0.0001	0.00	0.000	0.137
		15-19	0.4	0.0000	0.00	0.009	0.137
		20-24	1.0	0.0000	0.00	0.044	0.137
		25-29	1.1	0.0000	0.03	0.090	0.137
		30-34	1.7	0.0000	0.13	0.113	0.137
		35-39	2.4	0.0001	0.17	0.122	0.137
		40-44	3.0	0.0009	0.16	0.147	0.137
		45-49	3.6	0.0053	0.16	0.177	0.121
		50-54	4.3	0.0113	0.19	0.200	0.121
		55-59	5.2	0.0119	0.21	0.218	0.121
		60-64	6.0	0.0079	0.27	0.224	0.121
		65-69	6.7	0.0098	0.38	0.193	0.207
		70-74	6.9	0.0109	0.43	0.161	0.207
		75-79	6.4	0.0095	0.57	0.132	0.186
		80-84	5.9	0.0072	0.86	0.078	0.186
		85-89	6.2	0.0017	1.06	0.059	0.186
		90-94	6.5	0.0001	1.16	0.056	0.186
		95+	6.6	0.0001	1.29	0.052	0.186
Female	non-Māori	0-4	0.0	0.0000	0.00	0.000	0.229
		5-9	0.0	0.0000	0.00	0.000	0.229
		10-14	0.0	0.0000	0.00	0.000	0.229
		15-19	0.9	0.0000	0.00	0.021	0.229
		20-24	2.1	0.0000	0.00	0.102	0.229
		25-29	2.5	0.0000	0.06	0.191	0.229
		30-34	7.9	0.0000	0.26	0.255	0.229
		35-39	11.0	0.0001	0.33	0.299	0.229
		40-44	11.9	0.0007	0.30	0.353	0.229
		45-49	12.5	0.0040	0.28	0.411	0.155
		50-54	13.6	0.0078	0.28	0.449	0.155
		55-59	14.7	0.0069	0.30	0.468	0.155
		60-64	13.6	0.0047	0.27	0.493	0.155
		65-69	12.8	0.0049	0.31	0.462	0.122
		70-74	12.5	0.0051	0.32	0.402	0.122
		75-79	10.0	0.0047	0.33	0.358	0.145
		80-84	7.4	0.0075	0.46	0.222	0.145

85-89	9.7	0.0134	0.60	0.162	0.145
90-94	10.4	0.0156	0.65	0.157	0.145
95+	9.9	0.0156	0.69	0.143	0.145

Table S17. COPD input parameters

Sex	Ethnic group	Age group (years)	Incidence rate per 100,000	Case-fatality rate	Prevalence per 1000	Disability rate
Male	Māori	0-4	0.0	0.0000	0.0	0.125
		5-9	0.0	0.0000	0.0	0.125
		10-14	0.0	0.0000	0.0	0.125
		15-19	45.2	0.0000	2.9	0.125
		20-24	74.1	0.0000	5.9	0.125
		25-29	99.3	0.0002	10.3	0.125
		30-34	107.1	0.0012	15.4	0.125
		35-39	160.1	0.0020	21.7	0.125
		40-44	206.7	0.0019	30.8	0.125
		45-49	320.1	0.0015	43.1	0.083
		50-54	528.7	0.0019	64.0	0.083
		55-59	696.8	0.0038	93.8	0.091
		60-64	832.2	0.0074	129.3	0.091
		65-69	1008.7	0.0110	169.3	0.100
		70-74	1157.4	0.0176	213.0	0.100
		75-79	1196.9	0.0259	252.6	0.097
		80-84	1164.2	0.0322	282.7	0.097
		85-89	1136.9	0.0394	303.8	0.087
		90-94	1054.3	0.0540	309.9	0.087
		95+	960.7	0.0791	293.4	0.087
Female	Māori	0-4	0.0	0.0000	0.0	0.224
		5-9	0.0	0.0000	0.0	0.224
		10-14	0.0	0.0000	0.0	0.224
		15-19	30.1	0.0000	2.2	0.224
		20-24	51.3	0.0005	4.2	0.224
		25-29	82.0	0.0015	7.5	0.224
		30-34	123.4	0.0018	12.5	0.224
		35-39	181.6	0.0016	19.9	0.224
		40-44	249.7	0.0018	30.5	0.224
		45-49	344.9	0.0022	44.8	0.160
		50-54	458.4	0.0027	64.4	0.160
		55-59	553.5	0.0053	88.4	0.167
		60-64	664.4	0.0111	115.0	0.167
		65-69	766.5	0.0159	143.2	0.170
		70-74	839.4	0.0225	171.0	0.170
		75-79	873.6	0.0290	194.2	0.149
		80-84	868.7	0.0306	213.3	0.149
		85-89	830.5	0.0289	230.1	0.113
		90-94	765.5	0.0267	244.9	0.113
		95+	690.0	0.0246	257.1	0.113
Male	non-Māori	0-4	0.0	0.0000	0.0	0.117
		5-9	0.0	0.0000	0.0	0.117
		10-14	0.0	0.0000	0.0	0.117
		15-19	35.2	0.0000	1.7	0.117
		20-24	66.1	0.0000	4.4	0.117
		25-29	61.6	0.0000	7.7	0.117
		30-34	49.2	0.0001	10.4	0.117

Female	non-Māori	35-39	67.1	0.0002	13.2	0.117
		40-44	84.2	0.0003	17.0	0.117
		45-49	136.4	0.0005	22.2	0.083
		50-54	235.5	0.0008	31.5	0.083
		55-59	304.8	0.0018	44.9	0.084
		60-64	380.3	0.0039	60.9	0.084
		65-69	658.7	0.0063	84.3	0.096
		70-74	906.8	0.0101	120.4	0.096
		75-79	1030.2	0.0156	161.3	0.095
		80-84	1054.2	0.0228	200.0	0.095
		85-89	954.5	0.0333	227.1	0.095
		90-94	847.6	0.0480	236.3	0.095
		95+	755.9	0.0720	225.6	0.095
		0-4	0.0	0.0000	0.0	0.217
		5-9	0.0	0.0000	0.0	0.217
		10-14	0.0	0.0000	0.0	0.217
		15-19	17.6	0.0000	1.2	0.217
		20-24	33.2	0.0000	2.5	0.217
		25-29	53.8	0.0000	4.6	0.217
		30-34	81.6	0.0001	8.0	0.217
		35-39	116.8	0.0002	12.9	0.217
		40-44	159.9	0.0003	19.8	0.217
		45-49	214.6	0.0005	29.0	0.119
		50-54	277.7	0.0008	41.2	0.119
		55-59	340.9	0.0018	56.4	0.116
		60-64	408.8	0.0035	74.3	0.116
		65-69	474.3	0.0054	94.7	0.122
		70-74	526.3	0.0087	116.5	0.122
		75-79	555.2	0.0132	137.6	0.127
		80-84	558.3	0.0178	155.8	0.127
		85-89	536.7	0.0238	169.3	0.117
		90-94	496.1	0.0333	175.0	0.117
		95+	450.2	0.0484	170.7	0.117

