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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ABSTRACT

Objective Restricting tobacco sales to pharmacies only, including the provision of cessation advice, has been suggested as a potential measure to hasten progress towards the tobacco endgame. We aimed to quantify the impacts of this hypothetical intervention package on future smoking prevalence, population health and health system costs for a country with an endgame goal: New Zealand (NZ).

Methods We used two peer-reviewed simulation models: 1) a dynamic population forecasting model for smoking prevalence and 2) a closed cohort multi-state life-table model for future health gains and costs by sex, age and ethnicity. Greater costs due to increased travel distances to purchase tobacco were treated as an increase in the price of tobacco. Annual cessation rates were multiplied with the effect size for brief opportunistic cessation advice on sustained smoking abstinence.

Results The intervention package was associated with a reduction in future smoking prevalence, such that by 2025 prevalence was 17.3%/6.8% for Māori (Indigenous)/non-Māori compared to 20.5%/8.1% projected under no intervention. The measure was furthermore estimated to accrue 41 700 discounted quality-adjusted life-years (QALYs) (95% uncertainty interval (UI): 33 500 to 51 600) over the remainder of the 2011 NZ population's lives. Of these QALYs gained, 74% were due to the provision of cessation advice over and above the limiting of sales to pharmacies.

Conclusions This work provides modelling-level evidence that the package of restricting tobacco sales to only pharmacies combined with cessation advice in these settings can accelerate progress towards the tobacco endgame, and achieve large population health benefits and cost-savings.

INTRODUCTION

Ready access to tobacco retail outlets has been associated with increased smoking uptake among adolescents, and increased consumption and reduced success of smoking cessation in adults.[1–4] As a result, restricting the number, type and location of tobacco retail outlets has been hypothesised to hasten progress towards the tobacco endgame.[5–8] One particular bold measure would be to restrict tobacco sales to pharmacies exclusively (while banning sales elsewhere). This measure was first proposed in the Icelandic Parliament in 2011.[9 10] While the policy has not been implemented to date, the idea has resonated in the literature as a potential way to help accelerate progress in reducing smoking prevalence.[11–14]

This idea strongly contrasts with the growing movement in some countries (e.g. the USA, Canada[15–17]) to ban tobacco sales at pharmacies. In the USA, as well as other countries such as Canada, Japan, Indonesia and Columbia, pharmacies have been, and in some cases still are, just one of many outlets commonly selling tobacco.[18] Proponents of a ban on tobacco sales at pharmacies argue that selling tobacco contradicts the image of pharmacies as health-related facilities and that a ban will reduce the density of tobacco retail outlets.[15 16] While banning tobacco sales at pharmacies would reduce the total number of tobacco retail outlets, other types of outlet reduction strategies would result in greater reductions.[19] Restricting tobacco sales to exclusively pharmacies instead (and banning sales at all other types of outlets such as supermarkets, convenience stores, gasoline stations, etc), would in most settings result in a substantive reduction in overall tobacco retail outlet density. Contrary to other existing types of outlets, at pharmacies tobacco sales could be combined with brief cessation advice by trained health professionals.[20] It is not uncommon for pharmacists to participate in programmes that manage drug use among clients with the overall goal to improve population health outcomes. Internationally, many community pharmacies have for decades voluntarily participated in dispensing of methadone to clients to help manage opioid dependence or Needle Exchange Programmes, where injecting drug users are provided with clean needles, syringes and professional health advice.[21–25]

Longitudinal study evidence on the effectiveness of reducing access to tobacco retail outlets on smoking behaviours is scarce, but is suggestive of a beneficial impact. A Finnish cohort study found reduced access to tobacco retail outlets over time increased the odds of smoking cessation at follow-up by 20%–60%.[8] In addition, modelling studies suggest that substantially reducing the total number of tobacco retail outlets, shifting sales to liquor outlets only or reducing outlets in the vicinity of schools could hasten progress in reducing smoking prevalence compared with the status quo, and would moreover, result in population health gains

Table 1 Parameters and assumptions in the tobacco forecasting model and the tobacco MSLT model

