Supplementary Material – Additional Methods Details and Results Tables

Supplementary material for: "Restricting tobacco sales to only pharmacies combined with cessation advice – a modelling study of the future smoking prevalence, health and cost impacts"

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Figure S1: Schematic overview of the modelling approach of the tobacco forecasting model

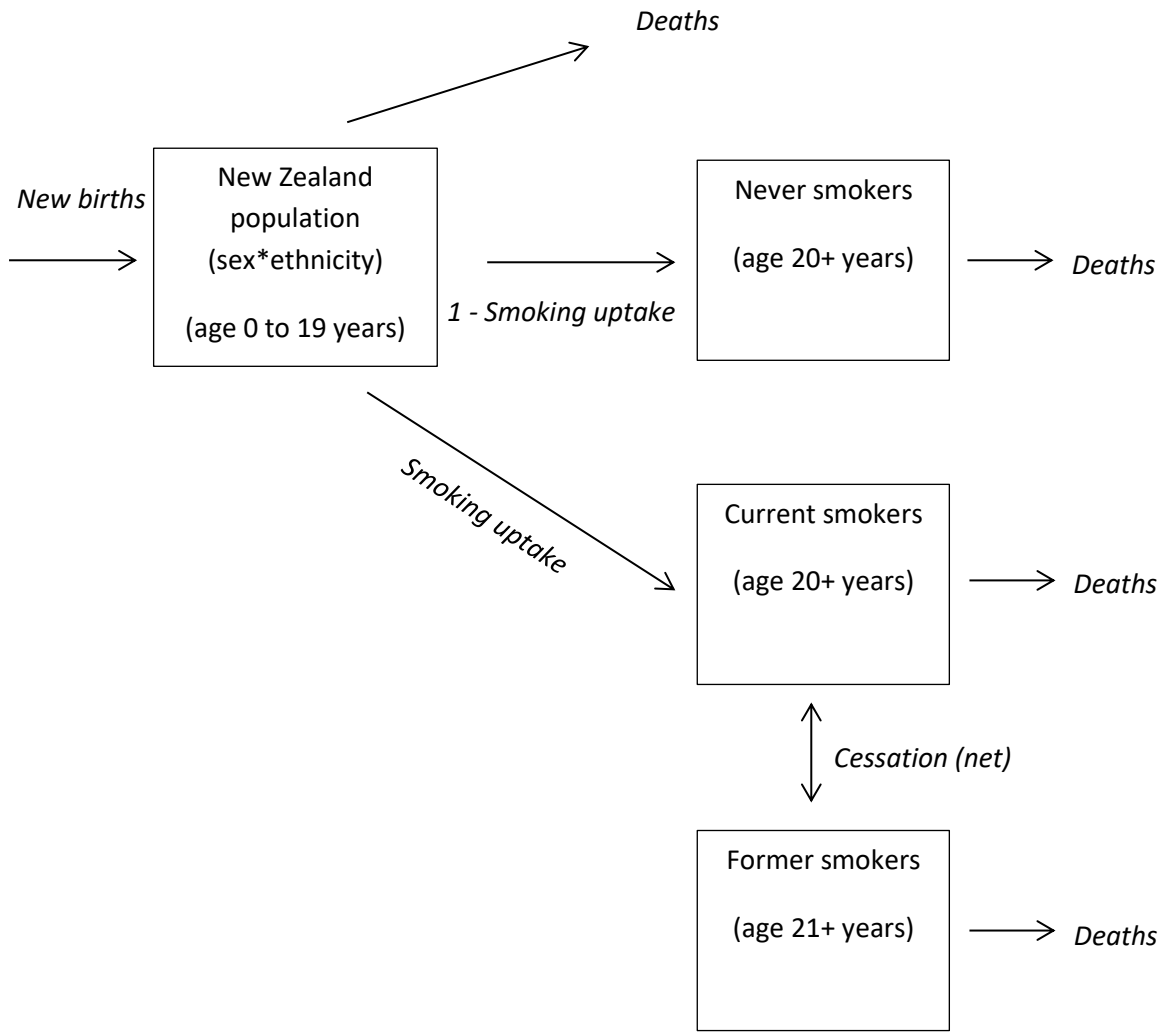


Figure S2: Schematic overview of the tobacco multi-state life-table model

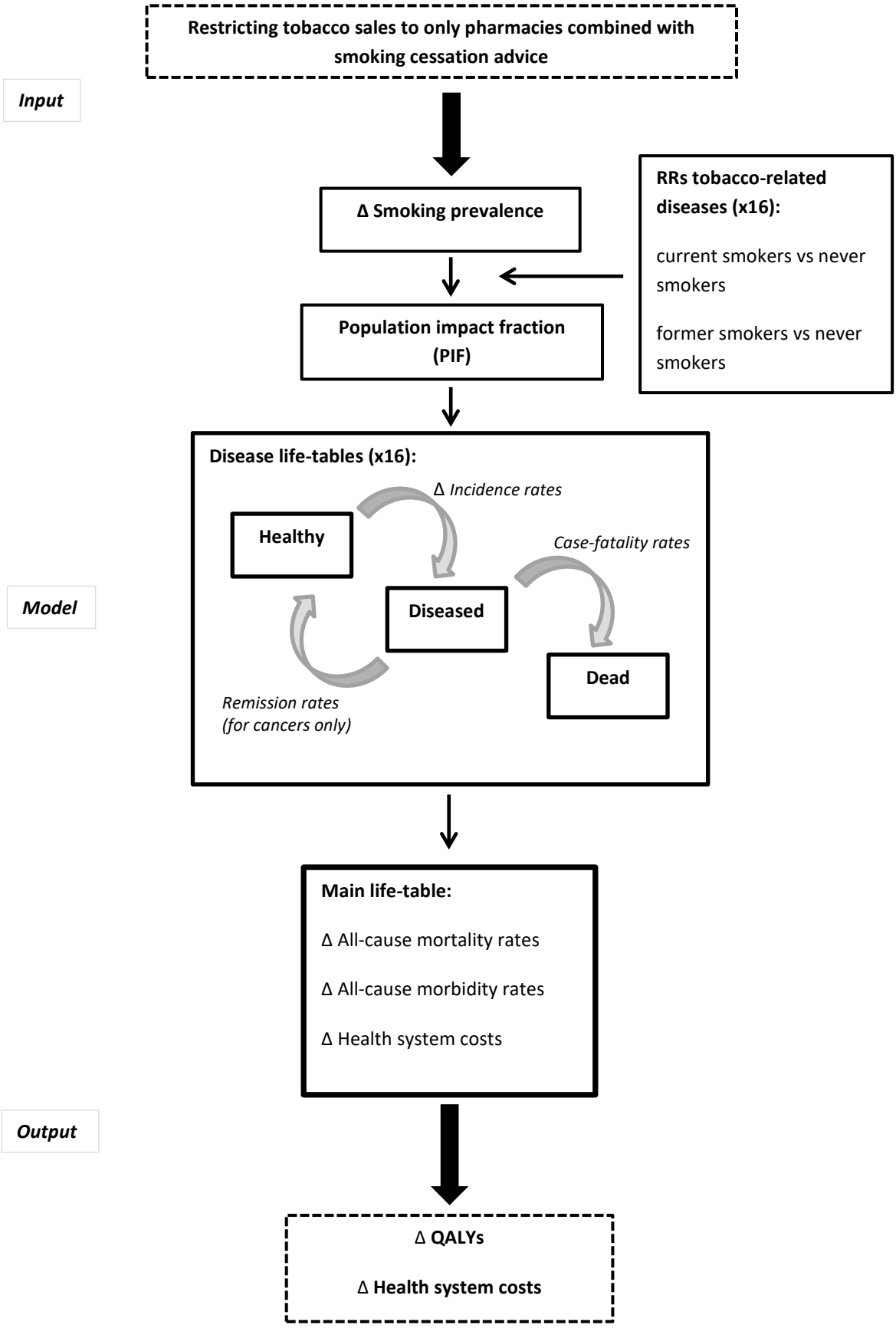
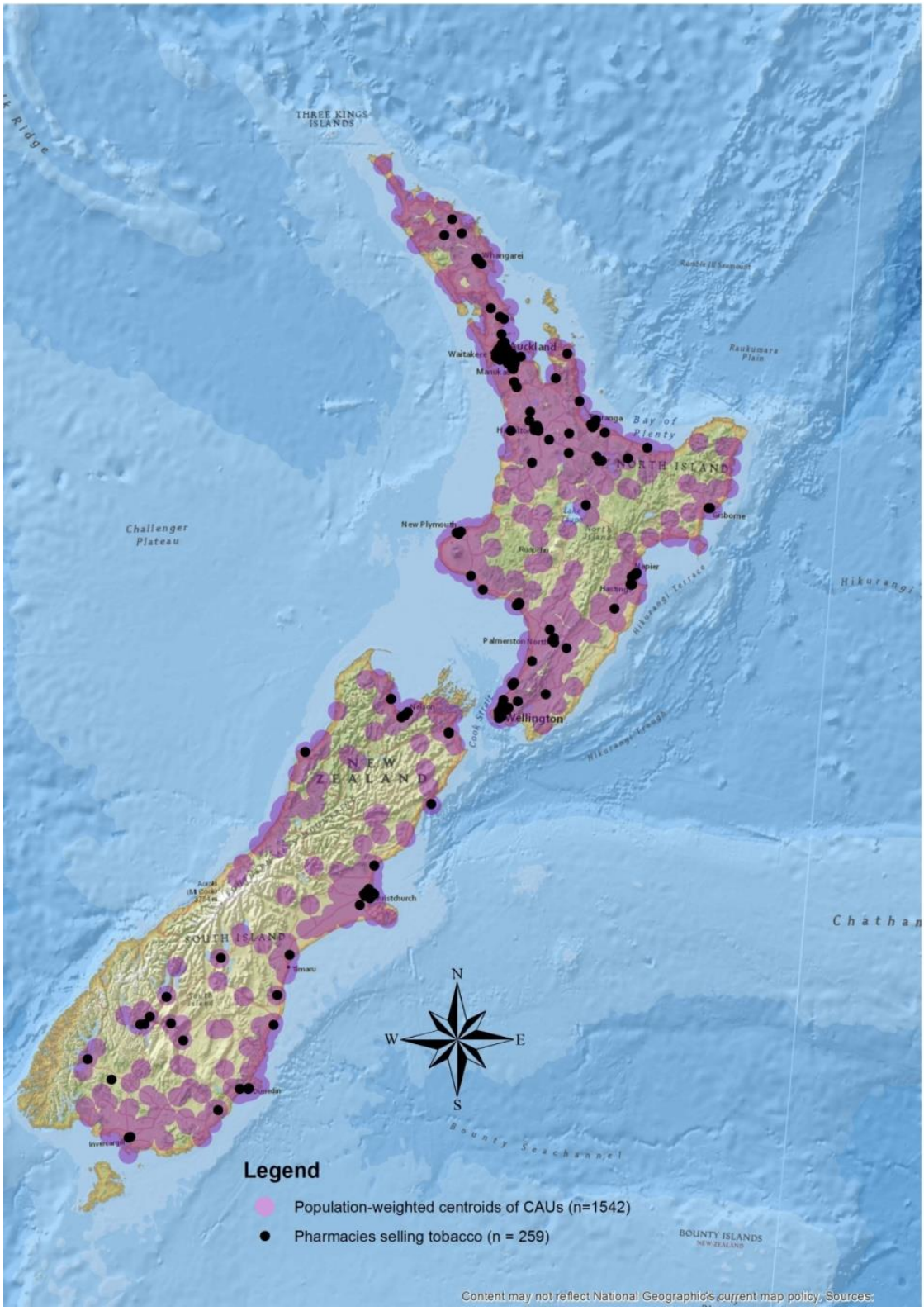