Table S18. LRTI input parameters

Sex	Ethnic group	Age group (years)	Mortality per 100,000	Disability rate
Male	Māori	0-4	11.86	0.00064
		5-9	0.00	0.00018
		10-14	0.00	0.00019
		15-19	0.00	0.00018
		20-24	0.00	0.00024
		25-29	0.00	0.00031
		30-34	0.00	0.00023
		35-39	0.00	0.00030
		40-44	1.99	0.00028
		45-49	0.00	0.00025
		50-54	15.47	0.00035
		55-59	6.63	0.00046
		60-64	0.00	0.00045
		65-69	0.00	0.00064
		70-74	19.97	0.00077
		75-79	74.44	0.00092
		80-84	174.66	0.00116

Female	Māori	85-89	312.50	0.00146
		90-94	312.50	0.00146
		95+	312.50	0.00146
		0-4	12.35	0.00059
		5-9	0.00	0.00022
		10-14	0.00	0.00008
		15-19	0.00	0.00027
		20-24	0.00	0.00030
		25-29	0.00	0.00032
		30-34	0.00	0.00029
		35-39	0.00	0.00030
		40-44	1.58	0.00031
		45-49	1.80	0.00033
		50-54	2.41	0.00044
		55-59	0.00	0.00053
		60-64	4.56	0.00060
		65-69	0.00	0.00078
		70-74	8.80	0.00063
		75-79	83.68	0.00077
		80-84	108.75	0.00083
Male	non-Māori	85-89	542.45	0.00095
		90-94	542.45	0.00095
		95+	542.45	0.00095
		0-4	3.69	0.00032
		5-9	0.30	0.00009
		10-14	0.54	0.00009
		15-19	0.00	0.00009
		20-24	0.00	0.00012
		25-29	0.00	0.00016
		30-34	0.00	0.00012
		35-39	0.29	0.00015
		40-44	0.00	0.00014
		45-49	0.25	0.00013
		50-54	1.72	0.00018
		55-59	2.02	0.00024
		60-64	2.06	0.00024
		65-69	4.28	0.00035
		70-74	11.13	0.00042
		75-79	26.31	0.00052
		80-84	105.42	0.00066
Female	non-Māori	85-89	474.57	0.00088
		90-94	474.57	0.00088
		95+	474.57	0.00088
		0-4	1.31	0.00026
		5-9	0.00	0.00010
		10-14	0.00	0.00004
		15-19	0.00	0.00012
		20-24	0.00	0.00013
		25-29	0.00	0.00014
		30-34	0.00	0.00013
		35-39	0.00	0.00014
		40-44	0.46	0.00014
		45-49	0.24	0.00015
		50-54	1.67	0.00020
		55-59	2.09	0.00025
		60-64	1.17	0.00028
		65-69	3.68	0.00037

70-74	8.72	0.00030
75-79	20.07	0.00038
80-84	92.26	0.00040
85-89	558.75	0.00046
90-94	558.75	0.00046
95+	558.75	0.00046

Table S19. Future APC trends in incidence, CFR and remission

	Incidence Trends				Case-Fatality Trends				Remission Trends			
	Non-Māori		Māori		Non-Māori		Māori		Non-Māori		Māori	
	Men	Woman	Men	Woman	Men	Woman	Men	Woman	Men	Woman	Men	Woman
CHD	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%				
Stroke	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%				
COPD	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%				
LRTI												
Bladder Cancer	0.10%	1.00%	0.10%	0.90%	4.20%	4.49%	3.00%	2.47%	-2.40%	-1.77%	-5.38%	-7.04%
Head & Neck Cancer	-1.80%	-0.30%	0.80%	2.40%	-1.26%	-1.55%	-1.28%	-1.33%	1.93%	1.13%	1.87%	1.72%
Esophageal Cancer	0.10%	-0.60%	0.10%	-0.70%	-0.32%	-0.23%	-0.29%	-0.14%	1.98%	2.47%	2.12%	3.18%
Liver Cancer	1.90%	1.60%	-0.10%	-0.30%	-0.71%	-0.86%	-0.77%	-0.76%	4.30%	3.64%	4.04%	4.06%
Cervical Cancer		-2.40%		-3.50%		-0.31%		-0.28%		0.20%		0.26%
Endometrial Cancer		0.50%		0.40%		-1.91%		-1.85%		0.73%		0.88%
Kidney Cancer	1.30%	1.50%	1.30%	1.50%	-1.83%	-1.83%	-1.64%	-1.56%	0.93%	0.93%	1.39%	1.61%
Leukemia	1.90%	1.50%	1.80%	1.40%	-3.50%	-2.51%	-2.90%	-1.76%	1.37%	4.04%	2.91%	6.75%
Lung Cancer	-3.80%	-0.40%	-2.90%	0.50%	0.02%	0.02%	0.02%	0.02%	-0.24%	-0.24%	-0.29%	-0.25%
Melanoma	1.90%	1.60%	1.90%	1.60%								
Pancreas Cancer	-1.80%	-1.40%	-1.80%	-1.40%	-0.03%	-0.02%	-0.02%	-0.01%	0.23%	0.30%	0.28%	0.33%
Stomach Cancer	-1.50%	-1.40%	-0.50%	-0.50%	-0.48%	-0.45%	-0.36%	-0.37%	1.04%	1.14%	1.47%	1.42%
Thyroid Cancer	1.90%	3.70%	1.90%	3.70%	-2.60%	-2.61%	-2.60%	-2.60%	0.05%	0.04%	0.07%	0.06%

Appendix C: Association of smoking and vaping with disease incidence rates

Health impact of changing exposure to tobacco smoke

We modelled the health benefits of interventions through a reduction in incidence of each smoking-related disease (Equation 1). Note that all calculations were done by age, gender and ethnicity, although we omit these subscripts from the following equations for clarity.

$$I'_x = I_x \times (1 - \text{PIF}_x) \quad (1)$$

where:

I_x is the current incidence of disease x in the population;

I'_x is the new incidence of disease x after an intervention is implemented; and

PIF_x is the population impact fraction for disease x .

