

ORIGINAL ARTICLE

Projecting future smoking prevalence to 2025 and beyond in New Zealand using smoking prevalence data from the 2013 Census

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Abstract

Background We have previously published a forecasting model of future smoking prevalence in New Zealand (NZ). Under business-as-usual (BAU) assumptions NZ's smokefree 2025 goal was not attained by any demographic group. However, the 2013 Census (which included a question on smoking) showed a greater than expected fall in prevalence, especially for Māori. We therefore aimed to provide upgraded projections to inform policy around tobacco endgame planning.

Method The previously developed dynamic forecasting model was re-specified using smoking prevalence data from the 2006 and 2013 censuses from NZ. Calculations included changes in initiation by age 20 years, and net annual cessation rates, by sex, age, and ethnicity (Māori vs non-Māori). Projections under 2006–2013 trends (adjusted for no tax rises since 2010), by sex and ethnicity were made out to 2025 and beyond.

Results Between the 2006 and 2013 censuses (adjusted for no tax rises since 2010), initiation of daily smoking by age 20 years decreased annually by 3.4% (95% uncertainty interval 3.2% to 3.6%) and 2.7% (2.5% to 2.8%) for non-Māori men and women, and by 2.9% (2.6% to 3.2%) and 3.2% (2.9% to 3.5%) for Māori respectively. Annual net smoking cessation rates ranged from 3.7% to 7.7% across demographic groups. The revised projected smoking prevalence in 2025 (allowing for tax increases that have occurred from 2010 to 2014) was 8.3% and 6.4% for non-Māori, and 18.7% and 19.3% for Māori men and women, respectively.

Conclusions The upgraded smoking prevalence projections still suggests that the NZ Government's smokefree 2025 goal would not be attained by any demographic group. It is likely that more intensive existing interventions, or entirely novel ones, will be needed to achieve the 2025 endgame goal.

Internationally, there seems to be a growing interest in setting tobacco endgame goals – i.e. planning towards achieving close to zero prevalence of tobacco use within a specific time frame with the ultimate goal of eliminating the tobacco-related health burden in the foreseeable future.^{1,2}

As of mid-2014, New Zealand is one of four countries that has a government with a smokefree national goal, to be achieved within the next 10 to 25 years.^{3–6} The New Zealand goal is to (further) reduce the prevalence of smoking and the availability of tobacco products to minimum levels by 2025,⁵ which is often interpreted as reaching a smoking prevalence of below 5%.⁷

In light of New Zealand's smokefree goal, and the persistently higher observed smoking rates in Māori compared to the general population,⁸ it is important to explore if the 2025 target is achievable under current trends in smoking uptake and cessation. Exploring what it would take to get under 5% smoking prevalence for all New Zealanders by 2025, was therefore the main rationale for our analysis that was published in 2013.⁹ This modelling work suggested that under business-as-usual (BAU) assumptions, smoking prevalence in 2025 would be 11% and 9% for non-Māori men and women, and 30% and 37% for Māori respectively. However, at the time of this modelling work, 2013 Census data were not available.

Three data series on smoking prevalence from the more regularly conducted New Zealand Health Survey (NZHS) from 2002 to 2011 were therefore used to provide information on recent annual trends in smoking uptake and cessation as input for future BAU smoking prevalence projections.

These data, however, often had wide 95% confidence intervals around smoking prevalence estimates, especially for Māori.

Since this previous modelling work, smoking prevalence data from the New Zealand 2013 Census has become available,¹⁰ and this reported a lower than expected smoking prevalence, especially for Māori. Between the 2006 and 2013 censuses, daily smoking rates fell from 20.7% to 15.1% in adults aged 15 years and over, and from 42.2% to 32.7% for Māori¹¹ (compared to a daily smoking prevalence of 17.0% for the general adult population, and 38.4% for Māori in the 2011/2012 NZHS).¹²

With these population-wide data (and the 2006 Census which also included a question on smoking), much more accurate information is now available to estimate changes over time in initiation and cessation rates. Therefore, in this new study we aimed to provide new BAU smoking prevalence projections to 2025 and beyond to inform tobacco endgame planning in New Zealand.