Parameter	Source/details (parentheses are 95% uncertainty limits within which values were sampled)	Uncertainty and scenario analyses
Cigarette pack price	► The baseline pack price for a pack of 20 cigarettes in 2011: NZ$14.50 (based on the prices of the 10 most popular brands at the time)	► Uncertainty: gamma ±10% standard deviation (SD) NZ$1.45 in 2011 (95% UI: NZ$11.87 to NZ$17.40)
Travel costs (treated as an incremental increase in the price of a pack of 20 cigarettes)	► The incremental travel costs for the intervention years wherein the number of tobacco retail outlets were reduced and then shifted to just 259 pharmacies nationwide were calculated with a mathematical formula[29] including three parameters: – vehicle running costs per distance travelled (e.g. fuel, car maintenance, but excluding insurance and depreciation cost; NZ$0.28/km); – a monetary value on time spent travelling (e.g. personal non-work-related travel time cost derived from NZ survey data; NZ$7.18/hour); – an increasing proportional rate for the fraction of the total trip that was designated as tobacco purchase-related (and hence the travel costs that could be apportioned to changes in access to outlets ranging from 14% at baseline to 30% in the year tobacco sales were restricted to the 259 pharmacies[29]).	► To estimate the overall uncertainty around incremental travel costs (i.e. incremental increase in the price of a pack of 20 cigarettes), uncertainties around the running cost of a car, the value on time spent in car for travel and the amount of travel explicitly for tobacco were mathematically combined in a single 'total travel cost formula'. The formula was run a 1000 times with Monte Carlo simulations for each intervention year in TreeAge software. ► All three travel cost parameters were assumed to fall into the 'more uncertain variables' category. As such, an uncertainty with a log-normal distribution of ±20% SD around the running cost of a car was assumed. An uncertainty with a log-normal distribution of ±20% SD around the value on personal travel time was assumed. An uncertainty with a beta distribution of ±20% SD around the proportion of a trip being for the purchase of tobacco was assumed. ► Total cost uncertainty log-normal distribution, ±25% SD. ► For example, for an incremental travel cost increase of NZ$1.50 the modelled 95% UI was NZ$0.71 to NZ$3.16. ► In a scenario analysis (A), different travel costs were applied. That is, tobacco sales were restricted to 299 NZ pharmacies via an auction system (assuming a 95% absolute reduction in the baseline number of outlets). It was thereby assumed that those pharmacies located in more densely populated areas were more likely to be successful in bidding for a licence to sell tobacco.
Age-varying tobacco price elasticities (prevalence)	► Non-Māori: price elasticities of −0.38 (for those aged 15–20 years), −0.29 (for those aged 21–24 years), −0.19 (for those aged 25–24 years) and −0.10 (for those aged 35+ years) for tobacco smoking prevalence applied in the year of the tax increase.[28] ► Māori: the aforementioned price elasticities were scaled up by 20%, given economic theory, international evidence on increased price sensitivity in other social groupings, and NZ evidence for increased price sensitivity among Māori.[50 51]	► Uncertainty: non-Māori, ±20% SD, normal, correlated 1.0 across the four age groups; Māori absolute scalar of +20% within each of the four age groups, ±10 percentage points (95% UI: 0.4% to 39.6% higher price elasticities among Māori compared with non-Māori). ► In a scenario analysis (B), age-varying price elasticities were halved (yet maintaining the 20% scalar for Māori) to reflect a potential scenario of reduced sensitivity of customers to an indirect price increase from increased travel costs. ► Another scenario analysis (C): same price elasticities for Māori and non-Māori.
Illicit tobacco market dynamics	► The illicit market was set to start at 1% of the market share (based on recent NZ work[52]). ► Every 10% increase in the legal price of a pack of 20 cigarettes equated to a 1% increase in the illicit market. ► The tobacco price used in the modelling was a combined function of the legal market price of tobacco, the illicit price of tobacco (75% of the legal price which we estimated from Australian work in the absence of NZ data[53]) and the size of the illicit market.	► Uncertainty of ±20% SD, beta distribution, around the illicit price of tobacco.
Brief opportunistic advice to quit smoking by pharmacists	► To estimate the effectiveness of brief smoking cessation advice provided in the community pharmacy setting, systematic reviews were consulted.[54–58] – We identified five systematic reviews of which two had performed a meta-analysis.[54 56] Most of the included studies analysed more intensive behavioural cessation interventions with multiple follow-up sessions, or simultaneously included the effect of nicotine replacement therapy products. – No studies were identified that had explored the effectiveness of interventions whereby smokers were targeted opportunistically by pharmacists with brief advice to quit smoking. – A systematic review on brief smoking cessation advice interventions provided by general practitioners (GPs) by Aveyard et al was as such used.[38] – This review only included studies whereby brief cessation advice was given opportunistically (i.e. participants were not selected by motivation to quit). Based on a meta-analysis of eight studies, it was estimated that, compared with no intervention, brief opportunistic advice to quit smoking on medical grounds increased the success rate of 12 months sustained smoking abstinence by 47% (relative risk (RR)=1.47, 95% CI 1.24 to 1.75). – This estimate was consequently used as a proxy measure for the effect size of brief opportunistic advice given by pharmacists. ► In the 'base-case' model, the sex, ethnicity and age group-specific annual cessation rates were multiplied with the above effect size for brief smoking cessation advice by pharmacists from 2020 to 2025.	► Uncertainty: RR, reported in the meta-analysis: 95% CI 1.24 to 1.75. ► In a scenario analysis (D), the effect size of brief cessation advice was not modelled, thereby only assuming the effect from the outlet reduction component of the intervention. ► In a second scenario analysis (E), the effect size for opportunistic brief smoking cessation advice was halved, assuming the GP advice may not be a good proxy for such advice by a pharmacist. ► In a third scenario analysis (F), the effect size was reduced by 20% per year, assuming that smokers would become desensitised to hearing such advice each year (and that this impact outweighed trends in increased smoking denormalisation with the highly constrained tobacco retail environment).

Continued

Table 1 Continued

Parameter	Source/details (parentheses are 95% uncertainty limits within which values were sampled)	Uncertainty and scenario analyses
Intervention cost	► Cost of passing an Act in NZ to mandate the changes to the tobacco retail environment: NZ$3.54 million (m).[40] ► Additional cost for the running of the nationwide pharmacist-led cessation programme assigned to each smoker for each year the programme was run. The latter cost component was the cost of pharmacists' time to: – give the advice; – record this in a database; – provide a 'receipt of counselling session' from 2020 to 2025. ► The maximum time of brief opportunistic advice to quit smoking was estimated at 10 min, comprising 5 min for the brief opportunistic advice[38] and 5 min administration time. – The cost for this time was based on the average yearly wage of a pharmacist in NZ, which was estimated at NZ$90 000 (with an additional 50% of the average salary for overhead costs[59]). ► Using these cost inputs, the running cost of this programme equated to NZ$12.50 per smoker given advice (i.e. 10 min of pharmacist time (assuming 48 weeks of work per year and 37.5 hours per week)). ► Per year an additional estimated NZ$20 000 was assumed for auditing costs by the Ministry of Health (to check pharmacy's databases and conduct random visits at the start of each year to check if cessation advice is being given). ► It was assumed that pharmacies may need to include additional margins for both profit and to cover any additional costs (e.g. for increased staffing, staff training, storage and security).	► Uncertainty cost of passing an Act in NZ: gamma SD NZ$1.05 m in 2011 only (95% UI 2.0 to 6.2 m) ► Uncertainty cessation advice cost: gamma distribution, ±20% SD (95% UI NZ$8.07 to NZ$18.11). ► In the first scenario analysis relating to cost (G), the cost for the running of the nationwide pharmacist-led cessation programme was doubled (NZ$25 per smoker per year). ► In another scenario analysis (H), the cost of running the brief cessation programme was removed, as well as the government paid audit costs. This scenario required pharmacists to provide cessation advice as part of holding a licence to sell tobacco. In addition, pharmacists were required to cover the audit costs by way of paying an annual surveillance fee (as per recent developments in Finland where tobacco licence holders pay a surveillance fee to cover monitoring costs which is linked to the number of checkouts per store[60]). ► In a final scenario analysis relating to the intervention cost (I), we estimated how much the cost for pharmacist-led brief opportunistic cessation advice (at once per year per smoker) would have to be to make the intervention package no longer cost-saving.