Each PIF_x ⁹ was derived from the current smoking prevalence, the new smoking prevalence following intervention and the relative risks of smoking-related diseases (Equation 2).

$$\text{PIF}_x = \frac{\left[p_n + p_c \text{RR}_{xc} + \sum_{t=0}^{100} p(t)_f \text{RR}_{xf}(t) \right] - \left[p'_n + p'_c \text{RR}_{xc} + \sum_{t=0}^{100} p'(t)_f \text{RR}_{xf}(t) \right]}{\left[p_n + p_c \text{RR}_{xc} + \sum_{t=0}^{100} p(t)_f \text{RR}_{xf}(t) \right]} \quad (2)$$

where:

RR_{xc} is the risk of disease x in current smokers, relative to never smokers;

$\text{RR}_{xf}(t)$ is the risk of disease x among former smokers at time t since cessation, relative to never smokers;

p_c and p'_c are the prevalence of people who report currently smoking at least one cigarette daily, before and after intervention;

p_n and p'_n are the prevalence of prevalence of people who report never having smoked at least one cigarette daily, before and after intervention; and

p_f and p'_f are the prevalence of prevalence of people who report past smoking of at least one cigarette daily, before and after intervention.

Relative risks of smoking-related diseases

We applied risks of smoking-related disease from New Zealand-specific epidemiological studies where possible. Unlike the large cohort studies, such as the US based Cancer Prevention Study II (CPS II), the New Zealand studies^{7,10,11} make use of national cancer registry (and mortality) data linked with data from the regular censuses, which have episodically included questions on smoking behaviour since 1976. For risks of chronic obstructive pulmonary disease and lower respiratory tract infections, however, we had to

draw on international studies ¹². Table S20 gives a summary of all the relative risk values used in the modeling and their sources.

Table S20. Relative risks of smoking-related diseases for current versus never smokers

Disease	Relative risk (95% uncertainty interval)	Confounding adjustment*	Source
Coronary heart disease	Men: 1.61 (1.44 to 1.80) Women: 1.66 (1.27 to 2.17)		New Zealand linked data ¹¹
Stroke	Men: 2.52 (2.12 to 2.99) Women: 2.20 (1.66 to 2.90)		New Zealand linked data ¹¹
Chronic obstructive pulmonary disease	Men: 10.80 (8.40 to 13.90) Women: 12.30 (9.90 to 15.20)		CPS-II ¹²
Lower respiratory tract infection	Men: 1.90 (1.50 to 2.40) Women: 2.20 (1.70 to 2.80)		CPS-II ¹²
Lung cancer	9.28 (8.31 to 10.40)**		New Zealand linked data ⁷
Mouth and oropharyngeal cancer	2.30 (1.94 to 2.72) **		New Zealand linked data ⁷
Esophageal cancer	2.14 (1.73 to 2.65) **	-0.4 to -0.1	New Zealand linked data ⁷
Pancreatic cancer	1.68 (1.44 to 1.96) **	0.1 to 0.2	New Zealand linked data ⁷
Bladder cancer	2.22 (1.94 to 2.55) **		New Zealand linked data ⁷
Kidney cancer	1.29 (1.07 to 1.56) **		New Zealand linked data ⁷
Stomach cancer	1.42 (1.22 to 1.66) **	0.07 to 0.10	New Zealand linked data ⁷
Liver cancer	1.75 (1.37 to 2.24) **	-0.10 to -0.20	New Zealand linked data ⁷
Cervical cancer	1.82 (1.51 to 2.20) **		New Zealand linked data ⁷
Endometrial cancer#	0.67 (0.56 to 0.79) **	0.08	New Zealand linked data ⁷
Melanoma#	0.62 (0.56 to 0.69) **		New Zealand linked data ⁷
Thyroid cancer#	0.76 (0.58 to 1.00) **		New Zealand linked data ⁷

* Additional change in RR to additionally correct for potential residual confounding by alcohol and obesity (which were not captured in census data).

**Rate ratio values adjusted for selection bias and confounding (e.g. due to socio-economic factors) and exposure misclassification.

That is, there is some evidence that tobacco smoking protects against these cancers (possibly due to hormonal effects)

(Note that we did include a scenario analysis substituting the CPS II relative risks for CHD and stroke for the ‘default’ relative risks above.)

We assumed no excess risk of lower respiratory tract infection immediately after cessation of smoking, but for all other diseases, we assumed that the current smoker disease risks decline with time since cessation, using regression models derived by Hoogenveen et al.¹³ The regression model parameters are shown in Table S21. We assumed no excess risk remained after 20 years.

$$RR_{xf}(t)=1+ (RR_{xc}-1)\exp[-\gamma t] \quad RR_{xf}(t)=1+ (RR_{xc}-1)\exp[-\gamma t]$$

(1)

$$\gamma = \gamma_0 \exp[-\eta (a-50)] \quad \gamma = \gamma_0 \exp[-\eta (a-50)]$$

(2)

where:

- γ is a regression coefficient for time (t);
- γ_0 is the regression coefficient value at age 50 (minimum observed age of age gradient ¹³);
- and
- η is a regression coefficient for age (a);

Table S21. Regression coefficients used to estimate declining risks of disease with smoking cessation

Disease	γ_0	η
Coronary heart disease ¹³	0.24228	0.05822
Stroke ¹³	0.31947	0.01648
Chronic obstructive pulmonary disease ¹³	0.20333	0.03087
Cancers		
Lung cancer ¹³	0.15637	0.02065
Mouth and oropharyngeal cancer ¹³	0.0493028	0
Esophageal cancer ¹³	0.0537424	0
Pancreatic cancer ¹³	0.09279	0
Bladder cancer ¹³	0.05417	0
Kidney cancer ¹³	0.0385957	0
Stomach cancer ¹³	0.0264112	0
Liver cancer*	0.0525	0
Cervical cancer*	0.0525	0
Endometrial cancer* #	0.0525	0
Melanoma* #	0.0525	0
Thyroid cancer* #	0.0525	0

* Estimated as average of all other cancers, excluding lung cancer.