Methods

As detailed in the previous work,⁹ the modelling approach of the dynamic tobacco forecasting model for New Zealand closely followed the approach for an Australian model by Gartner et al.¹³

In this paper, we describe the general modelling approach, but mainly focus on the latest iterations to the previous model. The tobacco forecasting model is a dynamic model built in Microsoft Excel including a base and a forecasting model. In the base model, recent trends in smoking initiation and cessation are established, which are then used as inputs for future BAU smoking prevalence projections in the forecasting model. Changes in smoking initiation in this model are reflected as the annual percentage change in smoking prevalence in 20 year olds, whereas cessation is the annual net cessation rate which reflects the net effect of current smokers quitting and former smokers relapsing in a given year.

The previous dynamic forecasting model⁹ was built to project future smoking prevalence from the baseline year 2011. For the current analysis, wherein we provide new BAU smoking prevalence projections to 2025 and beyond using smoking prevalence data from the 2013 Census, the same baseline year of 2011 was maintained for consistency with other tobacco modelling work.^{14,15}

Thus, to update smoking prevalence projections from 2011 to 2025 and beyond, recent annual trends in initiation and cessation in New Zealand were estimated in the base model by using the following inputs: a) current, former, and never smoking prevalence data from the 2006 and 2013 censuses; (b) number of births by sex from 1981 to 2012; (c) annual 'year of age'-specific probabilities of dying from life-tables; and (d) estimates of relative risks of mortality for both current and former smokers from the New Zealand Census Mortality Study.

However, tobacco tax has increased each year by at least 10% since mid-2010 in New Zealand (but not from 2006 to 2009). It is very likely that these tobacco tax increases have played a role in the reduction in smoking rates that has been observed in the general adult population (e.g., from 20.7% to 15.1%) and in Māori (e.g., from 42.2% to 32.7%) between the 2006 and 2013 censuses.¹¹ However, in a BAU scenario we cannot assume that tax rises will continue indefinitely.

We therefore estimated annual changes in initiation rates and cessation rates between 2006 and 2013 *as though there had been no tax rises*, by simply adjusting the 2013 Census data to what we estimate it would have been in the absence of tax rises from 2010 using price elasticities for smoking prevalence of 0.38 (for ≤20 year olds), 0.29 (for 21-24 year olds), 0.19 (for 25-34 year olds), and 0.10 (for 35+ year olds) from New Zealand tobacco tax modelling work.¹⁴ The observed 2006 and 'tax rises removed' 2013 Census prevalence data was then used to estimate changes in initiation and net cessation during this period as previously explained.

The outputs from the base model (annual trends in initiation and cessation between 2006 and 2013 adjusted for no tax rises since 2010) were then used as inputs for the future BAU smoking prevalence projections from 2011 to 2060 in the forecasting model. As a starting smoking prevalence for the baseline year 2011, we calculated what the smoking prevalence in 2011 would have been by using the actual smoking prevalence data from 2013 and removing the effect of tax rises that occurred in 2012 and 2013 (using the same age-specific price elasticities as mentioned above).

For our BAU smoking prevalence projections by sex and ethnicity from 2011 to 2025 and beyond, we then applied the above initiation and cessation rates in the dynamic model from 2006 to 2013 with the slight modification of adding in the estimated effects of annual 10% tax increases in 2012, 2013, and 2014 that have

actually occurred. From 2014 onwards, we assumed no further tax increases, and trends in annual initiation and cessation rates to fall back to the 2006-2013 pattern had there been no tax increases since 2010.

Using population-wide census data to estimate annual initiation and cessation rates means that the uncertainty interval around these estimates is narrow (i.e., the census is an extremely large data base essentially meaning little random error). However, in reality, there is likely to be more uncertainty around the annual initiation and cessation parameters (for example caused by changing cultural norms around smoking [‘denormalisation’]).