Figure S3: Geographic location of the 259 community pharmacies selling tobacco in NZ from 2020 onwards and the population-weighted centroids of census area units (CAUs)[a]



[a] Number of pharmacies selling tobacco in the four biggest cities in NZ – Auckland: 82, Wellington: 13, Christchurch: 22, Hamilton: 13.

Table S1: Baseline model input parameters for the tobacco forecasting model

Parameter	Data source	Description	Trend/Uncertainty Analyses
Population counts	Statistics New Zealand (NZ) population estimates for 2011 by sex, age-group and ethnicity[1]	Population counts by single year of age, sex and ethnicity for 2011.	No uncertainty.
Birth projections	National population projections from 2011 to 2061[1]	Median estimate from national population projections for 2011 to 2061.	No uncertainty.
Mortality	NZ Census Mortality Study[2,3]	Mortality by single year of age, sex, and ethnicity from 2006 to 2011 from NZ Māori and non-Māori life-tables.	No uncertainty. Mortality projected forward assuming a 1% decline per year in mortality for never smokers and an annual decline in smoker mortality rate ratios of 2.75% for Māori and 2.0% for non-Māori populations (see [2,3] for derivation of trends).
Relative risks (RRs) of mortality	NZ Census Mortality Study[2,3]	RRs of dying for current, former, and never smokers by 5-year age-group, sex and ethnicity (see [4]). Future risks in current smokers were adjusted according to mortality projections as per described above.	Uncertainty: Normal distribution corrected for bootstrap bias in sampling from the log of the relative risk (see[5]).
Tobacco smoking prevalence	As per the 2013 NZ Census of Population and Dwellings,[6] back-estimated to 2011 (the baseline year for all modelling).	Prevalence of current, former, and never smokers by age-group, sex, and ethnicity for 2006 and 2013 derived from the following census question for those who were aged 15+ years: "Do you smoke cigarettes regularly (that is, one or more a day)?" Business-as-usual trends in annual smoking uptake and cessation rates were estimated in the baseline model. *Annual proportionate reduction in smoking uptake age 20*: -Non-Māori: male 0.0339, female 0.0276 -Māori: male 0.0288, female 0.0322 *Annual net cessation rates:* 20–34 y of age: -Non-Māori: male 0.0414, female 0.0554 -Māori: male 0.0393, female 0.0451 35–54 y of age: -Non-Māori: male 0.0384, female	*Annual proportionate reduction in smoking uptake age 20*: Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between the four sex by ethnicity groups. *Annual net cessation rates:* Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between 12 sex by age by ethnicity groups.

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

Table S2: Baseline model input parameters for the tobacco multi-state life-table model