For these diseases it is the decline in time of the protective effect – back to zero.

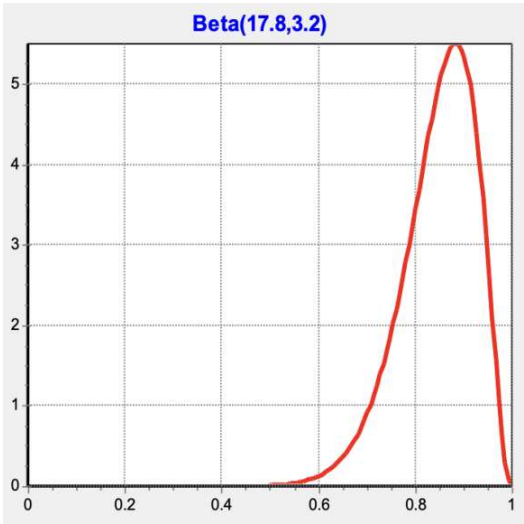
Appendix D: Expert knowledge elicitation process

There is no firm evidence on the amount by which smoking prevalence will reduce – as a result of quitting – with denicotinising tobacco. On the one hand, given nicotine is the addictive component there is reason to believe the vast majority of smokers will quit if only tobacco with sub-addictive levels of nicotine is available. This optimistic stance is further strengthened by possible positive reinforcement of denormalisation and suppliers exiting the market. On the other hand, some smokers maintain they will smoke regardless of nicotine, and for many smoking is a socially conditioned habit as well as a biological addiction. To parameterise our model, many of the co-authors of this paper were asked to independently estimate the most likely percentage reduction in smokers after five to ten-years compared to ongoing BAU trends with not denicotinisation. And to estimate a pessimistic and optimistic percentage reduction in smoking (that we interpreted as each individual’s 95% range of likely values). Table S22 shows the separate estimates, resulting in an average of 84.8% reduction as the most likely estimate, and average pessimistic and optimistic scenarios of 65.8% and 96.6%, respectively (equating to an approximated SD of 7.84%). Specifying this a Beta distribution (17.8, 3.2) gave a mean of 84.8%, median of 85.9%, 2.5th percentile of 67.0% and 97.5th percentile of 96.3%. Figure S2 below gives the probability density function).

Table S22. Co-authors estimates of the effect of denicotinisation on smoking prevalence

Co-authors	Pessimistic	Most likely	Optimistic
RE	50%	80%	95%
RM	50%	78.50%	95%
AW	80%	95%	99%
DAO	75%	85%	98%
TB	80%	90%	97.50%
NW	60%	80%	95%
Average	65.8%	84.8%	96.6%

Figure S2. Probability density function applied to average effect of denicotinisation on smoking cessation



It is interesting to compare our expert elicitation results with those done by the US Food and Drug Administration expert elicitation process, conducted in 2015 and published in the *New England Journal of Medicine*.¹⁴ It is important to note the key contextual differences with our process: our elicitation was undertaken in 2022; Aotearoa NZ is a country with strong border controls and ocean borders that limit potential illicit supply; Aotearoa NZ has liberal access to vaping as both an additional cessation support and substitute for those unwilling to or unable to quit nicotine altogether. Compared to Apelberg et al (2018), our experts’ estimates were more similar than the (surprisingly) large heterogeneity among experts in Apelberg et al. The Apelberg et al.’s expert median estimates of quitting in the first year ranged from 4.5% to 55%, and annual quitting in subsequent years ranged from 4.5% to 80% (table below). Calculating what this implies as the quitting after five years, it ranges from 20.6% to 99.9% (average across experts 77.2%). Our experts ranged from 78.5% to 95% in their ‘most likely’ estimates of quitting after five years and ranged from 65.8% to 96.6% for the average of their pessimist and optimistic estimates. In summary, our experts estimate somewhat higher quitting after five years than the Apelberg et al. experts – a difference that we believe is plausible due to the strengthened evidence base and the unique circumstances of Aotearoa NZ, but nevertheless must be noted as higher than that in Apelberg et al.

Apelberg et al experts.	A	B	C	D	E	F	G	H	Average of experts
a. Median percentage quitting in first year	20%	55%	20%	50%	9%	10%	4.5%	30%	25%
b. Median percentage quitting in subsequent years	13.5%	80%	10%	30%	15%	8%	4.5%	15%	22%
Implied quitting over five years = 1 - (1-a)×(1-b)^4	55.2%	99.9%	47.5%	88.0%	52.5%	35.5%	20.6%	63.5%	72.2%

Regarding reduced initiation of tobacco smoking, the Apelberg et al experts had an average of a 46% (range 21% to 75%) reduction in initiation in the first year and an average of a 49% (range 21% to 70%) reduction in initiation in subsequent years. Our experts (not by

independent elicitation as above for cessation, but rather a group discussion) settled on 10% of the BAU initiation by five years post implementation (95% UI 2.6% to 21.5%). As modelled, this was a 37%, 60%, 75%, 84% and 90% reduction in initiation compared with BAU by year post implementation, then held constant at 90% from year five onwards. Our estimate of reduced initiation is considerably greater than Apelberg et al – even our lower limit of reduction of 78.5% (i.e., 1 – 21.5%) is above the average of Apelberg et al.'s experts 95th percentile estimates of 71% (range 45% to 95% across experts). We attribute the higher estimates in the Aotearoa-NZ context to the ready access to vaping as a substitute, the strong border controls that should limit illicit supply, and the dramatic falls in young adult smoking prevalence in recent years in Aotearoa-NZ that gives more confidence in major reductions in initiation from mandatory denicotinisation of retail tobacco.

Returning to the increase in cessation, we operationalised it in the model by randomly drawing from the Beta distribution (17.8, 3.2). Assume the mean of 84.8% was drawn. We applied the following additional net cessation rate in the first five annual cycles of $1 - (1 - 84.8\%)^{(1/5)} = 31.3\%$. That is, after five cycles the 'survivorship' will be $1 - (1 - 31.3\%)^5 = 15.3\%$ (which is $1 - 84.8\%$). Given that this reduction was compared to future BAU, the percentage impact on the net cessation rate (NCR) was on that after the BAU NCR. For example, if BAU NCR in the next cycle was 5%, then under denicotinisation it would become $5\% + (1 - 5\%) \cdot 31.3\% = 34.8\%$.

