

# The great divide: mortality in Aotearoa

Professor Tony Blakely

He ora te whakapiri - life course symposium

October 2018

bode<sup>3</sup>

Burden of Disease Epidemiology, Equity  
and Cost Effectiveness Programme

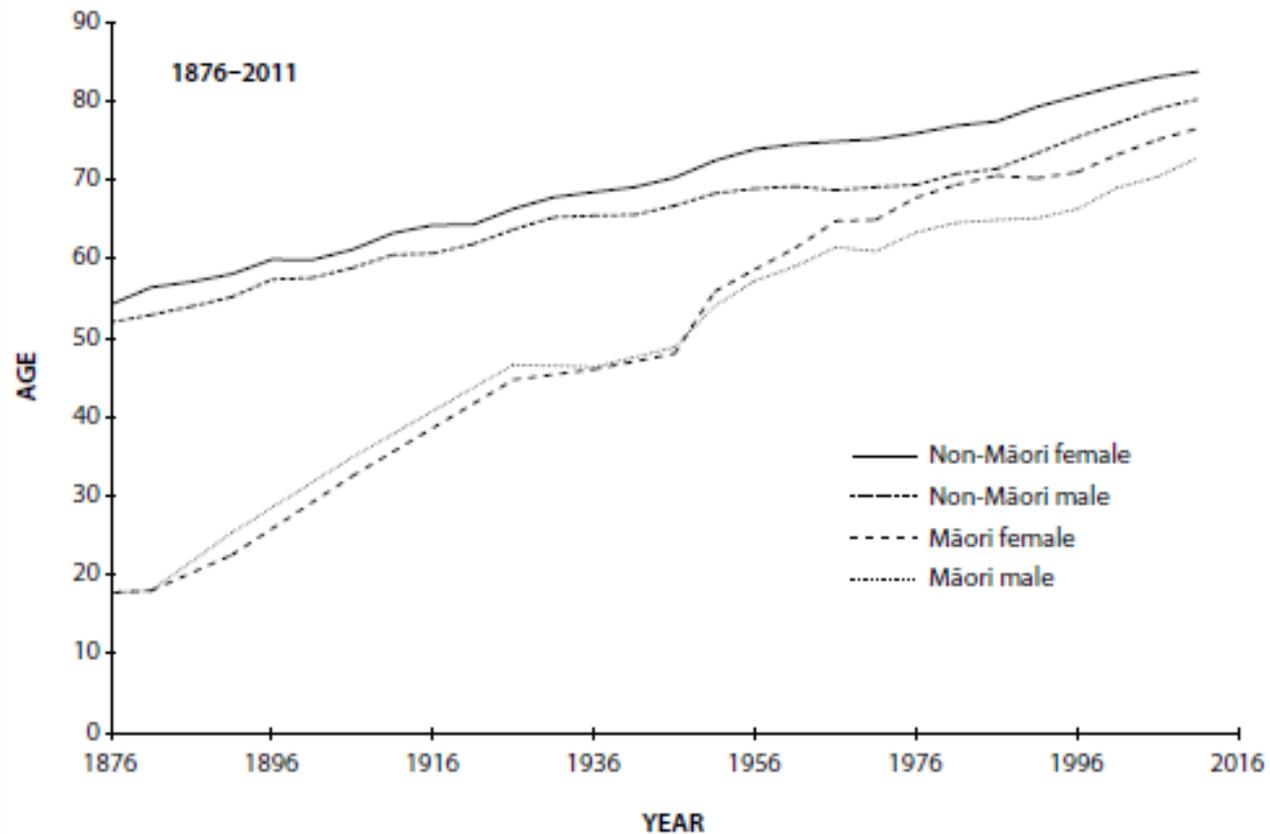
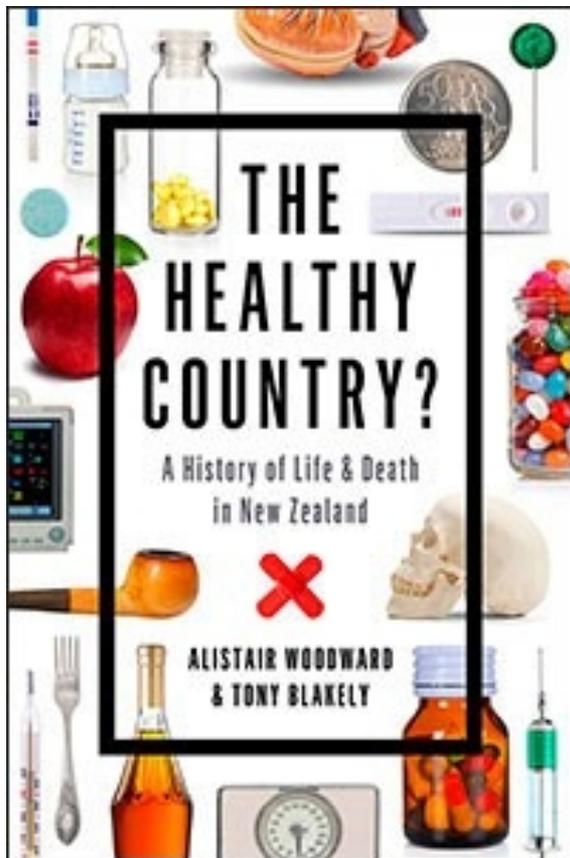


