Ending the Cardiovascular Disease Epidemic in New Zealand: What can Modelling tell us?

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Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme

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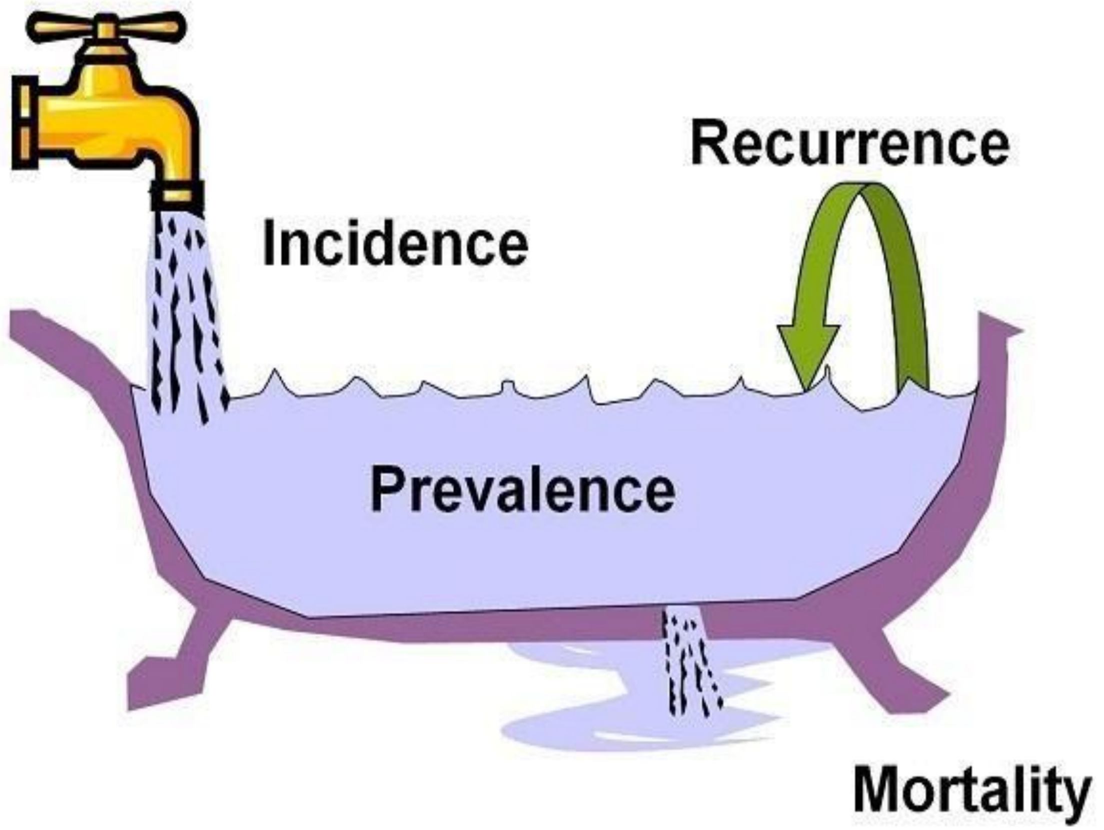
Structure of this presentation

- Modelling methods
- Results for sodium reduction
- Results for tobacco control
- Results for CVD preventive medications
- League tables
- Conclusions

Our multi-state life-table models



Methods – multi-state life-table

- A multi-state life-table is literally that: a life-table in which subjects (proportions of a cohort) can be in multiple states simultaneously

	A	B	C	D	E	F	G	H	I	
1					Life table cohort	Deaths in cohort				
2	sex	age	average mortality rate at age x	probability of dying between age x and x+1	no. of survivors at age x out of those in year 1	no. who die between age x and x+1	no. of person-years lived by cohort to age x+½	life expectancy	prevYLD rate from all causes	dis… p…
3		x	m_x	q_x	l_x	d_x	L_x	e_x	w_x	
4			mortality data	$q_x = 1 - EXP(-m_x)$	l_0 = population $l_x = l_{x-1} - d_{x-1}$	$d_x = q_x \times l_x$	$L_x = (l_x + l_{x+1})/2$ $L_{110+} = l_{110+}/m_{110+}$	$e_x = \Sigma L_x / l_x$	from BOD data	$Lw_x =$
7	male	4	0.000135194	0.0001	114928	16	114920	79.14	0.026408649	
8	male	5	0.00010438	0.0001	114912	12	114906	78.15	0.03374444	
9	male	6	8.39192E-05	0.0001	114900	10	114895	77.16	0.03374444	
10	male	7	6.41376E-05	0.0001	114891	7	114887	76.17	0.03374444	
11	male	8	5.40211E-05	0.0001	114883	6	114880	75.17	0.03374444	

LifeTable | CHD | Stroke | COPD | LRTI | BladderCan | CervicalCan | EndometrialCan

Ready 100%

Specific methods

- Models built in Excel & TreeAge (Markov macro-simulation)
- Health system perspective, 3% discount rate
- Built-in disease trends out into the future eg, declining CVD incidence, case-fatality rate (CFR)
- Disease-specific incidence, case-fatality, prevalence from range of sources, using DISMOD to ensure consistency:
  (mortality data, HealthTracker, NZ Burden of Disease Study (NZBDS), NZCMS)
- Morbidity incorporated using years lived with disability (YLDs) from NZBDS
- Costs in each state from rich linked NZ data, 2011 $