This additional intervention NCR for denicotinisation was applied for the first 5 cycles, then the NCR was set at twice the BAU NCR.

Table S23. Estimated smoking prevalence (20+ year olds) in Aotearoa/New Zealand by policy scenario for 2020, 2025, 2030, and 2040 by sex and ethnic group

Policy	Population group	2020		2025		2030		2035		2040	
		Prevalence	95% UI	Prevalence	95% UI	Prevalence	95% UI	Prevalence	95% UI	Prevalence	95% UI
Business as usual	Māori Female	37.1%	(37.1% to 37.1%)	32.3%	(28.9% to 34.0%)	27.9%	(22.3% to 31.0%)	23.9%	(17.1% to 28.1%)	20.2%	(12.9% to 25.4%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	10.1%	(9.0% to 10.6%)	8.5%	(6.8% to 9.4%)	7.1%	(5.1% to 8.3%)	5.9%	(3.8% to 7.4%)
	Māori Male	30.6%	(30.6% to 30.6%)	24.9%	(21.9% to 26.6%)	20.2%	(15.6% to 23.1%)	16.2%	(11.1% to 20.0%)	12.9%	(7.8% to 17.2%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	11.5%	(10.2% to 11.8%)	9.9%	(7.9% to 10.6%)	8.4%	(6.1% to 9.5%)	7.1%	(4.7% to 8.5%)
	All	15.4%	(15.4% to 15.4%)	13.2%	(11.8% to 13.8%)	11.2%	(9.0% to 12.3%)	9.5%	(6.8% to 11.0%)	7.9%	(5.1% to 9.8%)
Low nicotine	Māori Female	37.1%	(37.1% to 37.1%)	10.0%	(5.3% to 13.1%)	3.6%	(1.4% to 5.3%)	2.6%	(1.1% to 4.2%)	1.7%	(0.8% to 3.3%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	3.1%	(1.7% to 4.1%)	1.1%	(0.5% to 1.6%)	0.8%	(0.4% to 1.3%)	0.5%	(0.3% to 1.0%)
	Māori Male	30.6%	(30.6% to 30.6%)	7.7%	(4.1% to 9.9%)	2.6%	(1.0% to 3.8%)	1.6%	(0.8% to 2.8%)	0.9%	(0.5% to 2.1%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	3.6%	(1.9% to 4.7%)	1.4%	(0.5% to 1.9%)	1.0%	(0.5% to 1.5%)	0.7%	(0.4% to 1.3%)
	All	15.4%	(15.4% to 15.4%)	4.1%	(2.2% to 5.4%)	1.5%	(0.6% to 2.2%)	1.0%	(0.5% to 1.7%)	0.7%	(0.4% to 1.4%)
Low nicotine + media	Māori Female	37.1%	(37.1% to 37.1%)	10.0%	(5.3% to 13.0%)	3.6%	(1.4% to 5.3%)	2.6%	(1.1% to 4.2%)	1.7%	(0.8% to 3.3%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	3.1%	(1.7% to 4.1%)	1.1%	(0.5% to 1.6%)	0.8%	(0.4% to 1.3%)	0.5%	(0.3% to 1.0%)
	Māori Male	30.6%	(30.6% to 30.6%)	7.7%	(4.1% to 9.9%)	2.6%	(1.0% to 3.8%)	1.6%	(0.8% to 2.8%)	0.9%	(0.5% to 2.1%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	3.6%	(1.9% to 4.7%)	1.4%	(0.5% to 1.9%)	1.0%	(0.5% to 1.5%)	0.7%	(0.4% to 1.3%)
	All	15.4%	(15.4% to 15.4%)	4.1%	(2.2% to 5.3%)	1.5%	(0.6% to 2.2%)	1.0%	(0.5% to 1.7%)	0.7%	(0.4% to 1.4%)
Retail reduction	Māori Female	37.1%	(37.1% to 37.1%)	25.8%	(22.6% to 28.5%)	22.0%	(17.4% to 25.6%)	18.7%	(13.3% to 23.2%)	15.8%	(10.1% to 21.0%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	8.1%	(7.0% to 8.8%)	6.9%	(5.3% to 7.8%)	5.8%	(4.0% to 6.9%)	4.8%	(3.0% to 6.1%)
	Māori Male	30.6%	(30.6% to 30.6%)	19.8%	(17.0% to 22.1%)	16.0%	(12.1% to 19.1%)	12.9%	(8.6% to 16.5%)	10.4%	(6.1% to 14.2%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	9.2%	(8.0% to 9.8%)	8.1%	(6.2% to 8.8%)	6.9%	(4.8% to 7.9%)	5.8%	(3.7% to 7.1%)
	All	15.4%	(15.4% to 15.4%)	10.6%	(9.2% to 11.5%)	9.1%	(7.0% to 10.2%)	7.7%	(5.3% to 9.1%)	6.4%	(4.0% to 8.1%)
Smokefree generation	Māori Female	37.1%	(37.1% to 37.1%)	32.1%	(28.9% to 33.9%)	25.4%	(20.3% to 28.7%)	19.7%	(14.0% to 23.6%)	15.3%	(9.7% to 19.6%)
	Māori Male	30.6%	(30.6% to 30.6%)	24.8%	(21.9% to 26.5%)	18.4%	(14.2% to 21.3%)	13.3%	(9.1% to 16.7%)	9.8%	(6.0% to 13.2%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	10.1%	(9.1% to 10.8%)	8.2%	(6.6% to 9.3%)	6.6%	(4.7% to 7.9%)	5.2%	(3.4% to 6.7%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	11.5%	(10.3% to 12.1%)	9.5%	(7.7% to 10.5%)	7.8%	(5.6% to 9.0%)	6.2%	(4.1% to 7.7%)
	All	15.4%	(15.4% to 15.4%)	13.4%	(12.0% to 14.1%)	10.9%	(8.7% to 12.3%)	8.7%	(6.2% to 10.4%)	6.9%	(4.4% to 8.8%)
Combined interventions	Māori Female	37.1%	(37.1% to 37.1%)	8.2%	(4.3% to 10.5%)	2.9%	(1.1% to 4.3%)	2.1%	(0.9% to 3.4%)	1.4%	(0.7% to 2.7%)
	non-Māori Female	11.8%	(11.8% to 11.8%)	2.5%	(1.3% to 3.3%)	0.9%	(0.4% to 1.3%)	0.7%	(0.3% to 1.1%)	0.5%	(0.3% to 0.9%)
	Māori Male	30.6%	(30.6% to 30.6%)	6.3%	(3.4% to 7.9%)	2.1%	(0.9% to 3.1%)	1.3%	(0.6% to 2.3%)	0.8%	(0.5% to 1.8%)
	non-Māori Male	13.1%	(13.1% to 13.1%)	2.9%	(1.5% to 3.8%)	1.1%	(0.5% to 1.6%)	0.8%	(0.4% to 1.3%)	0.6%	(0.4% to 1.1%)
	All	15.4%	(15.4% to 15.4%)	3.3%	(1.8% to 4.3%)	1.2%	(0.5% to 1.8%)	0.9%	(0.4% to 1.4%)	0.6%	(0.4% to 1.2%)