Parameter	Data source	Trend/Uncertainty Analyses*
Population counts	Statistics NZ population size estimates for 2011 by sex, age-group and ethnicity.[1]	Nil uncertainty.
All-cause mortality rates	All-cause mortality rates for 2011 were derived from Statistics NZ life-tables for period 2010 to 2012.[7]	Trend: The future trend in all-cause mortality rates was determined by the weighted sum of trends of each of the 16 tobacco-related diseases. For each of these diseases, the weights were based on the proportion of deaths in 2011 by sex, age, and ethnicity. The remaining causes of death (non-tobacco related) were consistent with long-run mortality trends (eg, annual 2.25% decline for Māori, and 1.75% decline for non-Māori).[8] These trends were modelled out to 2026, with 0% per annum decline after that year. Nil uncertainty.
Tobacco-related disease-specific incidence, prevalence, case-fatality rates, and remission rates (the latter for cancers only)	Raw incidence, prevalence, case-fatality and remission rates data came from different sources such as NZBDS,[9] Health Tracker[10] (linked health data source in NZ), and other Ministry of Health data.[11] For each of the 16 tobacco-related diseases included in the modelling, coherent sets (by sex, age and ethnicity) of final incidence, prevalence, case-fatality, and remission rates (for cancers only) were produced by using DISMOD II.[12]	Trend: Tobacco-related incidence rates and case-fatality annual percentage change trends were based on historic trends.[13,14] These trends were projected out to 2026, then held constant. Future prevalence changes dynamically with the model. Uncertainty: Starting in 2011, rates all +/- 5% SD, correlations 1.0 between four sex by ethnicity group categories (eg, non-Māori women, non-Māori men, Māori women, and Māori men) for all diseases. Annual percentage change all +/- 0.5% SD, normal, correlations 1.0 between the four sex by ethnicity groups.
All-cause morbidity rates per capita in 2011 ('pYLD rates'')	Total prevalent years lived with disability (pYLDs) for all different disease causes were taken from NZBDS,[9] and combined. These were then calculated per capita resulting in age-, sex-, and ethnicity-specific 'pYLD rates'. The pYLD rates were used to adjust full life-years lived by the NZ population cohort for spent in suboptimal health.	No trend. Assumed to be constant into the future. Uncertainty: +/- 10% SD log-normal.
Disability rates per capita for each tobacco-related disease	Each disease was assigned with an age-, sex- and ethnicity-specific disability rate equal to YLDs for that disease (scaled down to adjust for comorbidities) from the NZBDS[9] projected forward to 2011, divided by the disease prevalence. The disability rate was assigned to the proportion of the cohort in each disease life-table.	No trend. Uncertainty: +/- 10% SD normal.
RRs for smoking and tobacco-related	RRs of disease incidence for the association of current (or former smoker) with never smoker were sourced from: NZ linked census-cancer data for	Uncertainty: Using probability density functions about RRs for current compared to never smokers of tobacco-related diseases. For RRs since time of

Parameter	Data source	Trend/Uncertainty Analyses*
disease incidence	cancers,[15] census-mortality data for cardiovascular diseases[16] (censuses include smoking question), and CPS II data for respiratory diseases.[17] Reduction in RRs over time since quitting for former smokers was modelled using equations and coefficients from Hoogenveen et al (2008).[18] With the exception of lower respiratory tract infection, where no excess risk was assumed immediately after smoking cessation. RRs were assumed to be 1 for ischaemic heart disease and stroke until age 35, for chronic obstructive pulmonary disease until age 30, and until age 20 for lower respiratory tract infection and all cancers.	cessation for former smokers, standard errors of regression coefficients were used as published (see supplementary information S2 of Blakely et al[19]).
Health system costs	Linked health data (hospitalisations, inpatient procedures, outpatients, pharmaceuticals, laboratories, and expected primary care usage) for each individual in NZ for the period from 2006 to 2010 had unit costs assigned to each disease event. From this data, five types of health system costs (in NZ$2011; by strata of sex and age) were estimated. These types of costs are explained in more detail in the text.	No trend. Uncertainty: +/- 10% SD, log-normal.
Tobacco smoking prevalence	As per the 2013 NZ Census of Population and Dwellings,[6] back-estimated for 2011 (the baseline year for all modelling).	Business-as-usual trends were estimated using the baseline smoking uptake and cessation rates from the BODE^3 Tobacco Forecasting Model. *Annual proportionate reduction in smoking uptake age 20*: -Non-Māori: male 0.0339, female 0.0276 -Māori: male 0.0288, female 0.0322 Uncertainty: +/- 20% SD, beta distribution, correlations 1.0 between the four sex by ethnicity groups. *Annual net cessation rates:* 20–34 y of age: -Non-Māori: male 0.0414, female 0.0554 -Māori: male 0.0393, female 0.0451 35–54 y of age: -Non-Māori: male 0.0384, female 0.0431 -Māori: male 0.0369, female 0.0472 55+ y of age: -Non-Māori: male 0.0722, female 0.0714 -Māori: male 0.0769, female 0.0699 Uncertainty: +/- 20% SD, beta, correlations 1.0 between 12 sex by age by ethnicity groups.