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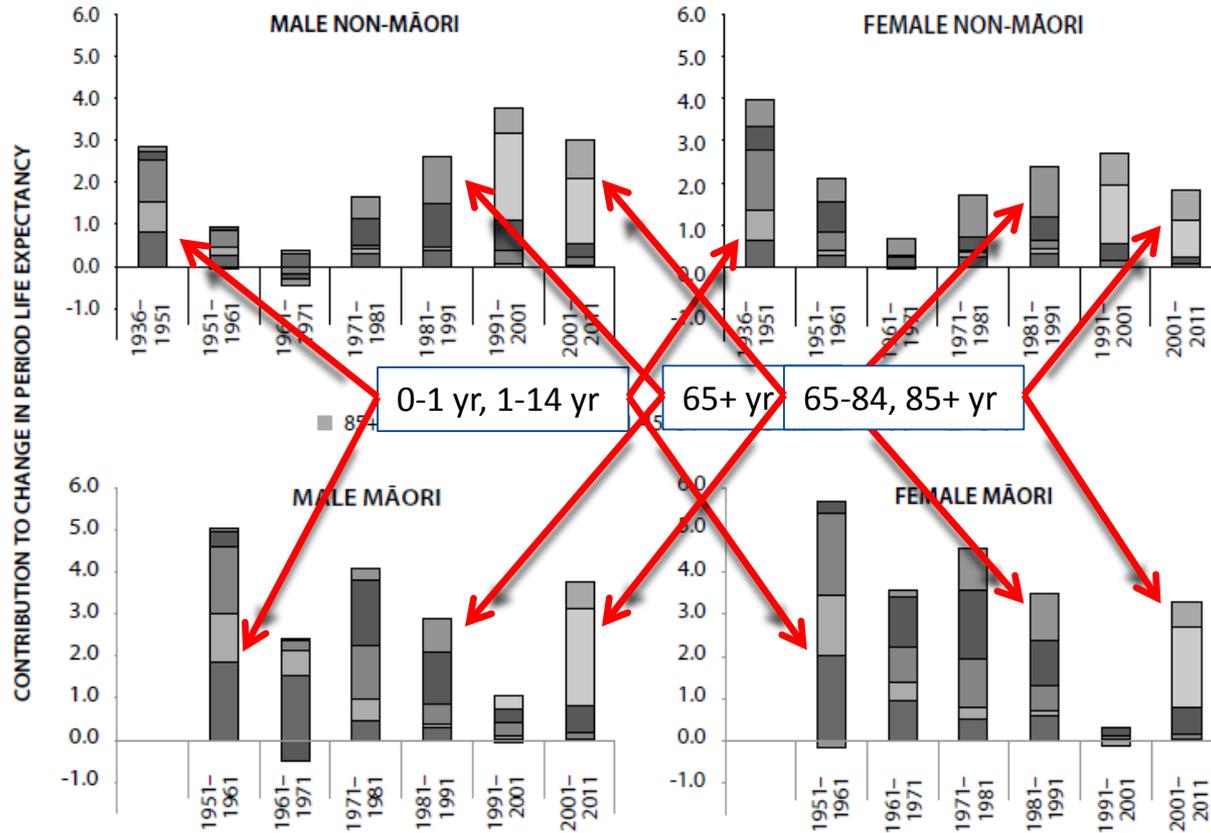
# What I will cover today

1. **The past 150 years** = historical and descriptive epidemiology:
  - The long-run history of mortality decline – and inequalities and period effects
2. **The past 30 to 40 years** = an example of contemporary epidemiological methods (counterfactual approach) to answer policy-relevant questions:
  - How much of the association of ethnicity with mortality, from 1981 to 2011, is due to socio-economic position and smoking?
  - What would have ethnic inequalities in mortality been had tobacco never arrived in NZ?
3. **The future** = examples of epidemiological simulation of future health:
  - Examples from BODE<sup>3</sup>: Tobacco tax, salt interventions, and more....