Table S24. Absolute change in premature deaths (i.e., before age 75 years)

Population	Year	BAU	Denicotinisation		Denicotinisation + media		Retail reduction		Smokefree generation		Combined interventions	
		Estimate	Estimate	95% UI	Estimate	95% UI	Estimate	95% UI	Estimate	95% UI	Estimate	95% UI
Māori	2020 to 2030	49,731	-437	(-567 to -306)	-443	(-571 to -315)	-147	(-208 to -98)	-1	(-1 to 0)	-503	(-616 to -392)
	2030 to 2040	64,618	-2,703	(-3,341 to -2,060)	-2,727	(-3,362 to -2,094)	-671	(-976 to -435)	-17	(-22 to -13)	-2871	(-3,485 to -2,264)
	2040 to 2050	83,543	-5,024	(-6,183 to -3,872)	-5,058	(-6,214 to -3,915)	-1,092	(-1,603 to -706)	-120	(-148 to -93)	-5232	(-6,349 to -4,134)
	2020 to 2040	114,349	-3,137	(-3,891 to -2,374)	-3,172	(-3,916 to -2,420)	-818	(-1,178 to -535)	-18	(-22 to -13)	-3371	(-4,075 to -2,664)
	2020 to 2050	197,892	-8,159	(-10,018 to -6,253)	-8,223	(-10,070 to -6,335)	-1,910	(-2,777 to -1,244)	-138	(-170 to -106)	-8614	(-10,423 to -6,807)
Non-Māori	2020 to 2030	336,543	-675	(-881 to -473)	-684	(-887 to -485)	-231	(-328 to -153)	-1	(-1 to 0)	-778	(-957 to -609)
	2030 to 2040	431,519	-4,137	(-5,156 to -3,128)	-4,170	(-5,176 to -3,173)	-1,051	(-1,526 to -681)	-15	(-19 to -10)	-4396	(-5,346 to -3,475)
	2040 to 2050	531,435	-7,803	(-9,683 to -5,919)	-7,853	(-9,712 to -6,001)	-1,792	(-2,655 to -1,153)	-55	(-72 to -40)	-8125	(-9,940 to -6,321)
	2020 to 2040	768,062	-4,804	(-5,997 to -3,609)	-4,846	(-6,033 to -3,681)	-1,282	(-1,857 to -835)	-15	(-20 to -11)	-5179	(-6,292 to -4,092)
	2020 to 2050	1,299,497	-12,610	(-15,698 to -9,562)	-12,698	(-15,729 to -9,693)	-3,072	(-4,526 to -1,984)	-70	(-92 to -51)	-13313	(-16,113 to -10,512)
All	2020 to 2030	386,274	-1,112	(-1,444 to -780)	-1,128	(-1,454 to -803)	-378	(-535 to -251)	-1	(-2 to -1)	-1280	(-1,569 to -1,001)
	2030 to 2040	496,137	-6,837	(-8,481 to -5,200)	-6,889	(-8,511 to -5,270)	-1,720	(-2,505 to -1,116)	-32	(-40 to -23)	-7266	(-8,821 to -5,756)
	2040 to 2050	614,978	-12,821	(-15,848 to -9,813)	-12,908	(-15,914 to -9,918)	-2,885	(-4,275 to -1,853)	-175	(-216 to -134)	-13367	(-16,233 to -10,485)
	2020 to 2040	882,411	-7,940	(-9,892 to -5,984)	-8,014	(-9,961 to -6,096)	-2,103	(-3,031 to -1,365)	-33	(-42 to -24)	-8543	(-10,367 to -6,777)
	2020 to 2050	1,497,389	-20,806	(-25,718 to -15,805)	-20,955	(-25,772 to -16,026)	-4,987	(-7,308 to -3,228)	-209	(-258 to -159)	-21939	(-26,599 to -17,386)

Table S25. Relative percentage change in premature deaths (i.e., before age 75 years)