MSLT, multi-state life-table; NZ, New Zealand; UI, uncertainty interval.

and health system cost-savings.[6 7] Research suggests brief opportunistic advice to quit smoking given to smokers in healthcare settings can also promote smoking cessation, and is an affordable strategy in most global settings.[26]

Yet, the potential smoking prevalence, population health and cost impacts of shifting tobacco sales exclusively to pharmacies combined with the provision of brief opportunistic advice to quit smoking are currently unknown. This study therefore aimed to quantify the future impacts of this intervention package in New Zealand (NZ)—a country with stark ethnic disparities in smoking prevalence , and a government-supported Smokefree goal for 2025. Unlike pharmacies in other countries, pharmacies in NZ currently do not sell tobacco.

METHODS

Two computer simulation models were used to estimate smoking prevalence, health and health system cost impacts of restricting tobacco sales exclusively to pharmacies: (1) a dynamic population forecasting model used to project future smoking prevalence[7 27–29] and (2) a multi-state life-table model used to estimate future population health outcomes and health system costs (using the estimated future prevalence from the former model).[6 29–32] Schematic overviews of both models and model parameters are presented in online supplementary figures S1 and S2 and tables S1 and S2.

Future smoking prevalence

A 'base component' estimated recent annual trends in smoking uptake and cessation by sex, age and ethnicity (Māori (Indigenous population) and non-Māori).[27] These rates were then used as inputs for the 'forecasting component' to project future smoking prevalence from 2011 until 2060, for business-as-usual (BAU; a continuation of baseline trends in smoking uptake and cessation) and for additional changes in future prevalence from restricting tobacco sales to pharmacies and the provision of cessation advice.

Future health and health system costs

An established tobacco multi-state life-table (MSLT) model[6 29–32] was used to estimate the impacts of restricting tobacco sales to pharmacies on future population health (in quality-adjusted life-years (QALYs)) and health system costs (in 2011 NZ dollars) for the NZ population alive in 2011 (4.4 million (m)), until death or age 110 years, over and above BAU.

All simulated population members were exposed to projected all-cause mortality and morbidity rates specified by sex, age and ethnicity. The main life-table was linked to 16 tobacco-related disease life-tables (11 cancers, two cardiovascular diseases and two respiratory diseases[30]), where proportions of the population simultaneously resided. Health system costs were from a detailed national dataset.[6 30]

The effect of restricting tobacco sales to pharmacies only (including the provision of cessation advice) was modelled through changes in smoking uptake and cessation compared to BAU, resulting in varying future smoking prevalence. This change was mathematically combined with relative risks for smoking-incidence rate ratios for the 16 diseases to generate population impact fractions (PIFs; 1-PIF=proportional reduction in future tobacco-related disease incidence), which consequently altered the risk of developing tobacco-related diseases. Changes in QALYs and health system costs over and above BAU are presented at 3% discounting per year.

Intervention specification

Overview of the intervention

In the base-case intervention, tobacco sales were hypothetically restricted to pharmacies only in a step-by-step legally required process over a ten-year period (similar to the Icelandic proposal[9]). From year ten onwards (2020), tobacco was legally exclusively sold by pharmacies, and remaining smokers were provided brief opportunistic cessation advice once per year in the pharmacy setting until 2025 (aligning the year of NZ's Smokefree goal). Pharmacies were only given the opportunity to opt-in at the start of the programme to prevent outlet numbers and accessibility to tobacco to increase over time. In the first nine years of the intervention, the number of tobacco retail outlets (e.g. supermarkets, convenience stores, gasoline stations and off-licence alcohol outlets; estimated at 5979 outlets[7]) was gradually reduced by 90%.[6 7] It was assumed an auction system would be used to reduce the number of tobacco retail licenses each year (with the assumption being that outlets in areas with the highest population density would be the successful bidders each year). As such, the new law would also require a tobacco retail licensing system (which NZ currently does not have), and would furthermore: (1) limit sales to one pack of 20 cigarettes per person per day, (2) prohibit internet and mail order sales and (3) prohibit tobacco outlets in any new locations. In year ten (2020), tobacco retail was designated to 26% of all community pharmacies in NZ (see online supplementary figure S3). The latter percentage was based on results from a small-scale survey (n=30), where 26% of surveyed pharmacists indicated that they were 'very likely' to 'extremely likely' to sell tobacco if the Government made tobacco sales exclusive to pharmacies (but leaving the option of individual pharmacies to opt-out) (see Petrović-van der Deen and Wilson[33] for further survey details).

Geospatial and econometric analyses

Geographic boundary files for population-weighted centroids of Census Area Units (CAUs; n=1542),[34] a NZ road centre line shape file, and address data on tobacco retail outlets (n=5979)[6 7] and community pharmacies (n=1082)[35] were loaded into a geographic information system (GIS) using ArcMap 10.3. From the 1082 community pharmacy addresses, 259 addresses were randomly selected (i.e. 26%—see online supplementary figure S3 for the geographical locations). The addresses were randomly selected as the survey[33] was not detailed enough to explore if the likelihood of support for pharmacy-only tobacco sales was dependent on location (urban, rural, etc) or other variables.

Travel distances and associated costs for a return trip from the population-weighted centres of the 1542 CAUs to the nearest tobacco retail outlet, along the NZ road network, were calculated at baseline and for each year that the tobacco retail landscape changed. Travel cost differences (as a result of increased travel distances) were treated as equivalent to annual increases in the price of a pack of 20 cigarettes (see online supplementary table S3). To take account for geographic heterogeneity in travel costs, CAUs were divided into three categories: urban, semi-urban and rural. Average net costs were then weighted by the proportion of Māori and non-Māori living within each area type, resulting in ethnicity-specific incremental travel costs in both models (see online supplementary table S3). Tobacco prevalence price elasticities by age and ethnicity were then used to estimate the prevalence, health and cost impacts in both models arising from the incremental travel cost increases (see Pearson *et al*[6 7] and table 1 for more details around methods).