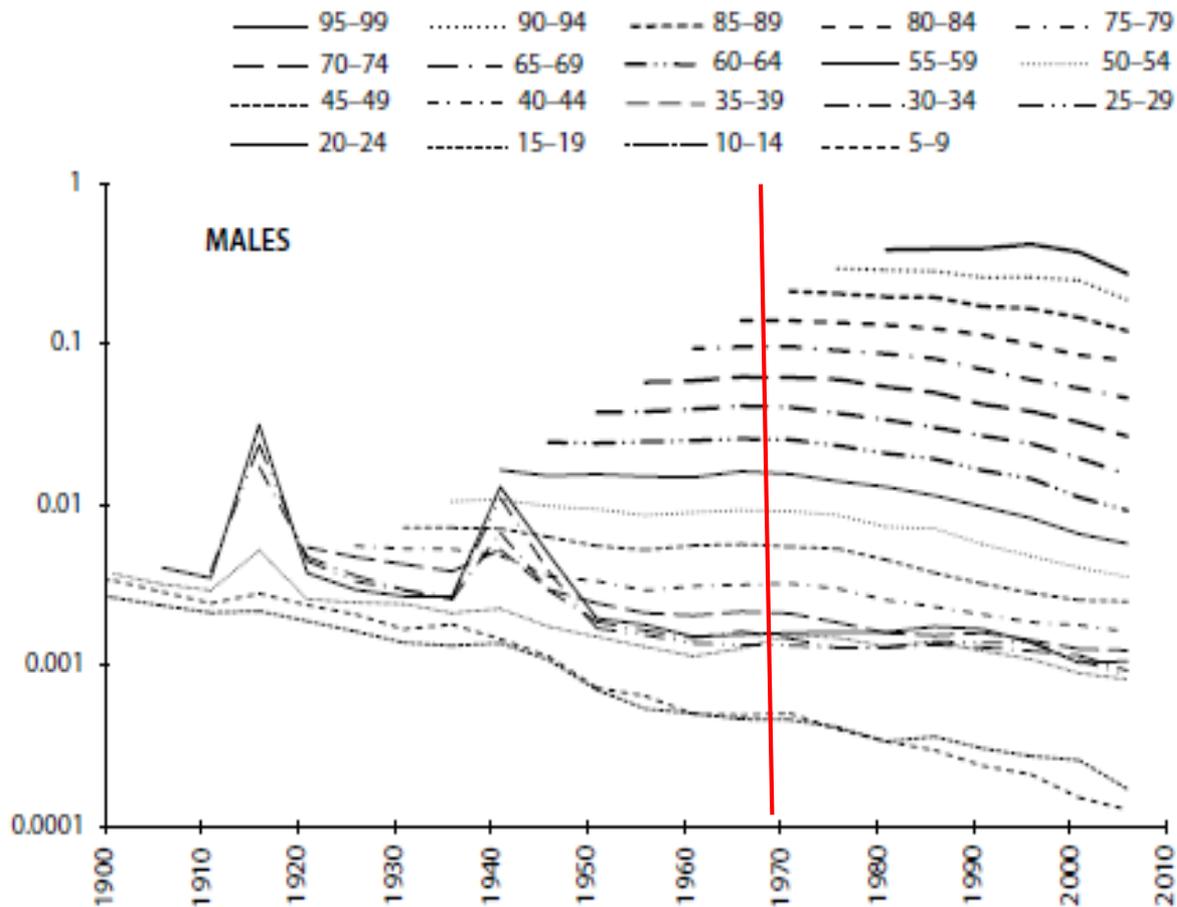
# Māori and non-Māori LE to 2010-12



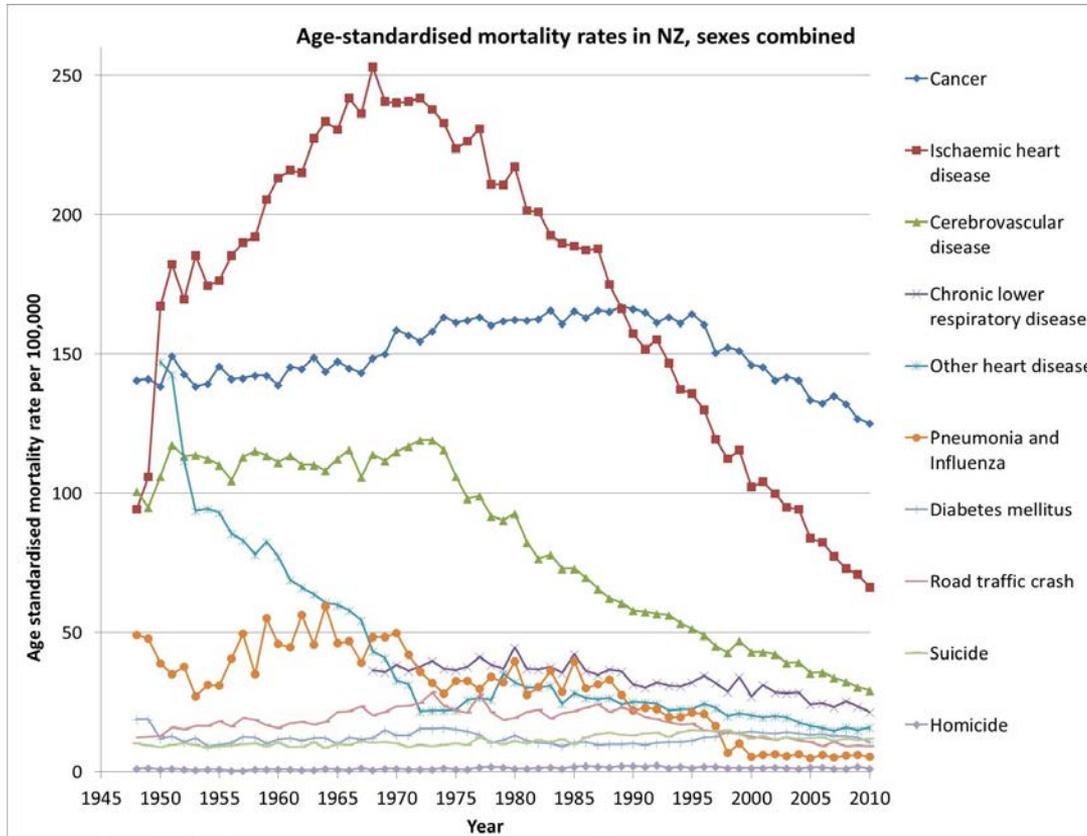
# Contribution to LE ↑ by age



# Older (NCD) mortality turned c.1970 (period effect)

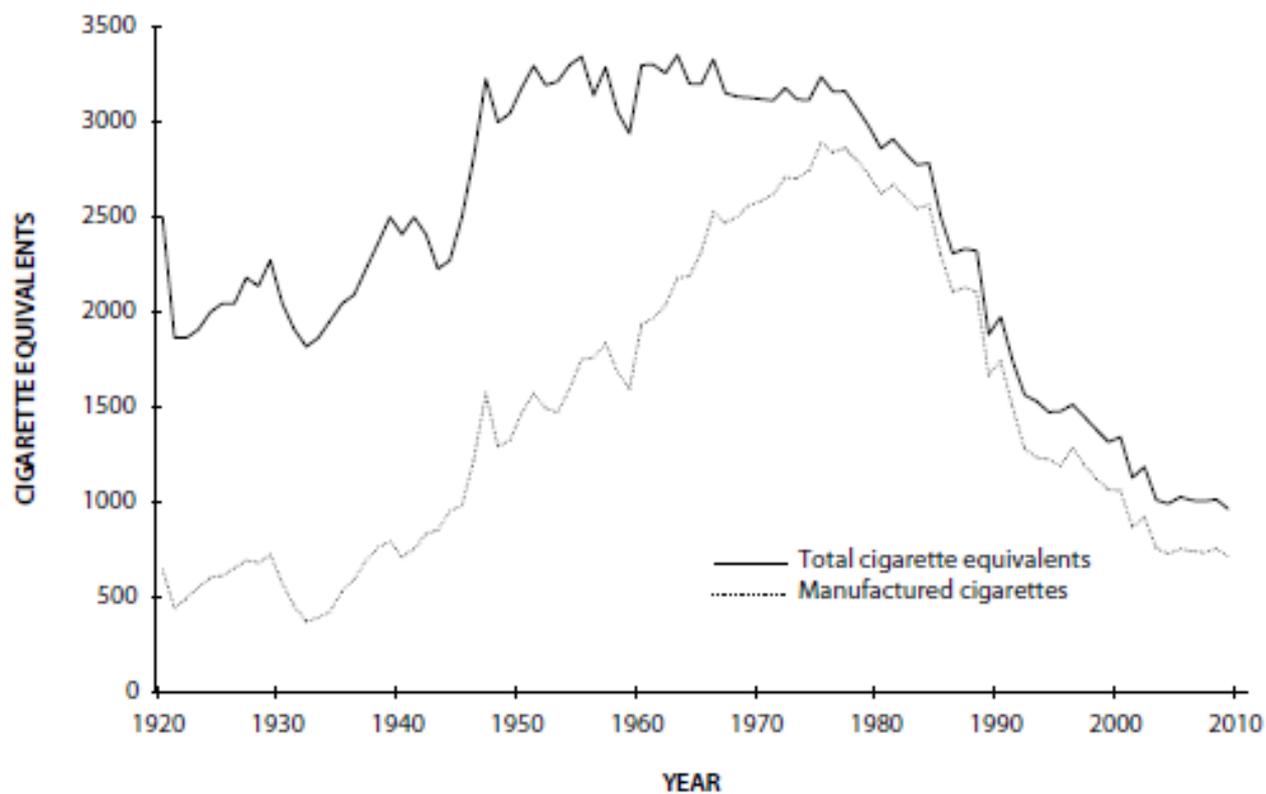


# Disease specific mortality over time



Source: Ministry of Health (2014).  