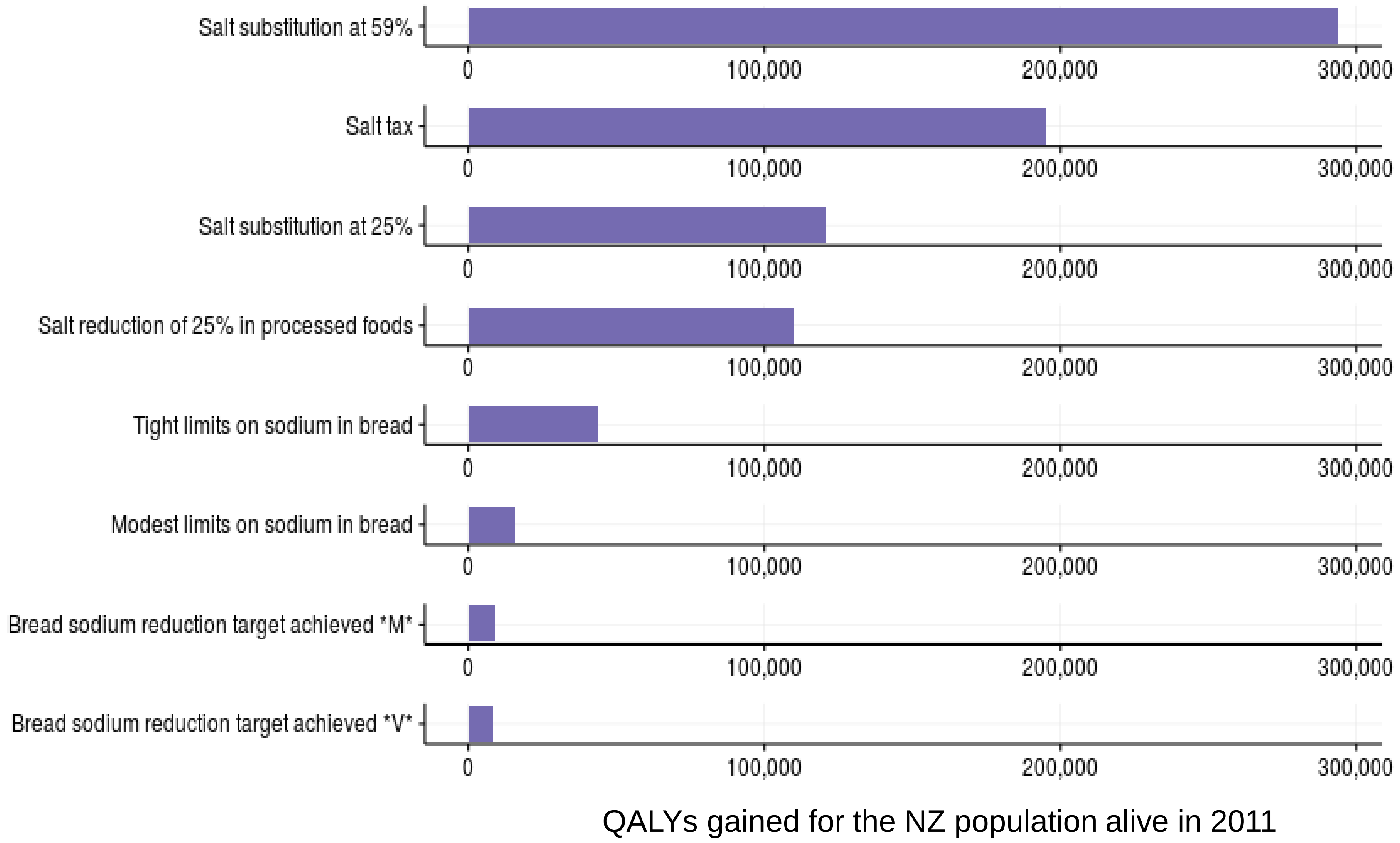
Dietary sodium interventions – contributing to a NZ league table

- A "diet high in sodium" 2nd most important dietary risk factor for health loss (Global Burden of Disease Study 2013).
- Countries use a wide range of interventions:
  - Labelling (many)
  - Maximum levels in foods (eg, bread)
  - Media campaigns (eg, UK)
  - Taxing salty foods (eg, Hungary)
  - Encouraging industry to reformulate food
  - Substitution with KCl (eg, Finland)
  - Dietary counselling (many)