Impact of brief opportunistic cessation advice on annual cessation rates

From 2020 until 2025 (aligned with NZ's Smokefree goal), all remaining smokers were offered brief opportunistic advice in the pharmacy setting to quit smoking once per year by participating pharmacies (see online supplementary material for some additional text on the feasibility of this intervention in terms of counselling workload per pharmacy). Research suggests that most NZ pharmacists view providing public health services such as counselling as an important part of their role.[36] In addition, a small-scale survey (n=30) among pharmacists in Wellington Central, NZ suggested 97% agreed or strongly agreed with the statement: 'Pharmacists and pharmacy staff have a role in supporting smoking cessation and providing pharmacotherapy to smokers wanting to quit'.[37]

On each sale of tobacco the person would be required to show their driving licence or other official document with date of birth to the pharmacist. If it was the month of their birth they would be required to have a brief cessation counselling session and then the pharmacist would print out a 'receipt of counselling' letter. This could then be shown elsewhere if purchasing tobacco from a different outlet in that same month (so that repeat counselling sessions would not be required that same month). This system could be audited by the Ministry of Health with random checks at participating pharmacies. During the brief counselling session, pharmacists were assumed to raise the topic of quitting smoking with the customer, and advise the customer to quit smoking on general health grounds.[26 38 39] As such, annual baseline cessation rates by sex, age and ethnicity (Māori and non-Māori)[27] were increased by the estimated effect size for brief opportunistic cessation advice on 12-month sustained abstinence (i.e. 47% (95% UI 24% to 75%, see table 1 for more details and related scenarios, i.e., if the background net cessation rate was 2%, then in the year of the intervention it increased to 2.94%).[38] The cost of restricting tobacco sales to only pharmacies included the costs of initiating a new law in NZ (NZ$3.54 m[40]), and the costs of pharmacy-delivered smoking cessation advice once per year (see details around the estimated cost per smoker in table 1, and estimated annual costs from 2020 to 2025 in online supplementary table S6).

Scenario analyses and uncertainty

There is uncertainty around future BAU smoking prevalence, population health and health sector cost projections. In addition, there is substantial uncertainty around the effect size of reducing the number and type of outlets selling tobacco on smoking uptake and cessation rates, and providing opportunistic cessation advice on smoking cessation rates. There is also wide uncertainty around the costs of providing opportunistic cessation advice once per year to all smokers. Where uncertainty was unknown, we used the following approach: an SD of ±5% for 'reasonably certain variables' (e.g. incidence rates of diseases at baseline), ±10% SD for moderately uncertain variables (e.g. disease costs) and ±20% SD for 'more uncertain variables' (e.g. price elasticities, costs of cessation advice). The intervention package was simulated 2000 times in Monte Carlo simulation, drawing from the probability density function about parameters as specified in table 1 (and see online supplementary tables S1 and S2). This number of iterations provided stability of the central estimates and the upper and lower uncertainty limits, and has also been used in our previously published modelling work.[6 29–32] There is also uncertainty related to structural assumptions about the modelled intervention, so where possible we addressed this with deterministic scenario analyses (A–I) as described in table 1.

Results

Future smoking prevalence

Figure 1 presents the future smoking prevalence projections for Māori and non-Māori as per the modelled intervention package of restricting tobacco sales to pharmacies only, combined with brief opportunistic advice to quit smoking in the pharmacy setting. Under BAU, smoking prevalence was projected

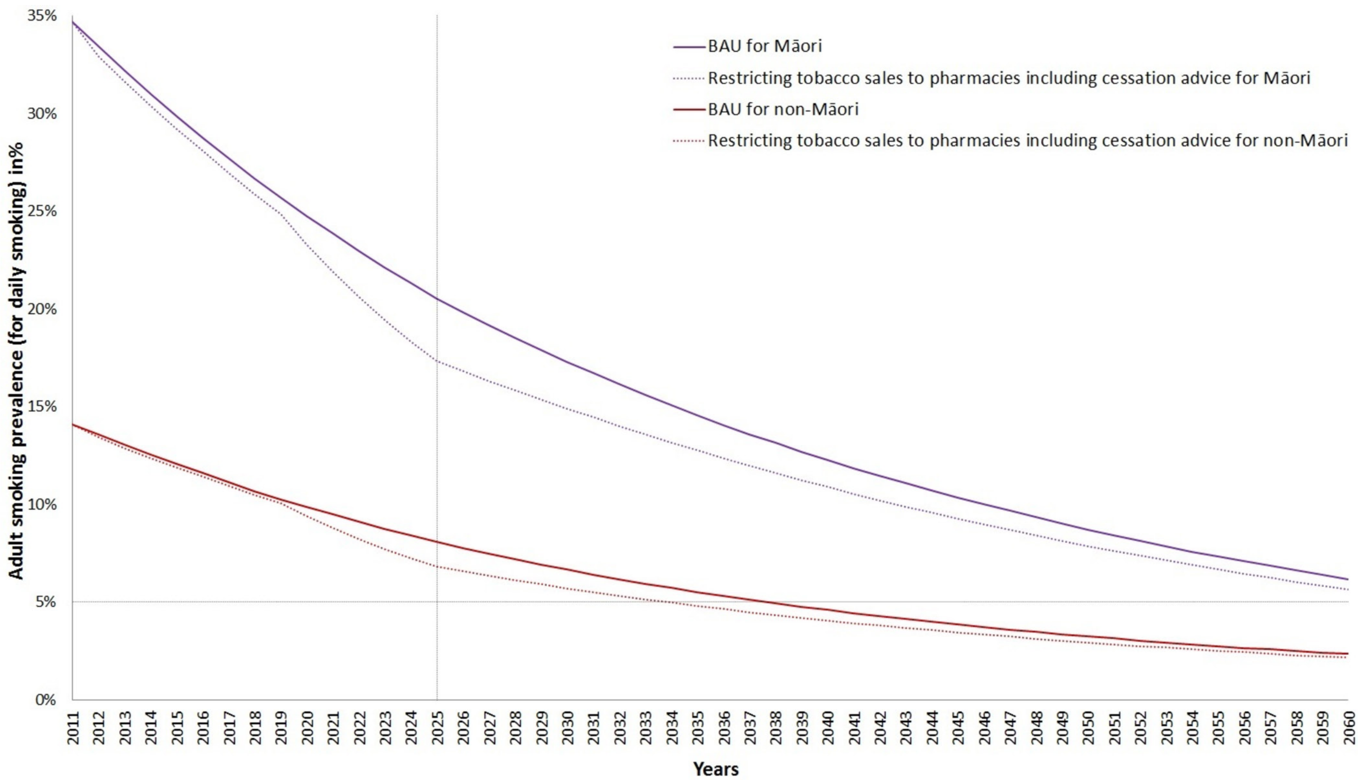

Figure 1 Future smoking prevalence projections under an endgame intervention package that restricts tobacco sales to pharmacies only and includes annual brief opportunistic smoking cessation advice, for Māori and non-Māori compared to business-as-usual (BAU).