Historic mortality rates, 1948-2010.

# Tobacco



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OPEN

Epidemiology Publish Ahead of Print

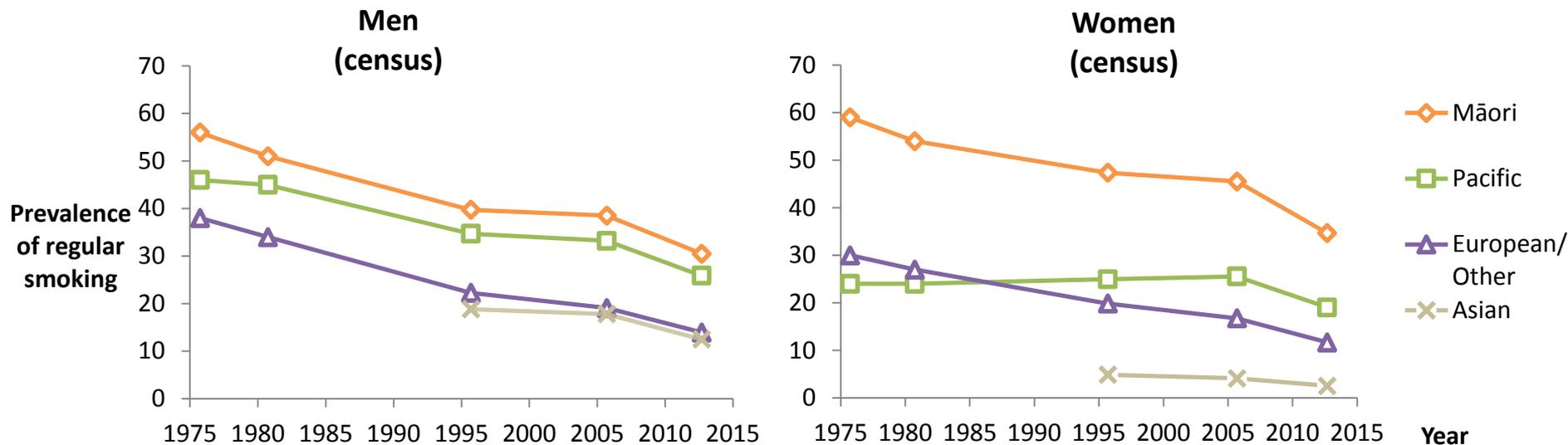
DOI: 10.1097/EDE.0000000000000842

Socio-economic and tobacco mediation of ethnic inequalities in mortality over time:

Repeated census-mortality cohort studies, 1981 to 2011

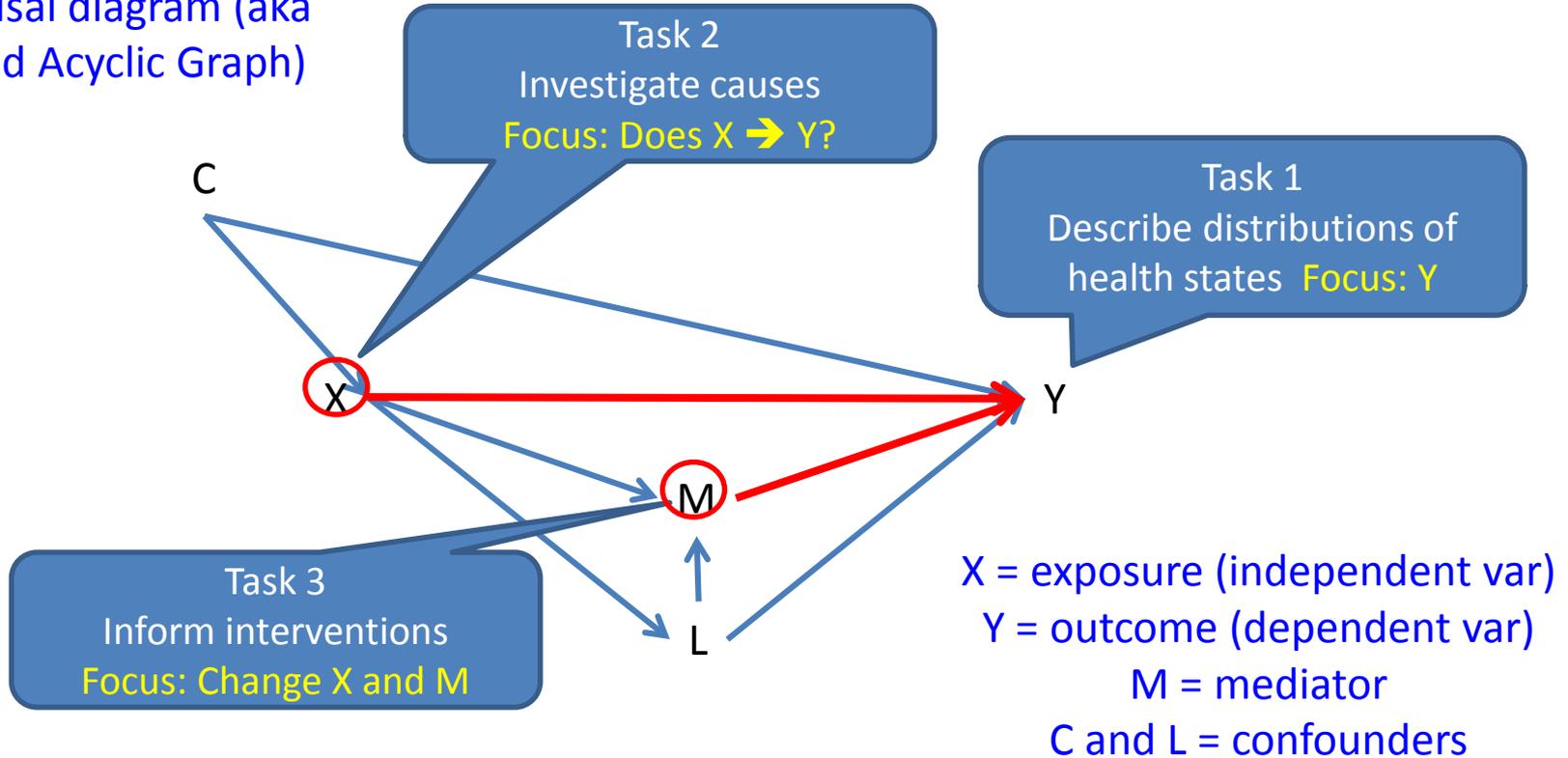
Tony Blakely\*<sup>1</sup>, George Disney<sup>1</sup>, Linda Valeri<sup>2</sup>, June Atkinson<sup>1</sup>, Andrea Teng<sup>1</sup>, Nick

# Smoking by ethnicity (census)



\*Current-smoking as measured by the census, unadjusted estimates

# The Tasks of Epidemiology in a causal diagram (aka Directed Acyclic Graph)



Slide courtesy of John Lynch

# Potential Outcomes Approach

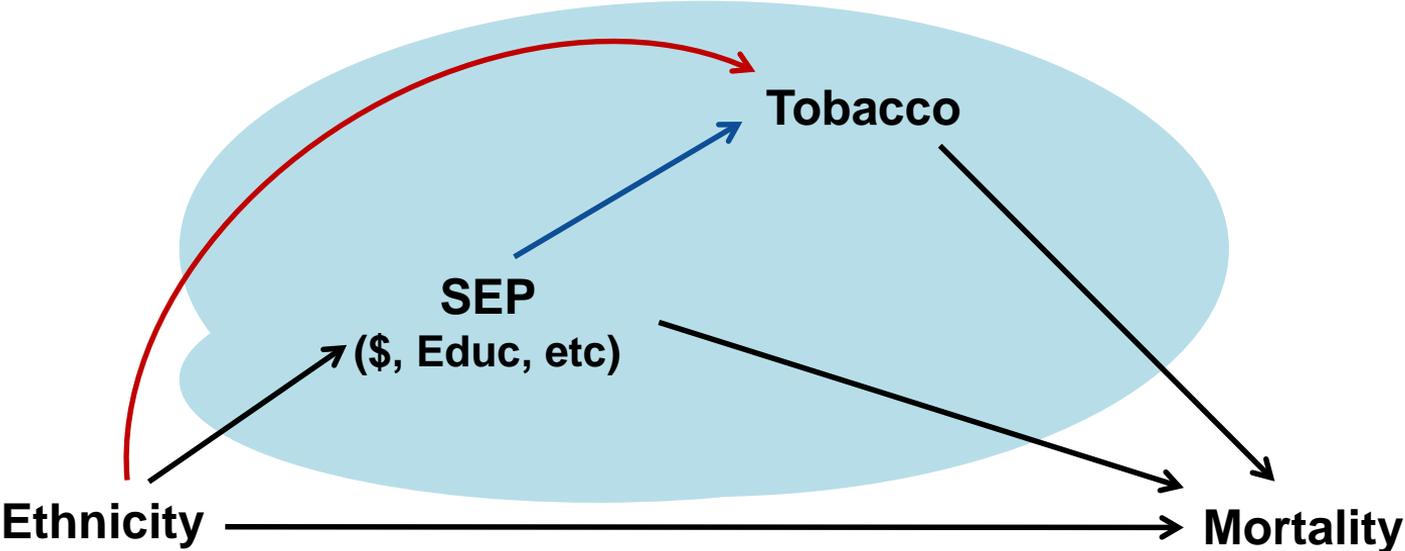
## What if ..... ?