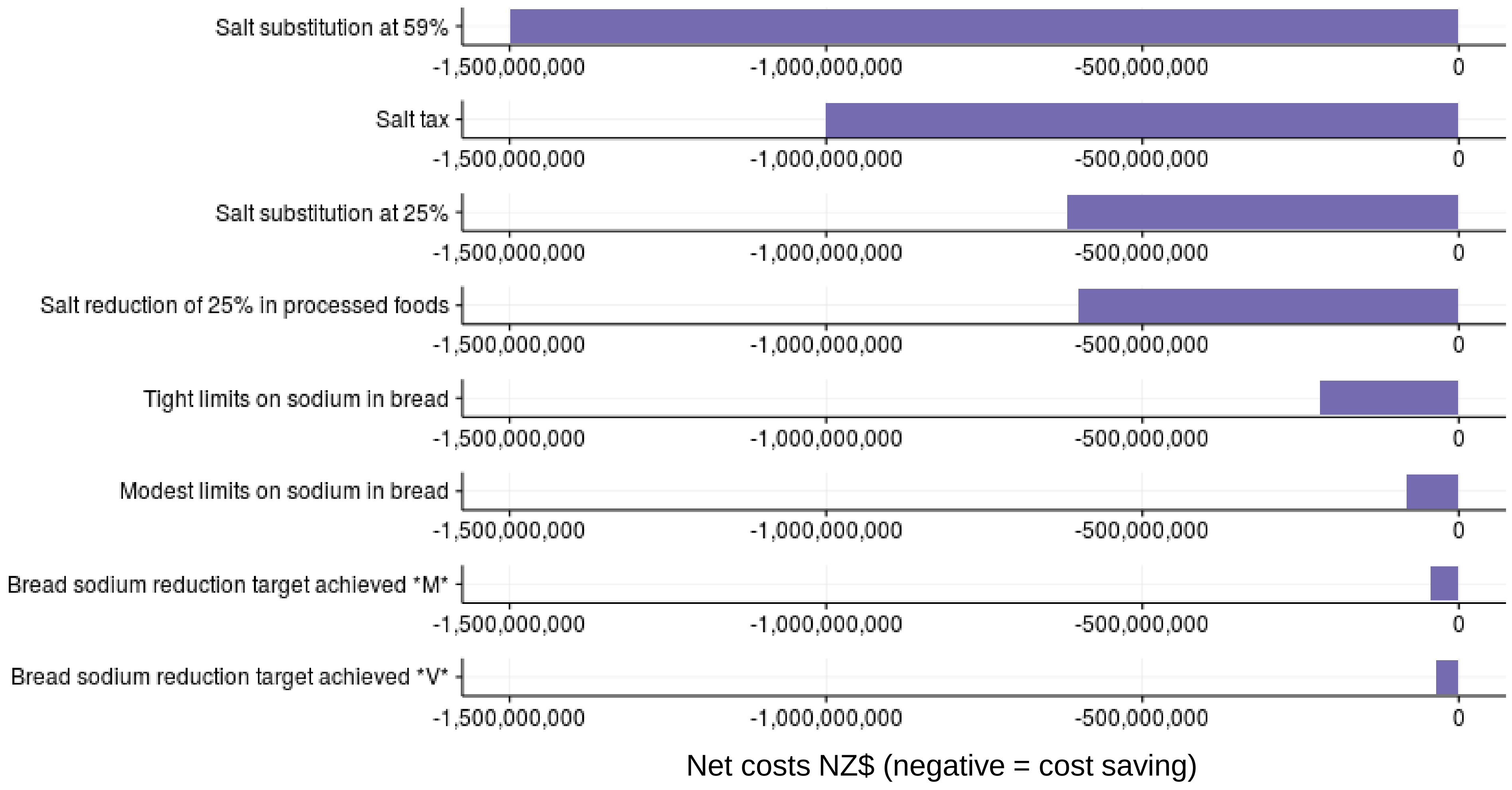
Specific methods (sodium reduction)

- Model built in TreeAge
- Estimates QALYs gained (↓CHD & ↓stroke)
- Population: 2.3 m NZ adults, aged 35+
- Methods details on BODE^3 website:
  - Nghiem et al 2015, *PLoS One*
  - Nghiem et al 2016, *BMC Public Health*
  - Wilson et al 2016, *Nutr J*
  - Online Reports: eg, model validation

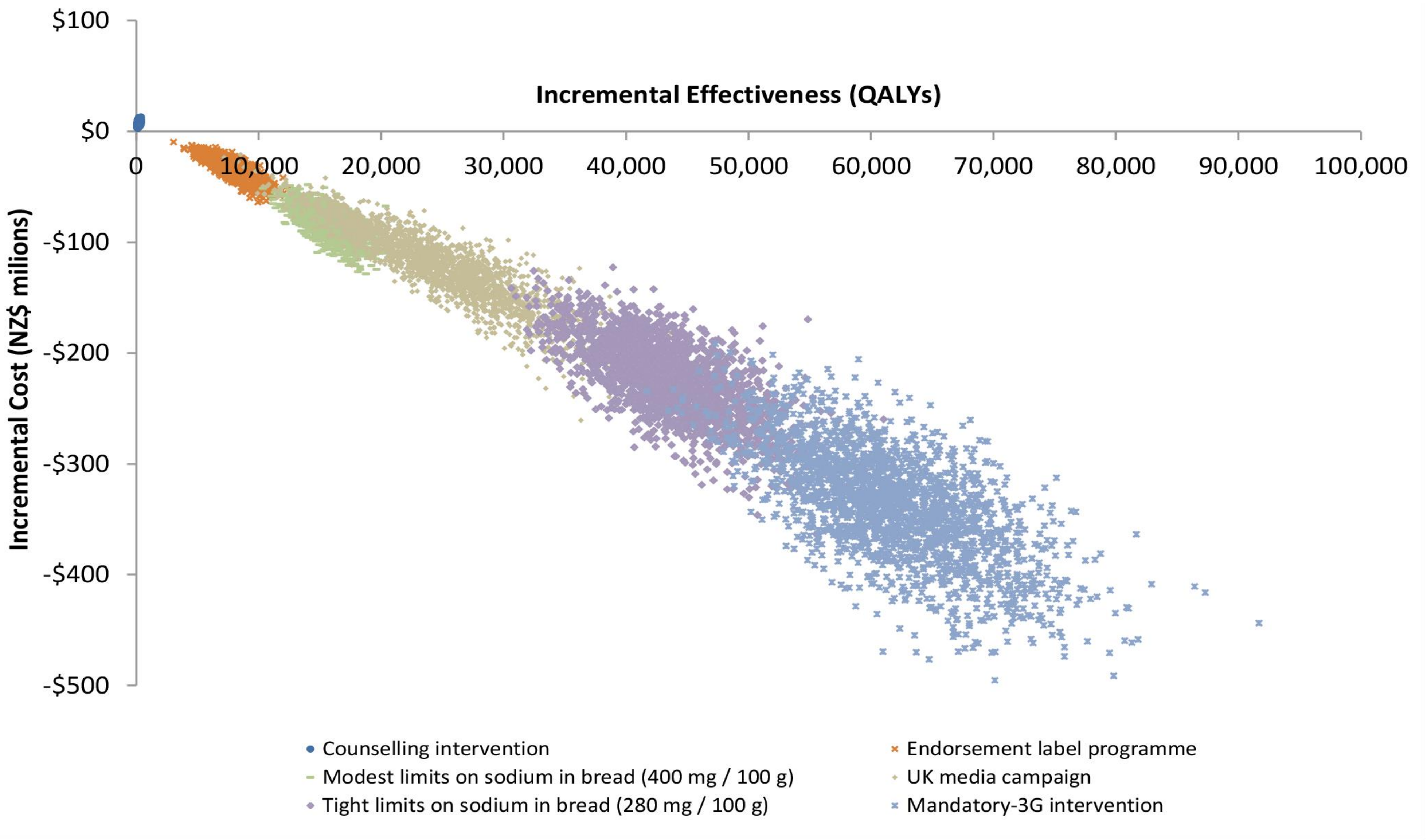
Screenshot, BODE³ Online Interactive League Table: QALY gains (life-time) for NZ population in 2011