to reduce from 34.7% in 2011 to 20.5% (95% UI 16.8% to 25.2%) for Māori, and from 14.1% to 8.1% (95% UI 6.4% to 10.3%)for non-Māori by 2025. But with the modelled intervention there were additional reductions in smoking prevalence by 2025 compared to BAU, that is, down to 17.3% (95% UI 13.3% to 22.4%) for Māori and 6.8% (95% UI 5.0% to 9.3%) for non-Māori. Compared to BAU, the intervention package was projected to reduce the absolute ethnic gap in smoking prevalence by 2.0 percentage points by 2025 (i.e. from 12.5% to 10.5%).

Results from deterministic scenario analyses about intervention parameters are presented in the online supplementary table S4. Scenario A—restricting tobacco sales to a different grouping of pharmacies (n=299, based on a 95% reduction in the baseline number of tobacco retail outlets, and an auction system for licences, see table 1 for further details around this and other scenarios) resulted in greater reductions in future smoking prevalence for both Māori (down to 16.1%) and non-Māori (6.5%). Scenarios B (halving price sensitivity to travel cost increases) and C (assuming the same price sensitivity for Māori and non-Māori) resulted in slightly more pessimistic future smoking prevalence projections.

Scenarios D, E and F focused on the effect size of brief opportunistic cessation advice on annual cessation rates. Future smoking prevalence trajectories for these scenarios are also presented in figure 1. Not including brief annual opportunistic cessation advice in the intervention wherein tobacco sales are restricted to pharmacies resulted in relatively minor reductions in smoking prevalence by 2025 compared to BAU, that is, down to 19.6% for Māori, and 7.8% for non-Māori. Scenario analyses E (effect size of cessation advice halved) and F (effect size of cessation advice reduced by 20% per year) still resulted in reductions in future smoking prevalence compared to BAU. Scenarios G to I focused on the cost of the intervention and were therefore only run in the MSLT model.

Future population health and health system costs

Gradually reducing the number of tobacco retail outlets and eventually restricting tobacco sales to 26% of community pharmacies only where sales are combined with the provision of brief opportunistic advice to quit smoking once per year, was projected to gain 41 700 discounted QALYs (95% UI 33 500 to 51 600) compared to BAU over the lifetime of the NZ population 'alive' in 2011 (table 2). That is, an estimated 15 300 QALYs (95% UI 11 900 to 19 600) for Māori and 26 400 QALYs (95% UI 20 900 to 33 200) for non-Māori. QALYs gained per capita were projected to be 3.1 times larger for Māori compared to non-Māori when age-standardised.

Results from scenarios A to I are presented in online supplementary table S5. Scenarios A (different locations of pharmacies) and D, E and F (focused on the effect size of brief cessation advice) most substantially changed projected QALY gains. Restricting tobacco sales to a different grouping of pharmacies resulted in a nearly 30% increase in projected QALY gains compared to the base-case model. Purely restricting tobacco sales to pharmacies only (without the cessation advice component of the intervention package—scenario D) reduced projected QALYs gained to 11 100. In other words, 74% of the projected QALY gain from the intervention package was due to providing brief opportunistic cessation advice once per year to all smokers.

The costs for this intervention package included the cost of implementing new legislation (NZ$3.5 m), as well as the cost of running the cessation programme from 2020 to 2025 (NZ$25.9 m including NZ$25.8 m for the cessation advice per smoker and NZ$120 000 for Ministry of Health auditing

Table 2 Health gain (QALYs) and health system cost-savings from the intervention package (restricting tobacco sales to pharmacies with smoking cessation advice), among the NZ population 'alive' in 2011 (3% discounting)*

	Non-Māori		Māori			Ethnic groupings combined	
Sex and age (in 2011)	QALYs	Cost-savings (NZ$ million)	QALYs	QALYs—equity*	Cost-savings (NZ$ million)	QALYs	Net cost-savings (NZ$ million)†
Sex and age groups combined	26 400 (20 900 to 33 200)	$554 ($400 to $749)	15 300 (11 900 to 19 600)	22 000 (17 200 to 27 700)	$217 ($152 to $300)	41 700 (33 500 to 51 600)	$741 ($531 to $1010)
Males							
0–14 years	1440	$45	1330	3430	$32	2760	$77
15–24 years	2680	$78	1610	1950	$37	4290	$115
25–44 years	5550	$127	1970	1710	$36	7520	$163
45–64 years	4080	$62	860	550	$11.3	4940	$73
65+ years	214	$1.50	16	17	$0.12	230	$1.63
All ages	14 000	**$313**	**5780**	**7660**	**$116**	19 800	**$430**
Females							
0–14 years	1380	$36	1950	4560	$26	3330	$62
15–24 years	2400	$61	2450	2590	$30	4850	$91
25–44 years	4810	$97	3680	2630	$35	8490	$132
45–64 years	3600	$46	1410	940	$9.4	5010	$55
65+ years	256	$1.19	38	39	$0.12	294	$1.31
All ages	12 400	**$241**	**9500**	10 800	**$101**	22 000	**$342**
Per capita (QALYs/1000 people and $)	7.1	$149	22.7 (ratio Māori/non-Māori=3.1‡)	27.3	$322	9.5	$168

*Māori 'QALYs equity' are calculated using non-Māori background mortality and morbidity rates, so as not to 'penalise' Māori due to worse background mortality and morbidity.
†Includes both the cost offsets and intervention cost, the latter being the cost of a law (see the '*Methods*' section) to introduce legislation to restrict tobacco sales to pharmacies only, and a cost per smoker per year for the provision of brief opportunistic cessation advice (table 1).
‡The ratio of QALYs gained per capita for Māori compared toh non-Māori was age-standardised (i.e. a procedure performed to allow the comparison of populations with different age structures) using the WHO World Standard Population Distribution, which are based on the world's average population between 2000 and 2025.[61]
§QALYs gained and health system costs saved are rounded to three meaningful digits.
NZ, New Zealand; QALY, quality-adjusted life-year.