At present, we are unable to quantify this structural uncertainty accurately. Therefore, to give a sense of this potential source of uncertainty in the initiation and cessation rates, additional modelling by sex and ethnicity was done. In the “optimistic scenario”, the annual percentage reduction in smoking prevalence in 20 year olds, and net annual cessation rates were multiplied by 1.5 (an arbitrary amount but one which is likely to capture a plausible amount of the uncertainty). In the “pessimistic scenario”, these rates were divided by 1.5. For example, if the BAU annual net cessation rate was 4.0%, this would increase to 6.0% in the optimistic scenario, whereas it would reduce to 2.7% in the pessimistic scenario.

Results

Table 1 shows the initiation and cessation results for 2002 to 2011 (from the previous model⁹) and for 2006 to 2013 (from the updated model with 2013 Census smoking prevalence adjusted for no tax increases since 2010). For 2006 to 2013, it indicates that daily smoking prevalence at age 20 years decreased annually by 3.4% (95% uncertainty interval [UI]: 3.2% to 3.6%) and 2.7% (95% UI: 2.5% to 2.8%) for non-Māori men and women, and by 2.9% (95% UI: 2.6% to 3.2%) and 3.2% (95% UI: 2.9% to 3.5%) for Māori respectively. Annual net cessation rates ranged from 3.7% to 7.7% and 4.5% to 6.9% in the different age groups (20–34, 35–54, 55+ years) in Māori men and women, and from 3.8% to 7.2% and 4.3% to 7.1% for non-Māori respectively.

Compared to the initiation and cessation results for the 2002 to 2011 period from the previous model,⁹ annual net cessation rates were found to be higher from 2006 to 2013 for Māori for all age groups, whereas annual net cessation rates were higher in non-Māori over 55 years of age in 2006 to 2013, but varying from lower to higher for the other age groups. Of note is that the uncertainty intervals were considerably less for the 2006 to 2013 estimates, due to very small standard errors in census data prevalence estimates (compared to prevalence estimates from the NZHS data series).

Also shown in Table 1 are the low and high values of these parameters (divided or multiplied by 1.5) for the pessimistic and optimistic projections.

Figures 1 and 2 show the new projections of future smoking prevalence by sex and ethnicity using the (adjusted) annual initiation and net cessation rates from 2006 to 2013. In these the slope of the future BAU smoking prevalence projections by sex and ethnicity is steep from 2011 to 2014 as these are the years where we allowed for the effect of the 10% tax rises that actually occurred.

Under a BAU scenario, the projected smoking prevalences in 2025 are 8.3% and 6.4% for non-Māori men and women, and 18.7% and 19.3% for Māori respectively. Under this BAU forecasting scenario, a below 5% smoking prevalence will be achieved by non-Māori women in the year 2032 and men in 2040, and sometime after 2060 for Māori men and women.

Only the optimistic scenario for non-Māori women is projected to reach below 5% smoking prevalence in 2025. However, this would require a substantial 50% increase in the annual percentage decrease smoking prevalence amongst 20 year olds from 2.7% to 4.1%, and in annual net cessation rates across the age groups (e.g., from 5.5% to 8.3% in 20–34 year olds).