Table S3: Incremental travel costs, summed incremental travel costs and total pack cost (direct and indirect costs) for the yearly reductions in the number of tobacco retail outlets and eventually restricting tobacco sales to 259 pharmacies only (NZ$)

Year	Incremental travel costs[a] (indirect costs)		Assumed cost of a pack of 20 cigarettes (indirect + direct costs)		Assumed illicit market share	Estimated illegal price[b]		Average cost (considering illegal price and market share)[c]	
	Māori	Non-Māori	Māori	Non-Māori		Māori	Non-Māori	Māori	Non-Māori
2011	-	-	$14.50	$14.50	1.0%	$10.87	$10.87	$14.46	$14.46
2011-2012	$1.23	$1.11	$15.73	$15.61	1.8%	$11.80	$11.71	$15.66	$15.54
2012-2013	$0.09	$0.08	$15.82	$15.69	1.9%	$11.87	$11.77	$15.74	$15.62
2013-2014	$0.09	$0.08	$15.91	$15.77	2.0%	$11.93	$11.83	$15.83	$15.69
2014-2015	$0.11	$0.11	$16.02	$15.88	2.0%	$12.02	$11.91	$15.94	$15.80
2015-2016	$0.09	$0.09	$16.11	$15.97	2.1%	$12.08	$11.98	$16.03	$15.89
2016-2017	$0.17	$0.17	$16.28	$16.14	2.2%	$12.21	$12.10	$16.19	$16.05
2017-2018	$0.20	$0.19	$16.48	$16.32	2.3%	$12.36	$12.24	$16.38	$16.23
2018-2019	$0.12	$0.12	$16.60	$16.44	2.4%	$12.45	$12.33	$16.50	$16.35
2019-2020	$0.22	$0.22	$16.83	$16.66	2.5%	$12.62	$12.49	$16.72	$16.55
2020-2021	$0.23	$0.18	$17.06	$16.83	2.7%	$12.79	$12.62	$16.94	$16.73

[a] Incremental travel costs were weighted by the proportion of Māori/non-Māori living in rural, semi-urban, and urban areas.

[b] The estimated illegal price was 75%[20] of the legal market price for a pack of 20 cigarettes (in this case 'the assumed cost of a pack of tobacco (indirect + direct)').

[c] Changes in the average price of a pack of 20 cigarettes are considered in the model to estimate the impact of the reduction in the number of tobacco retail outlets on future smoking prevalence (via price elasticities).

Table S4: Projected future tobacco smoking prevalence for 2025 by ethnicity under scenario analyses around intervention parameters

Scenario analyses (detailing variations from the base-case)	Māori	Non-Māori
Business-as-usual	20.5%	8.1%
'Base-case model' (restricting tobacco sales to pharmacies only including brief cessation advice)	17.3%	6.8%
Varying the number of pharmacies selling tobacco		
Scenario A – 299 pharmacies in densely populated areas	16.1%	6.5%
Tobacco price elasticities		
Scenario B – 50% lower price elasticities	17.7%	6.9%
Scenario C – Māori price elasticities same as non-Māori	17.5%	6.8%
Effect size for brief opportunistic advice to quit smoking		
Scenario D – No brief cessation advice	19.6%	7.8%
Scenario E – Effect size halved	18.4%	7.3%
Scenario F -– Effect size reduced 20% per year (from 2020 to 2025)	18.2%	7.2%