costs), see online supplementary table S6. Intervention package costs were projected to be NZ$29.4 m in total. Assuming these costs, the intervention package was projected to save NZ$741 m (95% UI NZ$531 m to NZ$1010 m) to the health system over the lifetime of the NZ population 'alive' in 2011. To put this in perspective, these cost-savings would represent avoidance of 0.24% of all future healthcare expenditures over the remainder of the lives of this 2011 cohort. Yet, uncertainty around the 'real' cost of running such a pharmacist-led cessation advice programme is wide, and likely to be wider than we were able to take into account in uncertainty analyses. As such, scenarios G, H and I focused on the cost of the intervention package. Doubling the per smoker cost (G) and removing the cost (shifting these costs to pharmacists instead; H) did not significantly alter the projected cost-savings. In scenario I, we estimated what the cost per smoker of the brief cessation advice would need to be to make this intervention package no longer cost-saving, which equated to NZ$376 per smoker.

DISCUSSION

Main findings and interpretation

These results suggest that compared to a continuation of current trends in smoking uptake and cessation, the modelled intervention package (restricting tobacco sales to pharmacies and associated cessation advice) could accelerate progress in reducing smoking prevalence. It would also achieve large population health gains and almost certainly achieve sizeable health system cost-savings. Compared to tobacco retail outlet reduction strategies we have modelled previously, such as substantively reducing the total number of tobacco retail outlets, prohibiting tobacco outlets in the direct vicinity of schools, or restricting tobacco sales to liquor outlets,[6 7 29] the intervention package modelled here resulted in greater reductions in future smoking prevalence. However, scenario analyses suggested that this effect is largely due to the impact of opportunistic cessation advice on annual cessation rates. Previous modelling work suggested that other types of tobacco endgame strategies (e.g. tobacco-free generation strategy, annual tax increases, sinking lid on supply strategy, combined endgame strategy)[29] could result in more sizeable reductions in future smoking prevalence, and QALYs gains and cost-savings to the health system.

Strengths and limitations

While the idea of restricting the sale of tobacco to only pharmacies has resonated in the tobacco endgame literature,[14] this is the first study that has attempted to quantify the potential impacts of such a strategy. We used two computer simulation models using rich local epidemiological and health system costing data, and smoking prevalence data from national censuses (validating the modelagainst most recent observational datais part of future work).[6 7 27–32] We also used results from a small-scale local survey to estimate the proportion of pharmacists that would be willing to sell tobacco from their stores if pharmacies were the only legal retail outlet,[33] and results from a meta-analysis for the effect size of brief opportunistic advice to quit smoking.

As with all modelling studies, the findings from this study rely heavily on assumptions made in the model. The impact of restricting tobacco sales to only pharmacies was captured through: (1) indirect price increases in the cost of a pack of cigarettes (i.e. through increased travel costs to fewer outlets) and (2) the impact of brief opportunistic advice. While consumer behaviour theory,[41 42] anecdotal evidence[43] and survey research[44 45] suggest that increased travel costs to purchase tobacco can be assumed to be similar to an increase in the cost of purchasing tobacco, it remains unknown whether price elasticities for changes in travel costs are different from price increases arising from tax. While there is genuine uncertainty around our applied method to estimate the impact of outlet reductions, a recent Finnish study supports the direction of the findings by suggesting that even small increases in the distance from home to the nearest tobacco retail outlet may induce quitting.[8]

A few limitations may pertain to the effect size for brief opportunistic cessation advice that was applied in the models. Due to limited evidence on the effectiveness of brief opportunistic advice provided by pharmacists, we relied on a meta-analysis of such advice given by GPs.[38] While brief cessation advice in the individual trials of the meta-analysis was given opportunistically to patients visiting general practices (rather than offered to those who were motivated to quit, which may introduce selection bias),[38] it is still possible that smokers who visit their GP for a health-related problem are more motivated to quit than the general population of smokers. In addition, it could be that cessation advice received from a GP, with whom patients over time may establish a bond of trust, may differ from advice being received by a pharmacist. If this were true, the effectiveness of the brief cessation component in the 'base-case' of this modelling may have been overestimated. Nonetheless, scenario analyses where the effect size was halved, reduced over time, or completely removed showed that sizeable health gains could still be realised from this type of intervention package compared to BAU. Another potential limitation of the modelled effect size for brief opportunistic cessation advice, is that not all continuing smokers may be open to receiving such advice. While a recent systematic review estimated that approximately 32% of current smokers may not be ready to quit smoking, it also suggested that smoking cessation interventions may just be as effective for this group as for smokers who are motivated to quit smoking.[46] Finally, if such an intervention was to be implemented, even greater benefits could potentially be achieved if those smokers who were willing to quit, and seeking further help, were also automatically referred to the Quitline or face-to-face counselling, or if pharmacists could be permitted to prescribe smoking cessation pharmaceuticals such as varenicline.

Furthermore, it is likely that interventions that dramatically alter the tobacco retail landscape, such as restricting tobacco sales to exclusively pharmacies, may also impact on tobacco smoking prevalence through other pathways such as social norms[47 48] and exposure to environmental cues (eg. tobacco retail displays and advertisements).[3 49] We were not able to quantify these pathways and positive spill-over effects in our models, which may have resulted in an underestimation of smoking prevalence reductions, future health gains and cost-savings. Nor were we able to capture potential synergies with other tobacco control interventions or the availability of alternative products such as e-cigarettes (with the possibility of combining the latter with the brief opportunistic cessation advice component). Finally, our model also did not take into account the possibility of pharmacies opting-out of selling tobacco after a few years in the programme. If this were the case, projected health gains and cost-savings are likely bigger due to the further reduced access to tobacco.