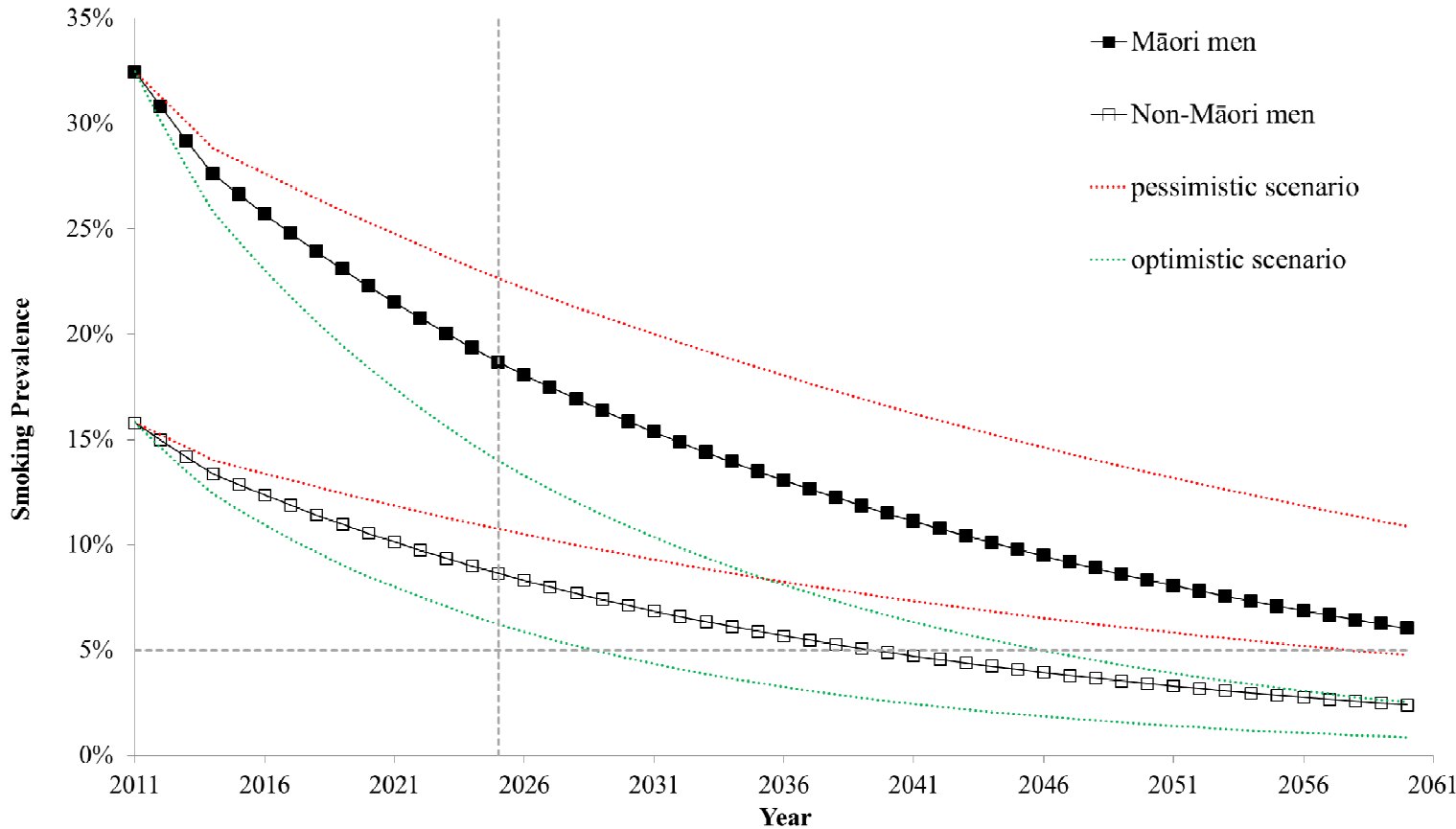
Table 1. Outputs from the baseline tobacco model for various demographic groups in New Zealand over time—net annual cessation rates and annual percentage changes in 20–24 year old smoking prevalence (reflecting smoking initiation levels) for non-Māori and Māori between 2002 and 2011 (original model) and 2006 and 2013 (updated model)*