Slide courtesy of John Lynch

*BetterStart*  
Child Health and Development  
Research Group

# Eth → SEP → tobacco → mortality



# Eth → SEP → tobacco → mortality

**RQ 1:** How much of the Māori:European/Other mortality inequality in NZ is mediated by:

1. Socio-economic position?
2. Socio-economic position and tobacco combined?
3. And does this amount of mediation change over time (1981-84, 1996-99, and 2006-11)?

Use natural direct and indirect effects

**Eth → SEP → tobacco → mortality**

**RQ 2:** If counter to fact New Zealand had been smoke free, how large would be Māori:European/Other inequalities?

**Use controlled direct effects**

# Mediation: natural effects

Let:

$a$  = Māori (i.e. exposed)

$a^*$  = European/Other (unexposed)

$m$  = values of mediator(s) (i.e. socio-economic position +/- tobacco) when exposed (i.e. 'naturally' occurring for a given individual when they are Māori)

$m^*$  = values of mediator(s) when unexposed (i.e. 'naturally' occurring for a given individual when they are European/Other)

# Mediation: natural effects

Then:

$E[Y_{aM}]$  = expected mortality (risk) for Māori with the mediators Māori have when they are Māori

- easy! Just the observed mortality among Māori

$E[Y_{a^*M^*}]$  = expected mortality (risk) for European/Other with the mediators Euro/Other have when they are Euro/Other

- easy! Just the observed mortality among European/Other

# Mediation: natural effects

$E[Y_{aM}]$  = expected mortality (risk) for Māori with the mediators Māori have when they are Māori

$E[Y_{a^*M^*}]$  = expected mortality (risk) for European/Other with the mediators Euro/Other have when they are Euro/Other

$E[Y_{aM^*}]$ , the expected mortality risk for Māori (a) with (counter to fact) mediators at the values expected had the person actually been European/Other ( $M^*$ )

- Eh what?

Miss Piggy is a pig-like Muppet character with blonde hair, wearing a black dress with a leopard print collar and a pearl necklace. She is smiling and has her hand near her face.

Kermie, that  
is a bit out of  
this world

Kermit the Frog is a green Muppet character with large white eyes, wearing a yellow collar. He is looking thoughtful with his hand to his chin.

No Miss Piggy,  
that is the cross-  
world assumption

# Mediation: natural effects

$E[Y_{aM}]$  = expected mortality (risk) for Māori with the mediators Māori have when they are Māori

$E[Y_{a^*M^*}]$  = expected mortality (risk) for European/Other with the mediators Euro/Other have when they are Euro/Other

$E[Y_{aM^*}]$ , the expected mortality risk for Māori (a) with (counter to fact) mediators at the values expected had the person actually been European/Other ( $M^*$ )

**This is the cross-world assumption**

# How do we estimate this ‘cross-world’ entity?

Number of ways, e.g.:

- Can be retrieved with parametric methods:
  - Regress mediator on exposure (and confounders)
  - Regress outcome on exposure and mediator (and confounders)
  - Do some algebra (and make a lot of assumptions)
- Can be directly estimated with predictive regression models (still with lots of assumptions) – what we will look at in a few slides

# How do we estimate $E[Y_{aM^*}]$ ?

Context: multiple mediators (some categorical, some continuous), binary exposure and outcome. Interactions (e.g. tobacco  $\rightarrow$  mortality RR vary by ethnicity strongly)