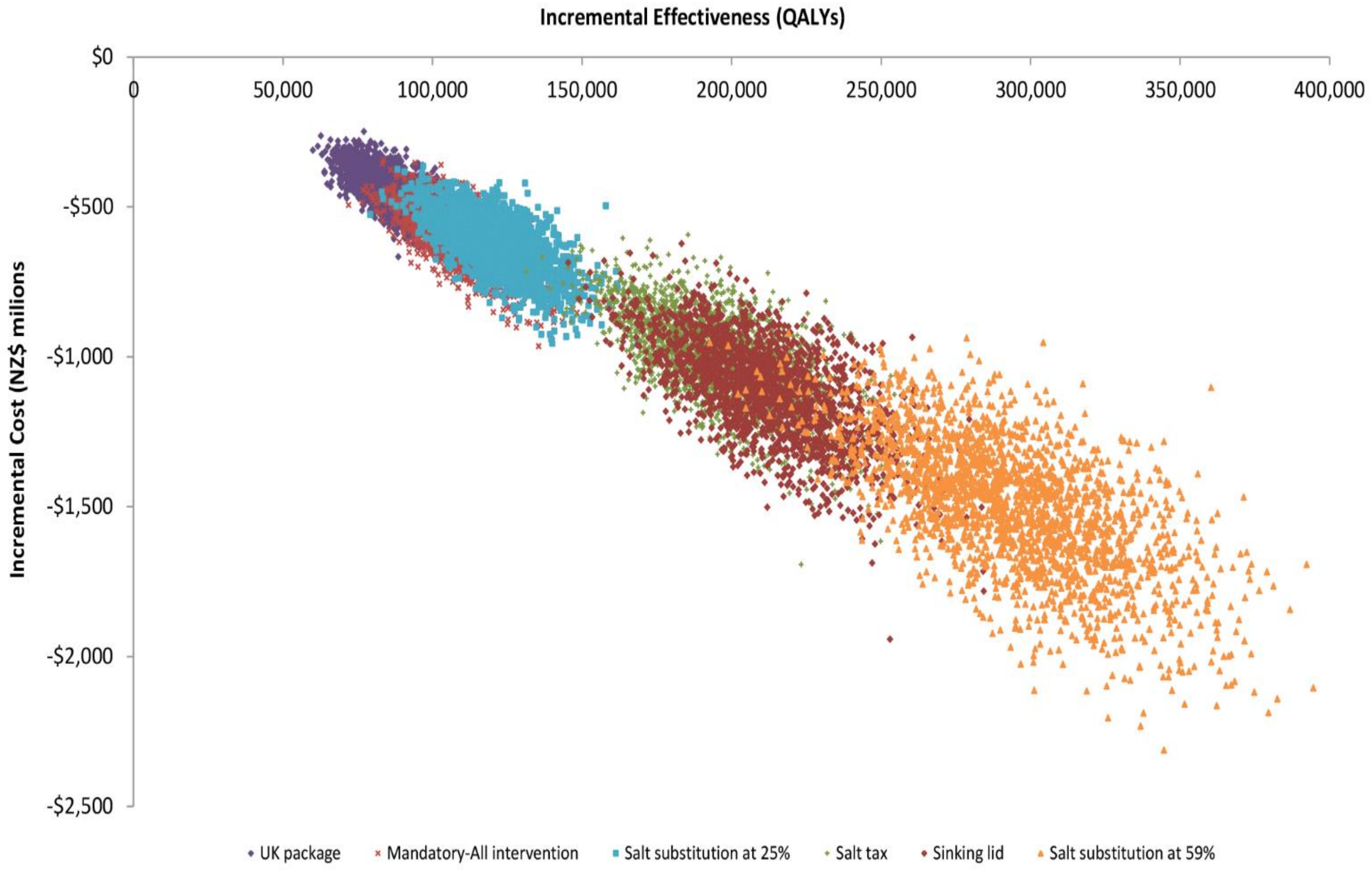
Screenshot, BODE³ Online Interactive League Table: Health system costs (life-time) NZ$ for NZ population