	2002 to 2011 (used in previous projections) ⁹		2006 Census to 2013 Census					
	Best estimates		Best estimates Scenarios for projections					
	Men	Women	Men	Women	Men	Women		
					Pessimistic scenario	Optimistic scenario	Pessimistic scenario	Optimistic scenario
<i>Non-Māori</i>								
Net cessation rates [†]								
20–34 years	3.2 (1.8 to 4.6)	4.4 (3.0 to 5.8)	4.1 (4.0 to 4.3)	5.5 (5.3 to 5.8)	2.8	6.2	3.7	8.3
35–54 years	3.8 (2.8 to 4.9)	5.9 (5.0 to 6.9)	3.8 (3.7 to 4.0)	4.3 (4.1 to 4.5)	2.6	5.8	2.9	6.5
55+ years	4.5 (3.2 to 6.0)	6.1 (4.7 to 7.2)	7.2 (7.0 to 7.5)	7.1 (6.9 to 7.4)	4.8	10.8	4.8	10.7
Smoking prevalence in 20-year olds [‡]	3.1 (0.8 to 5.7)	1.1 (-1.2 to 3.2)	3.4 (3.2 to 3.6)	2.7 (2.5 to 2.8)	2.3	5.1	1.8	4.1
<i>Māori</i>								
Net cessation rates [†]								
20–34 years	0.6 (-0.9 to 2.0)	1.4 (0.3 to 2.5)	3.9 (3.7 to 4.2)	4.5 (4.2 to 4.8)	2.6	5.9	3.0	6.8
35–54 years	2.8 (1.4 to 4.2)	3.5 (2.6 to 4.6)	3.7 (3.5 to 3.9)	4.7 (4.5 to 5.0)	2.5	5.5	3.1	7.1
55+ years	0.4 (-1.7 to 2.4)	5.8 (4.2 to 7.3)	7.7 (7.1 to 8.3)	6.9 (6.4 to 7.6)	5.1	11.5	4.7	10.5
Smoking prevalence in 20-year olds [‡]	4.7 (2.2 to 7.1)	0.0 (-2.2 to 1.8)	2.9 (2.6 to 3.2)	3.2 (2.9 to 3.5)	1.9	4.3	2.1	4.8

*The 2013 smoking prevalence data was first adjusted to what we estimate it would have been in the absence of tax rises from 2010. Changes in initiation rates and cessation rates between 2006 and 2013 were calculated using the adjusted 2013 Census data. †Although the pattern in annual cessation rates by age appears to be different from 2002 to 2011 (steadily increasing by age) than 2006 to 2013 (U-shaped pattern; higher cessation rates for 20-34 year olds and 55+ year olds, and somewhat lower cessation rates for 35-54 year olds), uncertainty intervals around the estimates for 2002-2011 are wide and overlapping for the different age groups. Some other countries with relatively advanced levels of tobacco control (for example United States and Canada) have recently reported higher abstinence rates in the younger and older age groups (albeit no statistically difference was found between the age groups).^{16,17} ‡Percentage decline, not absolute percentage change. Thus if 20 year old smoking prevalence is 20% at t_0 and the 'percentage decline in initiation rate' per annum is 3%, then the 20 year old smoking prevalence in year t_1 is $20\% \times (100\% - 3\%) = 19.4\%$. Furthermore, the smoking prevalence in year t_0 is $20\% \times 97\%^{10} = 14.7\%$.