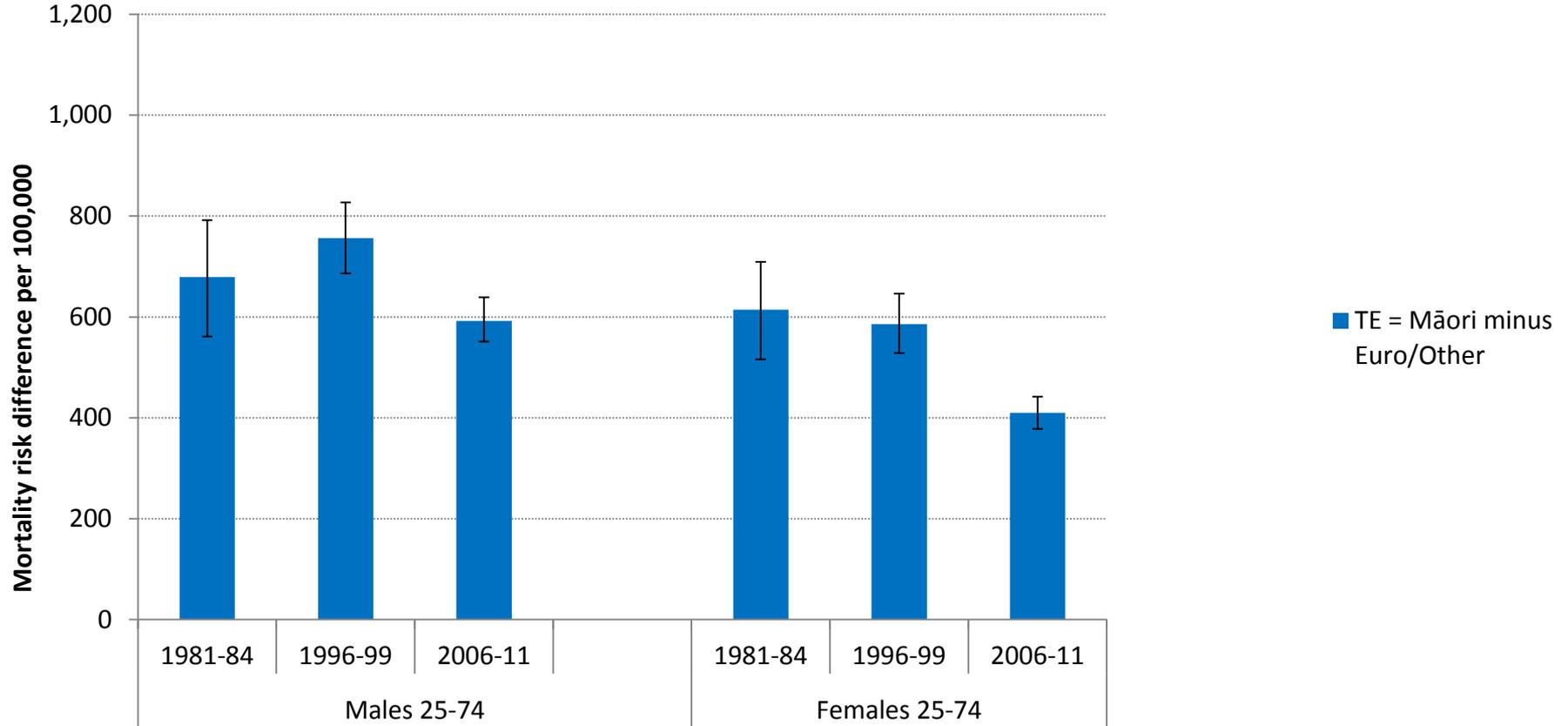
Solution:

1. Select logistic regression model to predict mortality, rich with interactions of exposures, mediators and confounders.
2. For 'best' model, simply change the ethnicity code from '0' to '1' among European/Other, and predict each European/Others expected 'potential outcome' had they been Māori (i.e.  $E[Y_{aM^*}]$ )
3. Use IPTWs to adjust for confounding, and compare and contrast  $E[Y_{aM}]$ ,  $E[Y_{a^*M^*}]$  and  $E[Y_{aM^*}]$  to generate TE, NDE, NIE, % mediated. **Easy!** (sort of – Ed)