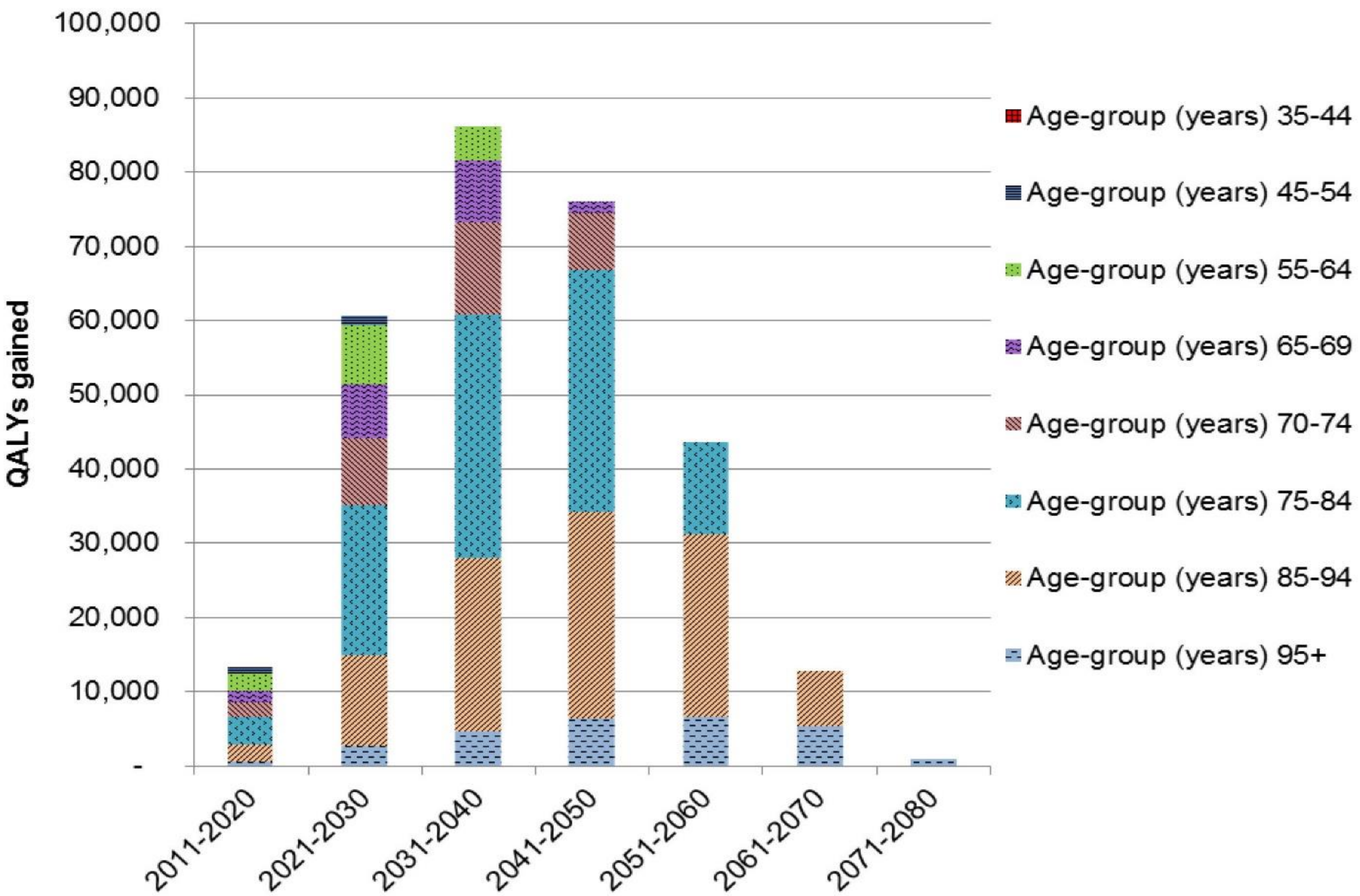
Published but not yet in the online league table: Cost-effectiveness planes (sodium reduction)



Cost-effectiveness plane: highest impact interventions (sodium reduction)



Who gains the QALYs & when (sodium reduction)



Selected issues

- Pro-equity: 33% higher per capita QALY gain for Māori from sodium reduction
- Salt tax revenue – a potential plus for some policy-makers
- Particularly strong case for progressing salt substitution (since it is happening already)
- Recent studies: uncertainty about hazard at Na+ <5g/d, high metabolic demands of salt excretion.