Population	Year	BAU	Denicotinisation		Denicotinisation + media		Retail reduction		Smokefree generation		Combined interventions	
		Estimate	% Change	95% UI	% Change	95% UI	% Change	95% UI	% Change	95% UI	% Change	95% UI
Māori	2020 to 2030	49731	-0.88	(-1.14 to -0.61)	-0.89	(-1.15 to -0.63)	-0.30	(-0.42 to -0.20)	0.00	(0.00 to 0.00)	-1.01	(-1.24 to -0.79)
	2030 to 2040	64618	-4.18	(-5.17 to -3.19)	-4.22	(-5.20 to -3.24)	-1.04	(-1.51 to -0.67)	-0.03	(-0.03 to -0.02)	-4.44	(-5.39 to -3.50)
	2040 to 2050	83543	-6.01	(-7.40 to -4.63)	-6.05	(-7.44 to -4.69)	-1.31	(-1.92 to -0.84)	-0.14	(-0.18 to -0.11)	-6.26	(-7.60 to -4.95)
	2020 to 2040	114349	-2.74	(-3.40 to -2.08)	-2.77	(-3.42 to -2.12)	-0.72	(-1.03 to -0.47)	-0.02	(-0.02 to -0.01)	-2.95	(-3.56 to -2.33)
	2020 to 2050	197892	-4.12	(-5.06 to -3.16)	-4.16	(-5.09 to -3.20)	-0.97	(-1.40 to -0.63)	-0.07	(-0.09 to -0.05)	-4.35	(-5.27 to -3.44)
Non-Māori	2020 to 2030	336543	-0.20	(-0.26 to -0.14)	-0.20	(-0.26 to -0.14)	-0.07	(-0.10 to -0.05)	0.00	(0.00 to 0.00)	-0.23	(-0.28 to -0.18)
	2030 to 2040	431519	-0.96	(-1.19 to -0.72)	-0.97	(-1.20 to -0.74)	-0.24	(-0.35 to -0.16)	0.00	(0.00 to 0.00)	-1.02	(-1.24 to -0.81)
	2040 to 2050	531435	-1.47	(-1.82 to -1.11)	-1.48	(-1.83 to -1.13)	-0.34	(-0.50 to -0.22)	-0.01	(-0.01 to -0.01)	-1.53	(-1.87 to -1.19)
	2020 to 2040	768062	-0.63	(-0.78 to -0.47)	-0.63	(-0.79 to -0.48)	-0.17	(-0.24 to -0.11)	0.00	(0.00 to 0.00)	-0.67	(-0.82 to -0.53)
	2020 to 2050	1299497	-0.97	(-1.21 to -0.74)	-0.98	(-1.21 to -0.75)	-0.24	(-0.35 to -0.15)	-0.01	(-0.01 to 0.00)	-1.02	(-1.24 to -0.81)
All population	2020 to 2030	386274	-0.29	(-0.37 to -0.20)	-0.29	(-0.38 to -0.21)	-0.10	(-0.14 to -0.06)	0.00	(0.00 to 0.00)	-0.33	(-0.41 to -0.26)
	2030 to 2040	496137	-1.38	(-1.71 to -1.05)	-1.39	(-1.72 to -1.06)	-0.35	(-0.50 to -0.22)	-0.01	(-0.01 to 0.00)	-1.46	(-1.78 to -1.16)
	2040 to 2050	614978	-2.08	(-2.58 to -1.60)	-2.10	(-2.59 to -1.61)	-0.47	(-0.70 to -0.30)	-0.03	(-0.04 to -0.02)	-2.17	(-2.64 to -1.70)
	2020 to 2040	882411	-0.90	(-1.12 to -0.68)	-0.91	(-1.13 to -0.69)	-0.24	(-0.34 to -0.15)	0.00	(0.00 to 0.00)	-0.97	(-1.17 to -0.77)
	2020 to 2050	1497389	-1.39	(-1.72 to -1.06)	-1.40	(-1.72 to -1.07)	-0.33	(-0.49 to -0.22)	-0.01	(-0.02 to -0.01)	-1.47	(-1.78 to -1.16)

Figure S3. Comparison of total health gains from tobacco endgame strategies modelled in this paper, with those we have previously modelled for the ANZ population of food taxes and subsidies¹⁴, colorectal cancer screening¹⁵, and 10% per annum increases in tobacco tax¹⁶

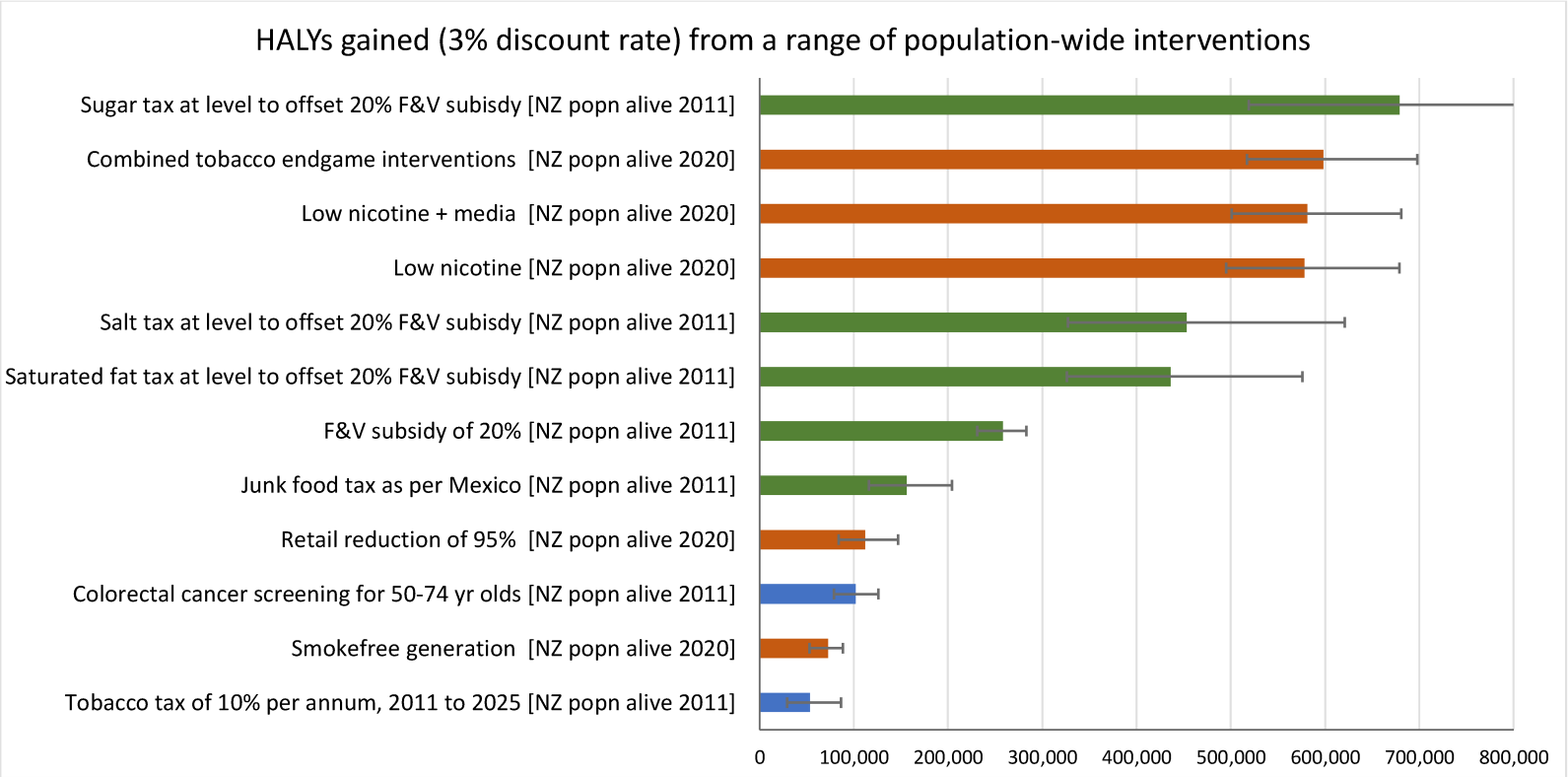


Table S26. Health gain (in HALYs gained; 3% discount rate) per 1,000 people alive in 2020 (base-year) in Aotearoa/New Zealand by the modelled policies, by timeline into the future