Table S5: Scenario and sensitivity analyses about health gains (in QALYs) and health system cost-savings for restricting tobacco sales to pharmacies only compared to BAU (expected values)

Scenario analyses (detailing variations from the base-case)	QALYs gained	Cost-savings (NZ$, millions)
'Base-case model' (restricting tobacco sales to pharmacies only including brief cessation advice)	42,100	$751
Varying the number of pharmacies selling tobacco		
Scenario A – 299 pharmacies in densely populated areas	54,100	$999
Tobacco price elasticities		
Scenario B – 50% lower price elasticities	37,000	$646
Scenario C – same price elasticities Māori/non-Māori	41,300	$739
Effect size of brief cessation advice		
Scenario D – No brief cessation advice	11,100	$224
Scenario E – Effect size halved	27,000	$481
Scenario F – Effect size reduced 20% per year (from 2020 to 2025)	31,300	$557
Cost pharmacist-led cessation programme		
Scenario G – Doubling the cost	42,100	$726
Scenario H – Removing the cost of running the brief cessation advice programme including audit costs (ie, requires pharmacists to provide cessation advice as part of holding a licence to sell tobacco and paying an annual surveillance fee)	42,100	$777
Scenario I – Estimating what the cost for pharmacist-led brief opportunistic cessation advice once per year per smoker would need to be to make the intervention package no longer cost-saving	42,100	$0
Sensitivity analysis: Discount rates		
0% per annum	166,000	$2240
6% per annum	12,800	$268

Table S6: Projected number of smokers under BAU and intervention and yearly cost of the pharmacist-led brief cessation programme under the base-case assumptions

Year	Projected number of smokers under BAU (A)	Projected number of smokers under intervention (B)	Difference (A minus B)	Yearly cost to run the cessation programme (NZ$, millions) [(B*NZ$12.5)+ NZ$20,000][a]
2020	423,084	400,802	22,282	$5.03
2021	399,604	368,515	31,088	$4.63
2022	377,497	339,606	37,892	$4.27
2023	356,643	313,097	43,546	$3.93
2024	386,181[b]	334,638[b]	51,543	$4.20
2025	364,588	308,211	56,377	$3.87
Total cost				***$25.93***

[a] The yearly cost of running the pharmacist-led brief cessation programme included an estimated cost of NZ$12.50 per smoker and NZ$20,000 auditing costs for the Ministry of Health (see Table 1 in the manuscript for more details).

[b] The increase in the absolute number of smokers from 2023 to 2024 is due to a new generation of young people having taking up smoking, yet smoking prevalence is still going down as the denominator is simultaneously changing.)

Feasibility of the hypothetical intervention in terms of counselling workload per pharmacy

To estimate the potential feasibility of a hypothetical intervention wherein tobacco sales are restricted to 26% of community pharmacies (n = 259) in New Zealand, we attempted to provide estimates of the average counselling workload per pharmacy from 2020 to 2025. As per presented in Table S6 in the Supplementary Material, we projected the number of smokers for each of the years counselling advice would be provided (2020 to 2025). Assuming the number of smokers is equally divided across these 259 pharmacies, each of these pharmacies is estimated to have an average counselling workload of 257 hours (((400,802 smokers in 2020/259 pharmacies)*10 minutes)/60) per year in 2020, with this having reduced to 198 hours (((308,211 smokers in 2020/259 pharmacies)*10 minutes)/60)) per year in 2025 due to the diminishing number of smokers. In other words, this would equate to an average of around 42 minutes of providing brief smoking cessation counselling per day per pharmacy in 2020 to around 32 minutes in 2025, with this likely being higher during months in which birthdays are slightly more common in New Zealand (September and October[21]), given counselling would be given during month of birth, and lower during other months. There are, however, differences in smoking prevalence by geographic region in New Zealand, meaning that the counselling workload per pharmacy may also differ by region.[22] Yet, the profit made from selling tobacco will as such also be higher in these regions, and could as such be devoted to hiring more staff.

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