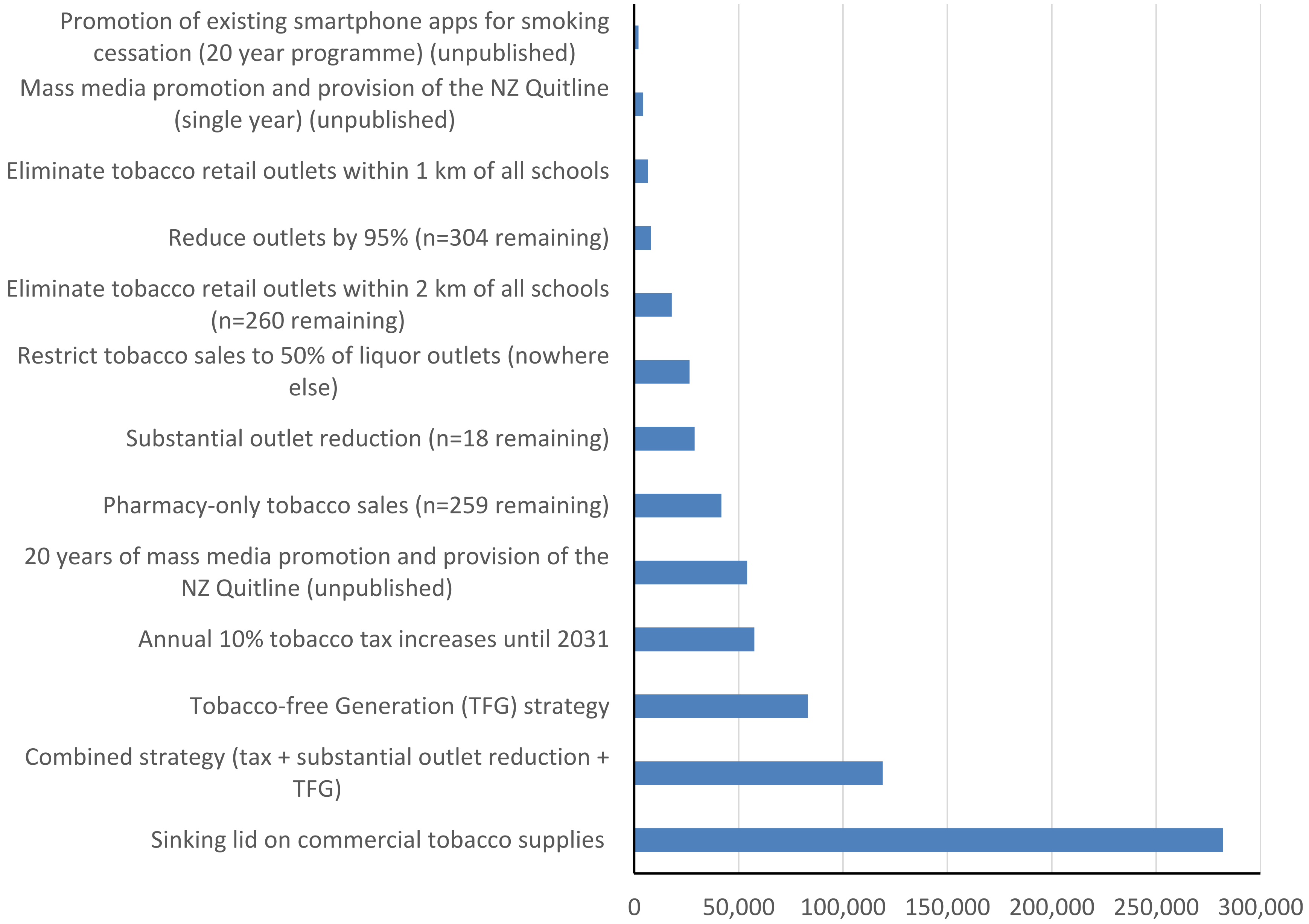
Summary: Sodium reduction

- In our league table: 32 methodologically comparable interventions for policy-makers to consider
- Sodium substitution – largest gains (& seems relatively feasible)
- Further work still needed on the possible hazard of low sodium intakes & metabolic impacts