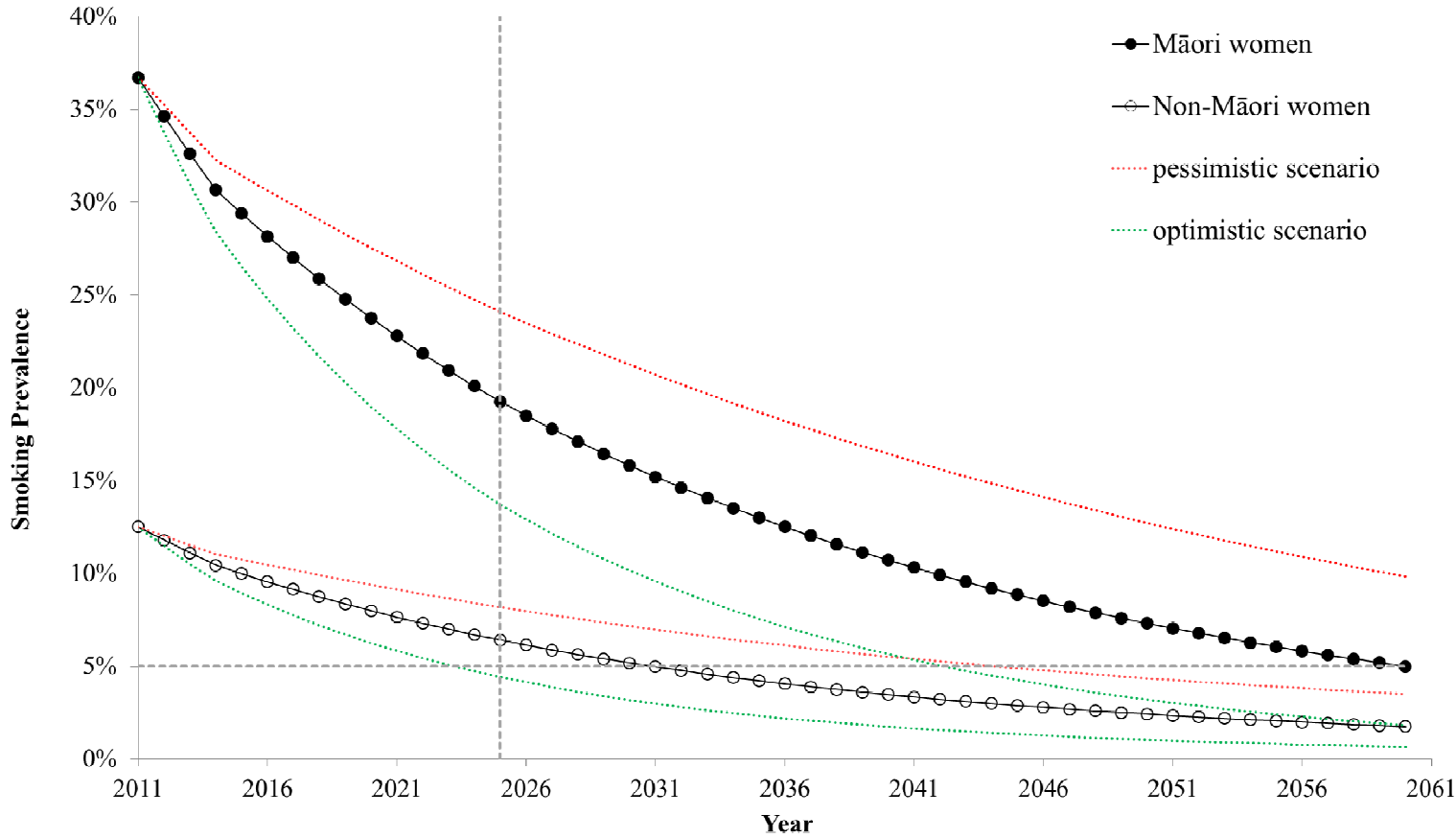
Note: 95% uncertainty intervals in parentheses.

Figure 1. Business-as-usual, optimistic scenario, and pessimistic scenario* projections of daily smoking prevalence for Māori and non-Māori men in New Zealand using change in initiation and net cessation parameters from 2006 to 2013 (adjusted for no tax rises since 2010)



*In the optimistic scenario, annual percentage reductions in smoking prevalence in 20 year olds and annual net cessation rates were multiplied by 1.5, whereas these rates were divided by 1.5 in the pessimistic scenario. For example, if the BAU annual net cessation rate was 4.0%, this would increase to 6.0% in the optimistic scenario, whereas in the pessimistic scenario it would reduce to 2.7%.

Figure 2 Business-as-usual, optimistic scenario, and pessimistic scenario projections of daily smoking prevalence for Māori and non-Māori women in New Zealand using change in initiation and net cessation parameters from 2006 to 2013 (adjusted for no tax rises since 2010)



Discussion

Projecting future smoking prevalence, using the most recent trends in initiation and cessation from full population census data on smoking and allowing for tax increases until 2014, resulted in an estimated prevalence in 2025 of 19% for both Māori men and women, and 8% and 6% for non-Māori respectively.

Although these projections are more favourable from a public health perspective (especially for Māori) than our previous modelling results using NZHS smoking data,⁹ a smoking prevalence below 5% by 2025 is still not attained by any demographic group. Furthermore, although the projected decline in smoking for Māori will be a welcomed development in the New Zealand health sector, large inequalities in smoking prevalence between non-Māori and Māori are projected to remain (under this BAU scenario).