CONCLUSIONS

This work provides modelling-level evidence that the package of restricting the sales of tobacco to only pharmacies along with cessation advice in these settings, can accelerate progress towards the tobacco endgame. This intervention is also likely to achieve large population health benefits and almost certainly large health system cost-savings. Nevertheless, policy-makers should consider a wide range of tobacco endgame interventions, some of which are probably even more effective and more cost-saving than the one modelled here.

What this paper adds

- Substantially changing the tobacco retail landscape has been suggested as one way to accelerate progress in countries adopting tobacco endgame goals.
- One option would be to restrict tobacco sales to pharmacies only, but there is still limited evidence for the effectiveness of such an intervention and it has never been modelled.
- This is the first study attempting to quantify the impact of an intervention package of restricting tobacco sales to pharmacies along with the provision of brief smoking cessation advice in these settings.
- It did so in a country with rich epidemiological and health costing data: New Zealand.
- This intervention package was estimated to result in additional reductions in smoking prevalence, sizeable health gains and large cost-savings to the health system.

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REFERENCES

1 Reitzel LR, Cromley EK, Li Y, *et al*. The effect of tobacco outlet density and proximity on smoking cessation. *Am J Public Health* 2011;101:315–20.
2 Marashi-Pour S, Cretikos M, Lyons C, *et al*. The association between the density of retail tobacco outlets, individual smoking status, neighbourhood socioeconomic status and school locations in New South Wales, Australia. *Spat Spatiotemporal Epidemiol* 2015;12:1–7.
3 Mistry R, Pednekar M, Pimple S, *et al*. Banning tobacco sales and advertisements near educational institutions may reduce students' tobacco use risk: evidence from Mumbai, India. *Tob Control* 2015;24:e100–e107.
4 Pearce J, Rind E, Shortt N, *et al*. Tobacco retail environments and social inequalities in individual-level smoking and cessation among scottish adults. *Nicotine Tob Res* 2016;18:138–46.
5 Henriksen L. The retail environment for tobacco: a barometer of progress towards the endgame. *Tob Control* 2015;24:e1–e2.
6 Pearson AL, Cleghorn CL, van der Deen FS, *et al*. Tobacco retail outlet restrictions: health and cost impacts from multistate life-table modelling in a national population. *Tob Control* 2017;26:579–85.
7 Pearson AL, van der Deen FS, Wilson N, *et al*. Theoretical impacts of a range of major tobacco retail outlet reduction interventions: modelling results in a country with a smoke-free nation goal. *Tob Control* 2015;24:e32–e38.
8 Pulakka A, Halonen JI, Kawachi I, *et al*. Association between distance from home to tobacco outlet and smoking cessation and relapse. *JAMA Intern Med* 2016;176:1512–9.