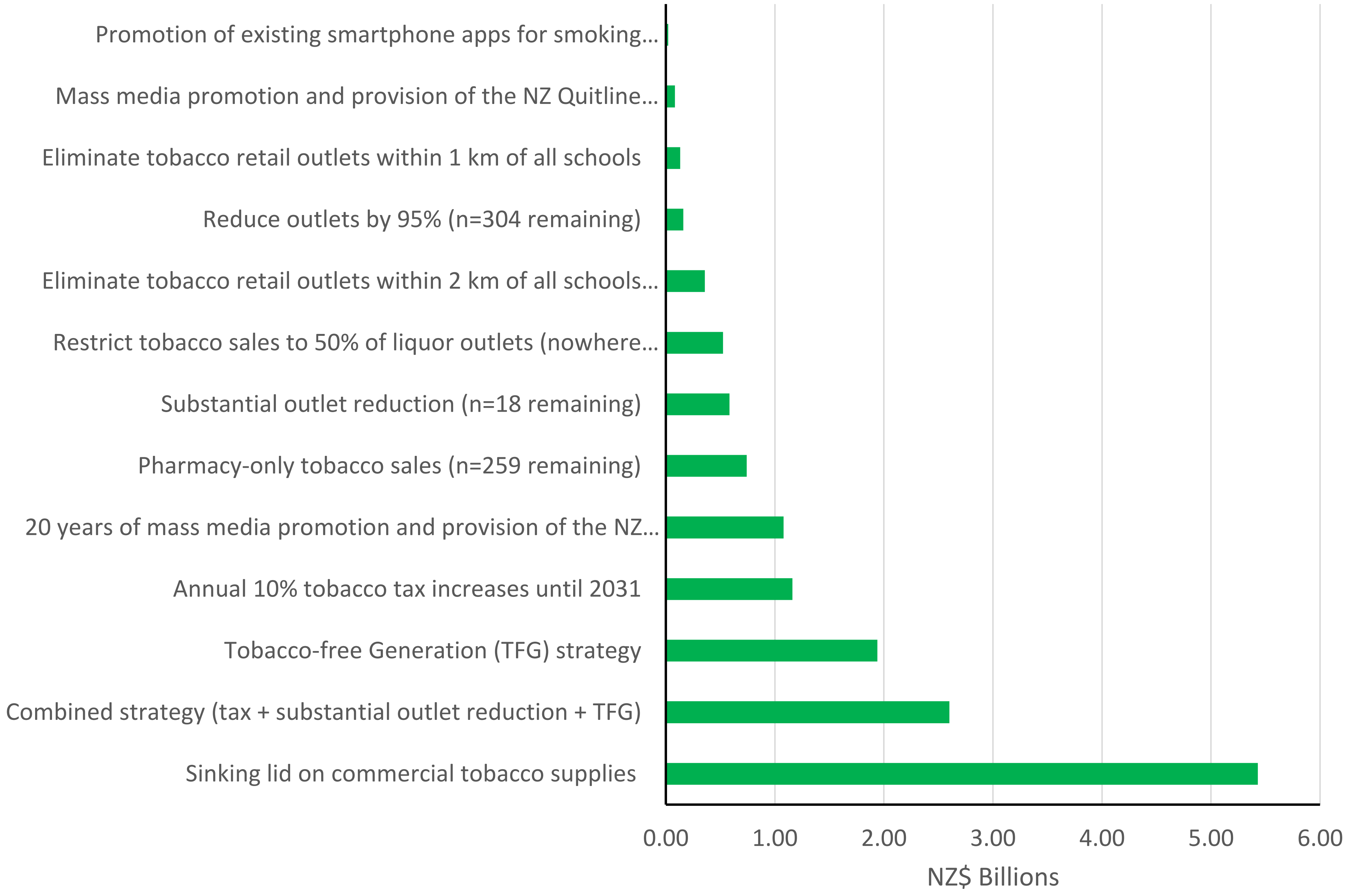
Tobacco control modelling

- Multi-state life-table model in Excel
- Models ↓IHD, ↓stroke, + 14 other conditions
- Methods details on BODE^3 website, eg:
  - Blakely et al 2015, *PLoS Med*
  - Pearson et al 2016, *Tob Control*
  - Nghiem et al 2017, *Tob Control*
  - Van der Deen et al 2017, *Tob Control*

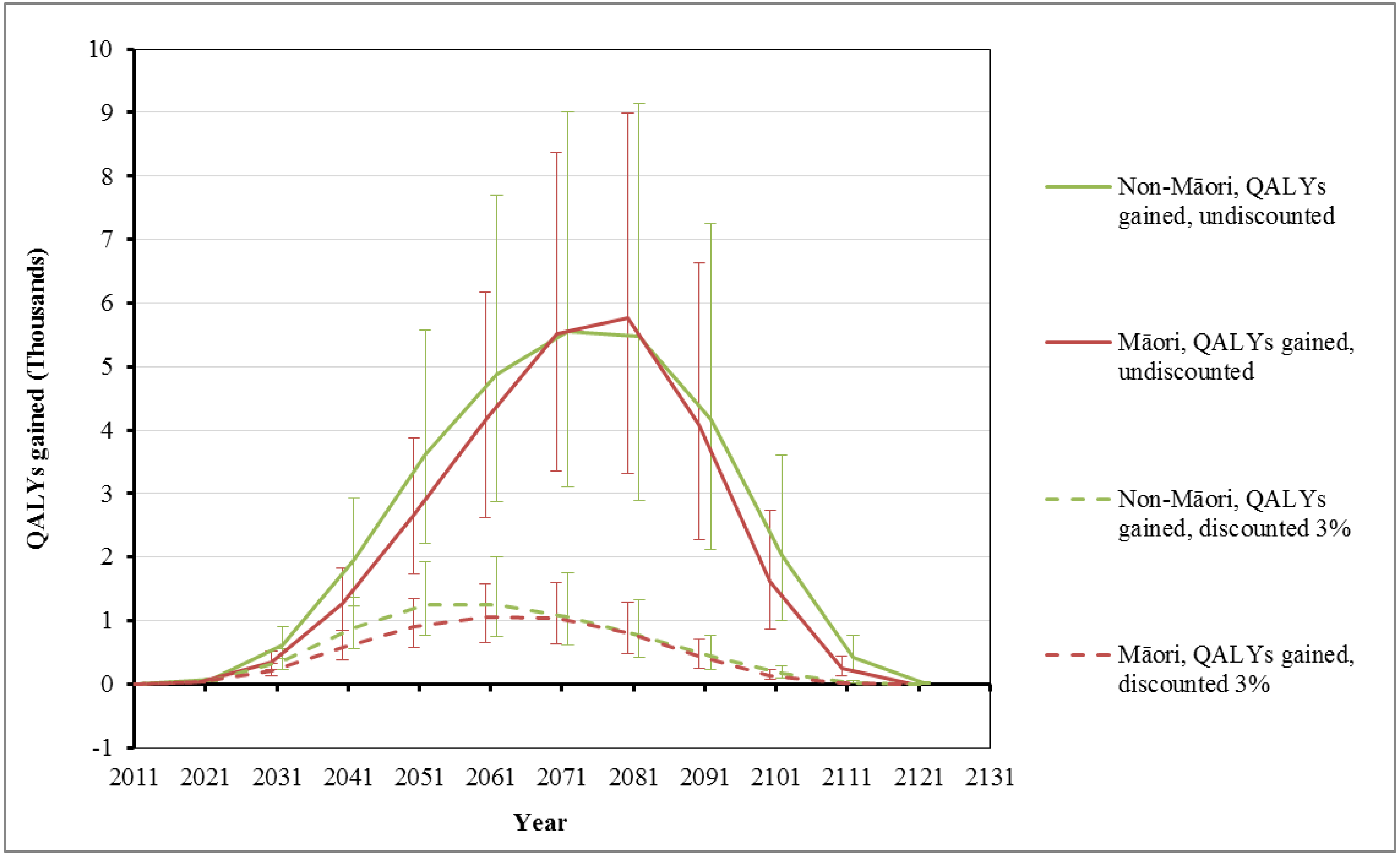
Tobacco control interventions: Health gain (QALYs) over the remainder of the lives of the 2011 NZ population



Tobacco control interventions: Net health system cost-savings accrued over the remainder of the lives of the 2011 NZ population in NZ$