Population	Years	Low nicotine		Low nicotine + media		Retail reduction		Smokefree generation		Combined interventions	
		Estimate	Relative risk compared to non-Māori	Estimate	Relative risk compared to non-Māori	Estimate	Relative risk compared to non-Māori	Estimate	Relative risk compared to non-Māori	Estimate	Relative risk compared to non-Māori
Māori female	2020 to 2030	0.29	3.23	0.30	3.24	0.11	3.13	0.01	4.91	0.34	3.24
	2031 to 2040	4.26	3.45	4.26	3.46	1.13	3.36	0.13	4.65	4.54	3.44
	2041 to 2131	37.80	4.62	37.80	4.58	6.20	3.82	7.66	8.48	39.02	4.57
	All	16.89	4.73	16.99	4.73	2.91	3.96	3.23	9.01	17.50	4.75
Non-Māori female	2020 to 2030	0.09	1	0.09	1	0.03	1	0.00	1	0.10	1
	2031 to 2040	1.23	1	1.24	1	0.34	1	0.03	1	1.32	1
	2041 to 2131	8.20	1	8.26	1	1.62	1	0.90	1	8.48	1
	All	3.55	1	3.57	1	0.73	1	0.36	1	3.68	1
Māori male	2020 to 2030	0.19	1.79	0.19	1.80	0.07	1.78	0.01	3.45	0.21	1.80
	2031 to 2040	2.50	1.81	2.51	1.82	0.68	1.81	0.09	3.16	2.67	1.82
	2041 to 2131	18.58	2.03	18.66	2.03	3.30	1.84	3.43	3.44	19.20	2.04
	All	8.30	2.12	8.33	2.12	1.54	1.93	1.42	3.61	8.59	2.12
Non-Māori male	2020 to 2030	0.10	1	0.11	1	0.04	1	0.00	1	0.12	1
	2031 to 2040	1.37	1	1.38	1	0.37	1	0.03	1	1.47	1
	2041 to 2131	9.06	1	9.12	1	1.78	1	1.00	1	9.41	1
	All	3.88	1	3.92	1	0.80	1	0.39	1	4.04	1

HALYs gained are age-standardized to the 2020 Māori population. Because we model a closed cohort (all ANZers alive in 2020), in out-years the HALYs gained are increasingly only among the younger birth cohorts in 2020. The ‘missing’ older people in out-years is why the RR comparing Māori to non-Māori for all years combined is higher than the weighted average of the three sub-periods.

Table S27. Sensitivity of Health gains results to policy effect specifications*

Population	Year	Denicotinisation		Denicotinisation + media		Retail reduction		Smokefree generation		Combined interventions	
		Estimate	95% UI	Estimate	95% UI	Estimate	95% UI	Estimate	95% UI	Estimate	95% UI
Māori	2020 to 2030	1,050	(901 to 1,130)	1,090	(934 to 1,167)	529	(473 to 656)	37	(28 to 47)	1,430	(1,240 to 1,560)
	2031 to 2040	10,700	(9,060 to 12,100)	11,500	(9,777 to 12,793)	3,900	(3,340 to 4,780)	514	(422 to 623)	12,900	(11,000 to 14,400)
	2041 to 2131	151,000	(112,000 to 190,000)	183,000	(139,119 to 224,223)	28,600	(22,700 to 36,900)	71,300	(53,800 to 83,500)	181,000	(137,000 to 225,000)
	All	163,000	(122,000 to 203,000)	196,000	(149,920 to 238,183)	33,200	(26,500 to 42,100)	71,900	(54,400 to 84,000)	195,000	(149,000 to 241,000)
Non-Māori	2020 to 2030	2,230	(1,910 to 2,390)	2,310	(1,973 to 2,456)	1,150	(1,020 to 1,430)	47	(35 to 62)	3,030	(2,620 to 3,330)
	2031 to 2040	22,200	(18,400 to 24,300)	23,600	(19,723 to 25,693)	8,060	(6,930 to 10,100)	757	(600 to 937)	26,700	(22,300 to 29,100)
	2041 to 2131	245,000	(175,000 to 294,000)	294,000	(214,785 to 341,991)	55,100	(42,900 to 71,500)	78,300	(57,500 to 89,000)	287,000	(208,000 to 342,000)
	All	269,000	(195,000 to 320,000)	320,000	(236,709 to 370,125)	64,800	(50,900 to 83,000)	79,200	(58,300 to 89,800)	317,000	(234,000 to 374,000)
All population	2020 to 2030	3,270	(2,810 to 3,510)	3,390	(2,907 to 3,623)	1,680	(1,500 to 2,090)	84	(63 to 109)	4,460	(3,860 to 4,880)
	2031 to 2040	33,000	(27,500 to 36,400)	35,100	(29,500 to 38,486)	12,000	(10,300 to 14,800)	1,270	(1,020 to 1,560)	39,600	(33,300 to 43,300)
	2041 to 2131	395,000	(287,000 to 484,000)	477,000	(353,905 to 566,214)	83,800	(65,600 to 108,000)	150,000	(111,000 to 173,000)	468,000	(345,000 to 566,000)
	All	432,000	(318,000 to 524,000)	516,000	(386,629 to 608,307)	98,000	(77,400 to 125,000)	151,000	(113,000 to 174,000)	513,000	(383,000 to 614,000)

* Denicotinisation policy set at the lower end of effectiveness (i.e., 97.5th percentile values of: the percentage reduction in smoking prevalence due to increased cessation over and above BAU of 67.1%, and the percentage reduction in initiation of 78.5%), and retail outlet reduction and the tobacco free generation set to their expected or median input values.

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