Attaining the 2025 goal for all New Zealanders may therefore require substantially larger increases in annual net cessation rates, and decreases in initiation than our optimistic scenario, especially for Māori.

Given the uncertainty around future tobacco control policy, we cannot assume that tax rises will continue indefinitely (in a BAU scenario). We therefore used price elasticities of demand for tobacco (varying by age) to estimate annual changes in initiation and cessation rates between 2006 and 2013 as though there had been no tax increases since 2010. These adjusted annual initiation and cessation rates were then applied in the model from 2014 onwards. That is, our BAU scenario projections are for a future world with no further tax increases, other than the routine annual inflation-adjustments (projections with tax increases are provided elsewhere¹⁴).

Although price elasticities may also vary by other demographics than age, such as sex, ethnicity, and level of deprivation,^{18,19} the adjusted 2013 prevalence only marginally changed after using price elasticities to remove the effect of tax rises that occurred since 2010 (e.g., from 30.5% to 30.9% for Māori men, from 34.7% to 35.1% for Māori women, from 15.5% to 15.7% for non-Māori men, and from 12.5% to 12.7% for non-Māori women). This means that, compared to the large reduction in the observed smoking prevalence between the 2006 and 2013 censuses, annual initiation and cessation rates in the model are not that sensitive to how much tax effect is removed (i.e., variations in price elasticities).

Using smoking prevalence data from the 2006 and 2013 censuses potentially has some limitations. First of all, the census captures the prevalence of daily smoking for those aged 15 years and over, whereas the NZHS also reports the prevalence of current smoking which includes both daily and non-daily smoking behaviour across the population.²⁰ According to the results of the 2012/2013 NZHS, the prevalence of non-daily smoking is approximately 2% in New Zealand.²⁰

The census might therefore underestimate the prevalence of any smoking behaviour across the population. Furthermore, about 6.7% of the New Zealand population did not answer the smoking question in the 2013 census.¹⁰ However, for the census prevalence to be notably biased would require the 6.7% of people not responding to the smoking question to have very different smoking behaviour to the other respondents.

The smoking prevalence results from the 2013 census seem credible when looking at the daily smoking rate reported in the 2012/2013 NZHS for the total adult population (15.5%).²⁰ Smoking prevalence data from the 2006 and 2013 censuses proved to be more stable, especially for Māori, than using data from multiple NZHS series.

Projecting (and updating) future BAU smoking prevalence may be useful for assisting policy makers in New Zealand in planning how much more intense tobacco control policy has to be (or if new major strategies are required such as a tobacco outlet phase down¹⁵) to achieve the endgame goal. It proved to be relatively easy to update the previously published forecasting model based on new prevalence data from the 2013 census, and by demographic group to estimate how inequalities may track into the

future under a BAU scenario. It also forms a possible foundation for future modelling of the impacts of a variety of novel tobacco control interventions (e.g., phasing down the level of nicotine in smoked tobacco) or changes in the future nicotine market (e.g., through increased availability of electronic cigarettes).

E-cigarettes appear to be increasingly popular in New Zealand owing to legal importation for personal use and potentially some level of illegal sales. It is possible that in the future there may be electronic cigarette brands that meet regulatory standards that allow them to be legally sold in New Zealand or that current New Zealand law is revised to permit sales of brands that meet minimal standards. If so, such changes in the nicotine market may impact on future trends in tobacco cigarette initiation and cessation rates.

Some recent signs of progress in tobacco policy planning are that the New Zealand Government has announced that the pattern of annual tax increases of 10% above annual inflation will be extended to 2016,²¹ and the Tobacco Plain Packaging Bill (as per Australia) has passed its first reading in Parliament with a majority of votes.²² Nevertheless, attaining the smokefree goal, and reducing large inequalities in smoking prevalence between Māori and non-Māori, will probably require implementation of more intense or entirely novel tobacco endgame strategies such as a more permanent approach to tobacco tax increases, a gradual phase-down in nicotine levels of tobacco products until a non-addictive level is reached, or major reductions in the number of current tobacco retail outlets (possibly limiting these to one outlet type only, for example pharmacies²³).

Competing interests: Nil.

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