9 Fridleifsdottir S, Backman T, Johannesdottir AR, *et al*. *Proposal for a parliamentary resolution on an action plan for tobacco prevention (unofficial translation*. Reykjavik: Ministry of Welfare, 2011.
10 Friðleifsdóttir S. *E-mail conversations with the former Minister of Health of Iceland*: Personal communication, 2014.
11 Henriksen L. Comprehensive tobacco marketing restrictions: promotion, packaging, price and place. *Tob Control* 2012;21:147–53.
12 Marsh L, Doscher C, Robertson LA. Characteristics of tobacco retailers in New Zealand. *Health Place* 2013;23:165–70.
13 Robertson L, Gendall P, Hoek J, *et al*. Smokers' perceptions of the relative effectiveness of five tobacco retail reduction policies. *Nicotine Tob Res* 2017;19:245–52.
14 McDaniel PA, Smith EA, Malone RE. The tobacco endgame: a qualitative review and synthesis. *Tob Control* 2016;25:594–604.
15 Katz MH. Tobacco-free pharmacies: can we extend the ban? *Tob Control* 2013;22:363–4.
16 Brennan TA, Schroeder SA. Ending sales of tobacco products in pharmacies. *JAMA* 2014;311:1105–6.
17 Tilson M. *Reducing the availability of tobacco products at retail: policy analysis*. Toronto: Non-Smokers' Rights Association, 2011.
18 Hudmon KS, Elkhadragy N, Kusynová Z, *et al*. Global sale of tobacco products and electronic nicotine delivery systems in community pharmacies. *Tob Control* 2017;26:e127–e129.
19 Myers AE, Hall MG, Isgett LF, *et al*. A comparison of three policy approaches for tobacco retailer reduction. *Prev Med* 2015;74:67–73.
20 van der Deen FS, Pearson AL, Wilson N. Ending the sale of cigarettes at US pharmacies. *JAMA* 2014;312:559.
21 Matheson C, Bond CM, Pitcairn J. Community pharmacy services for drug misusers in Scotland: what difference does 5 years make? *Addiction* 2002;97:1405–11.
22 Matheson C, Bond CM, Tinelli M. Community pharmacy harm reduction services for drug misusers: national service delivery and professional attitude development over a decade in Scotland. *J Public Health* 2007;29:350–7.
23 Henderson C, 2014. Needle Exchange Programme: Outlet types http://www.needle.co.nz/outlet_summary.html/15 (accessed 5 Mar 2015).
24 Winstock AR, Lea T, Sheridan J. Prevalence of diversion and injection of methadone and buprenorphine among clients receiving opioid treatment at community pharmacies in New South Wales, Australia. *Int J Drug Policy* 2008;19:450–8.
25 Nacopoulos AG, Lewtas AJ, Ousterhout MM. Syringe exchange programs: Impact on injection drug users and the role of the pharmacist from a U.S. perspective. *Journal of the American Pharmacists Association* 2010;50:148–57.
26 West R, Raw M, McNeill A, *et al*. Health-care interventions to promote and assist tobacco cessation: a review of efficacy, effectiveness and affordability for use in national guideline development. *Addiction* 2015;110:1388–403.
27 van der Deen FS, Ikeda T, Cobiac L, *et al*. Projecting future smoking prevalence to 2025 and beyond in New Zealand using smoking prevalence data from the 2013 Census. *N Z Med J* 2014;127:71–9.
28 Cobiac LJ, Ikeda T, Nghiem N, *et al*. Modelling the implications of regular increases in tobacco taxation in the tobacco endgame. *Tob Control* 2015;24:e154–e160.
29 van der Deen FS, Wilson N, Cleghorn CL, *et al*. Impact of five tobacco endgame strategies on future smoking prevalence, population health and health system costs: two modelling studies to inform the tobacco endgame. *Tob Control* 2018;27:278–86.
30 Blakely T, Cobiac LJ, Cleghorn CL, *et al*. Health, health inequality, and cost impacts of annual increases in tobacco tax: multistate life table modeling in New Zealand. *PLoS Med* 2015;12:e1001856.
31 Nghiem N, Cleghorn CL, Leung W, *et al*. A national quitline service and its promotion in the mass media: modelling the health gain, health equity and cost-utility. *Tob Control* 2018;27:434–41.
32 Cleghorn CL, Blakely T, Kvizhinadze G, *et al*. Impact of increasing tobacco taxes on working-age adults: short-term health gain, health equity and cost savings. *Tob Control* 2017.
33 Petrović-van der Deen FS, Wilson N. Restricting tobacco sales to only pharmacies as an endgame strategy: are pharmacies likely to opt in? *Aust N Z J Public Health* 2018;42:219–20.
34 Zealand SN, 2013. Geographic area files http://www.stats.govt.nz/browse_for_stats/Maps_and_geography/Geographic-areas/geographic-area-files.aspx (accessed 12 Dec 2013).
35 Ministry of Health, 2014. Facility code table http://www.health.govt.nz/nz-health-statistics/data-references/code-tables/common-code-tables/facility-code-table (accessed 19 May 2014).
36 Eades CE, Ferguson JS, O'Carroll RE. Public health in community pharmacy: a systematic review of pharmacist and consumer views. *BMC Public Health* 2011;11:582.
37 van der Deen FS. *Moving beyond tried and true, something bold, something new!? Using simulation modelling to estimate the future smoking prevalence, health and cost impacts of tobacco endgame strategies*. Wellington: University of Otago, 2017.
38 Aveyard P, Begh R, Parsons A, *et al*. Brief opportunistic smoking cessation interventions: a systematic review and meta-analysis to compare advice to quit and offer of assistance. *Addiction* 2012;107:1066–73.
39 Stead LF, Buitrago D, Preciado N, *et al*. Physician advice for smoking cessation. *Cochrane Database Syst Rev* 2013;5:CD000165.
40 Wilson N, Nghiem N, Foster R, *et al*. Estimating the cost of new public health legislation. *Bull World Health Organ* 2012;90:532–9.
41 Clarke PM. Cost-benefit analysis and mammographic screening: a travel cost approach. *J Health Econ* 1998;17:767–87.
42 Johnson RN. Search costs, lags and prices at the pump. *Rev Ind Organ* 2002;20:33–50.
43 World Health Organization, 2011. Tobacco-free cities for smoke-free air: a case study in Mecca and Medina http://www.who.int/kobe_centre/interventions/smoke_free/mecca_medina_web_final.pdf (accessed 15 May 2016).
44 Health Canada. *National baseline survey on the tobacco retail environment. Final report POR-04-48*. Ottowa: Corporate Research Associates Inc, 2005.
45 Paul CL, Mee KJ, Judd TM, *et al*. Anywhere, anytime: retail access to tobacco in New South Wales and its potential impact on consumption and quitting. *Soc Sci Med* 2010;71:799–806.
46 Ali A, Kaplan CM, Derefinko KJ, *et al*. Smoking cessation for smokers not ready to quit: meta-analysis and cost-effectiveness analysis. *Am J Prev Med* 2018;55:253–62.
47 McDaniel PA, Malone RE. Understanding community norms surrounding tobacco sales. *PLoS One* 2014;9:e106461.
48 Chapman S, Freeman B. Markers of the denormalisation of smoking and the tobacco industry. *Tob Control* 2008;17:25–31.
49 Novak SP, Reardon SF, Raudenbush SW, *et al*. Retail tobacco outlet density and youth cigarette smoking: a propensity-modeling approach. *Am J Public Health* 2006;96:670–6.
50 Grace RC, Kivell BM, Laugesen M. Predicting decreases in smoking with a cigarette purchase task: evidence from an excise tax rise in New Zealand. *Tob Control* 2015;24:582–7.
51 Ni Mhurchu C, Eyles H, Schilling C, *et al*. Food prices and consumer demand: differences across income levels and ethnic groups. *PLoS One* 2013;8:e75934.
52 Ajmal A, U VI, Vi U. Tobacco tax and the illicit trade in tobacco products in New Zealand. *Aust N Z J Public Health* 2015;39:116–20.
53 Scollo M, Bayly M, Wakefield M. Availability of illicit tobacco in small retail outlets before and after the implementation of Australian plain packaging legislation. *Tob Control* 2015;24:e45–e51.
54 Brown TJ, Todd A, O'Malley C, *et al*. Community pharmacy-delivered interventions for public health priorities: a systematic review of interventions for alcohol reduction, smoking cessation and weight management, including meta-analysis for smoking cessation. *BMJ Open* 2016;6:2.
55 Dent LA, Harris KJ, Noonan CW. Tobacco interventions delivered by pharmacists: a summary and systematic review. *Pharmacotherapy* 2007;27:1040–51.
56 Saba M, Diep J, Saini B, *et al*. Meta-analysis of the effectiveness of smoking cessation interventions in community pharmacy. *J Clin Pharm Ther* 2014;39:240–7.
57 Sinclair HK, Bond CM, Stead LF. Community pharmacy personnel interventions for smoking cessation. *Cochrane Database Syst Rev* 2004;4:CD003698.
58 Mdege ND, Chindove S. Effectiveness of tobacco use cessation interventions delivered by pharmacy personnel: a systematic review. *Res Social Adm Pharm* 2014;10:21–44.
59 Foster R, Blakely T, Wilson N, *et al*. *Protocol for direct costing of health sector interventions for economic modelling*. Wellington: Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme, Department of Health, University of Otago, 2012.
60 CNN, 2017. What Finland's plan to be tobacco-free can teach the world http://edition.cnn.com/2017/01/26/health/finland-tobacco-free-plan/ (accessed 26 Jan 2017).
61 Ahmad OB, Boschi-Pinto C, Lopez A, *et al*. *Age standardization of rates: A new WHO standard*. Geneva: World Health Organization, 2001.