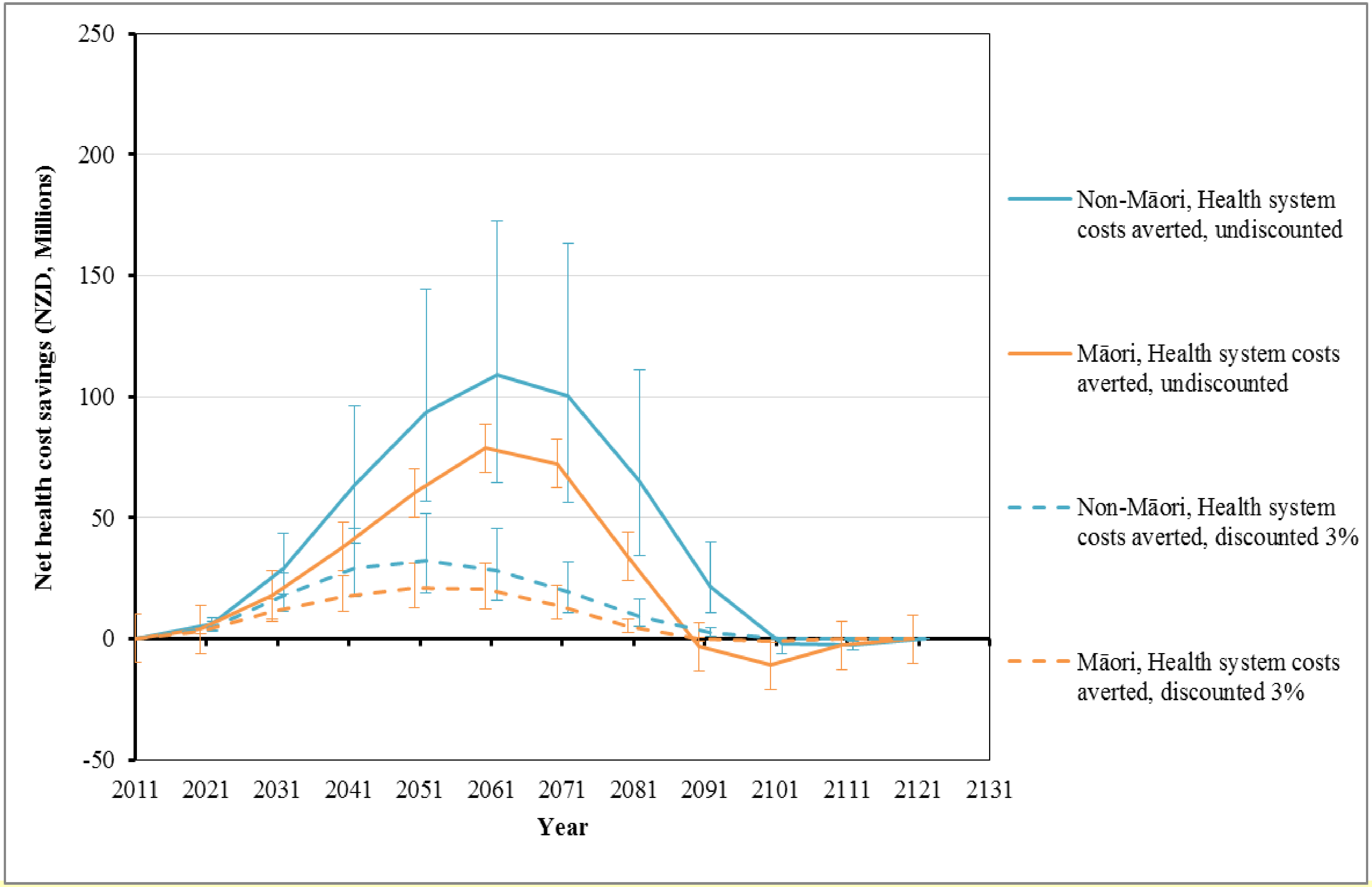


Health gains from tobacco tax increases



Slightly modified from PLoS Med paper

Cost-savings from tobacco tax increases



Slightly modified from PLoS Med paper

12 Tobacco Control Interventions

- All generate health gain and net cost-savings
- But only 17% of QALYs gain from CVD prevention since most is from:
  - COPD: 53%
  - Lung cancer: 26%
- But CVD benefits usually achieved sooner

Modelling CVD preventive medications

- Use of triple therapy (statin + anti-hypertensive + aspirin) for primary prevention
- Stratified by 5y absolute risk of CVD event
- NZ risk data (PREDICT) (Knight et al 2017, *PLoS One*)
- Multi-state life-table model in Excel
- Models: ↓IHD, ↓stroke, ↓colorectal cancer

Provisional results: 60-64y old men

Five-year cumulative risk category	QALYs gained	Cost offsets (NZ$ million)	Incremental cost-effectiveness ratio (ICER) in NZ$ per QALY gained, (95%UI)
>20%	25	$0.024	$969 ($-319 to $2,250)
>15, ≤20%	77	$0.037	$479 ($-1,200 to $2,090)
>10, ≤15%	324	$0.146	$449 ($-1,920 to $2,960)
>5, ≤10%	1440	$3.71	$2,580 ($-1,410 to $7,160)
>0, ≤5%	1230	$13.4	$11,000 ($3,660 to $19,200)

Average healthy life gained per man 60-64y man from offer of triple therapy for 5y *(provisional results)*

Five-year cumulative risk category	Non-Maori	Maori
>20%	3.2 months	2.7 months
>15, ≤20%	2.2 months	2.0 months
>10, ≤15%	1.5 months	1.4 months
>5, ≤10%	23 days	24 days
>0, ≤5%	12 days	13 days

League table development

- Includes all our published CVD intervention results (also compared to cancer control etc)
- Our envisaged backbone of communication with:
  - Researchers, policy-makers, public, other stakeholders
- To try it: See our *Public Health Expert* blog series on using the BODE^3 Interactive League Table

In Conclusion, Modelling can:

- Show the health gain and cost impacts of interventions to reduce CVD (eg, sodium, tobacco, pharmaceutical) – all with uncertainty
- Inform equity impacts (eg, Māori per capita QALY gain greater)
- Show timing of health gains & costs
- Facilitate league table development

But early stages in gauging policy-maker response to modelling outputs & league tables