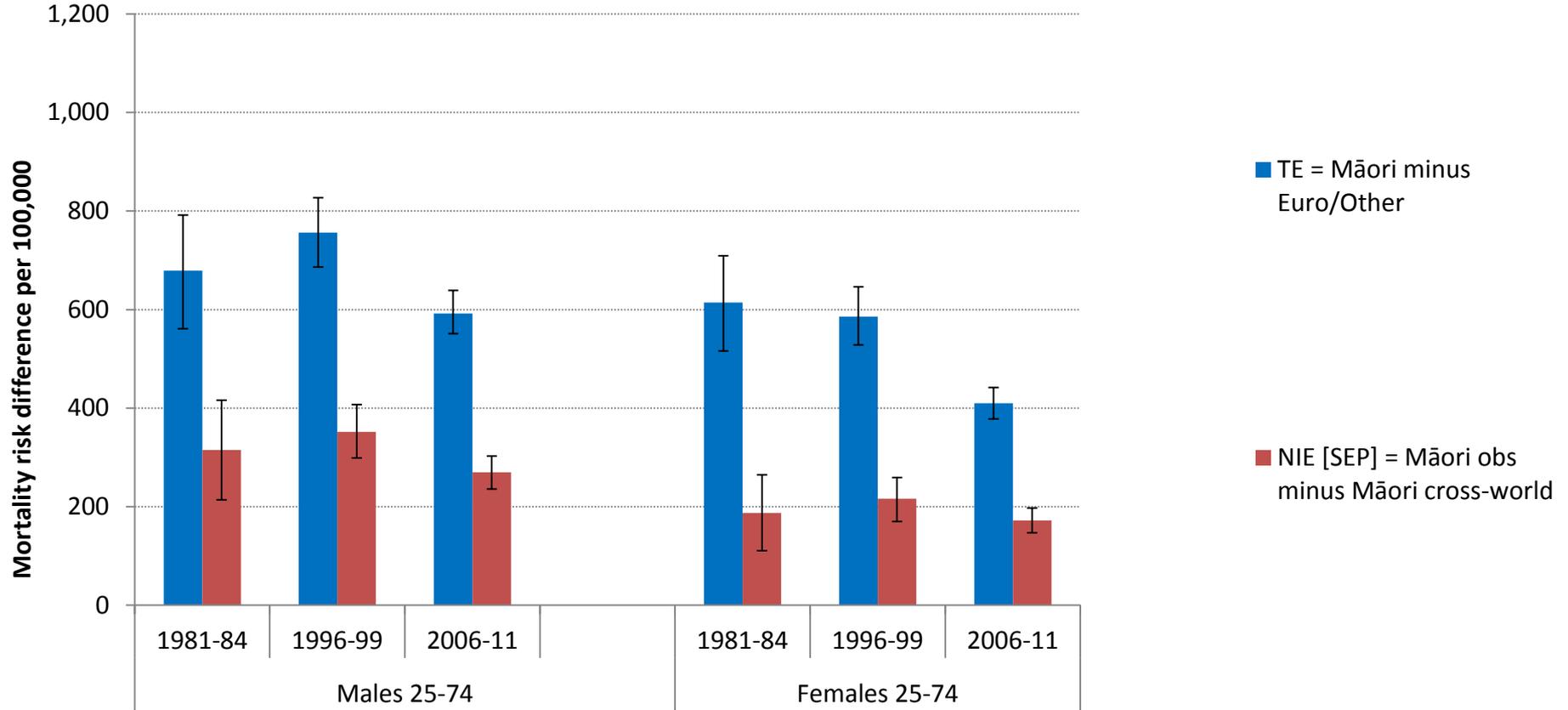
# Variables

- Exposure:
  - Ethnicity = dichotomous, Māori vs Euro/Other
- Confounders:
  - Age = categorical in 5 yr age groups (centred on 60-64)
- Mediators 1:
  - Education = cat; Ln(\$\$) = centred; Neigh Dep = centred; LFS = cat;
- Mediators 2:
  - Smoking = cat (never, current, ex)

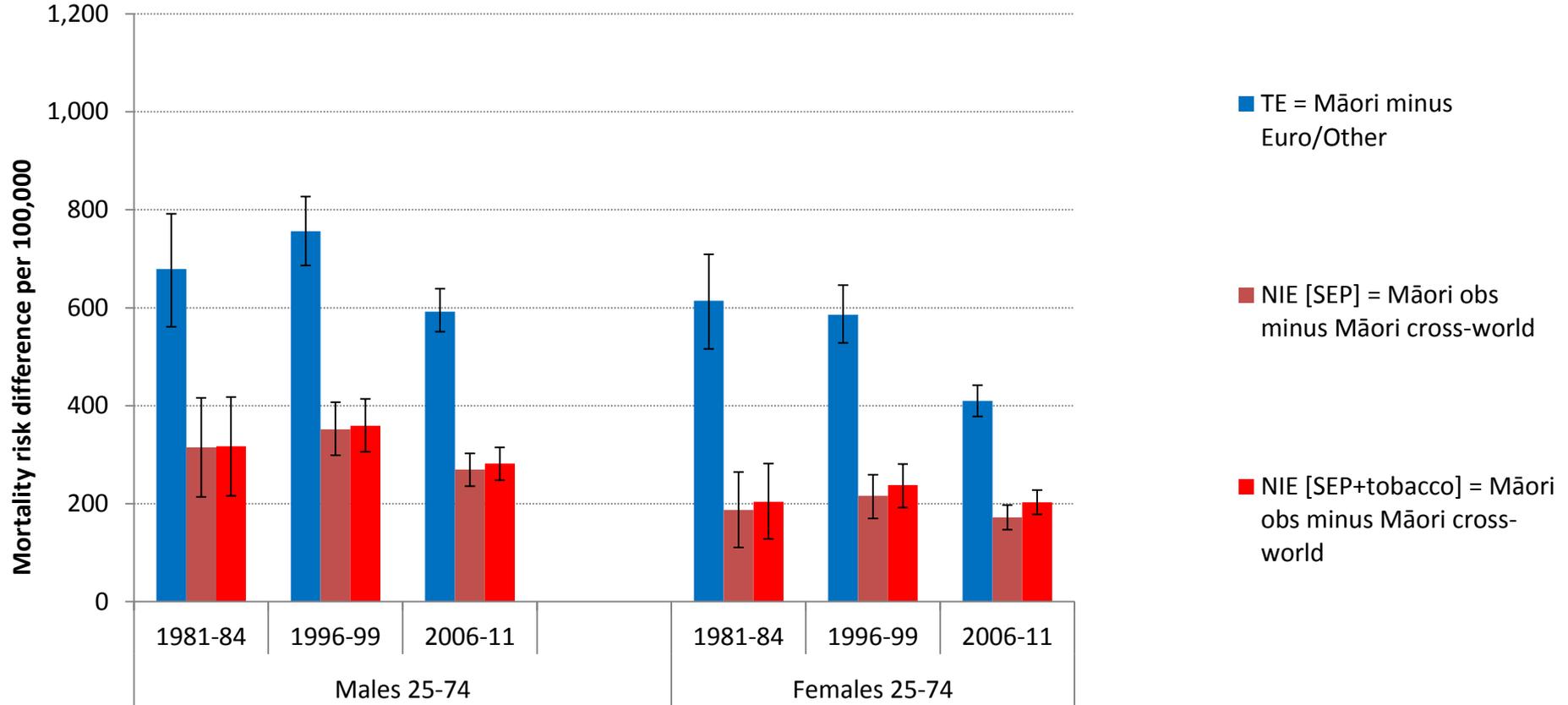
# Total effect, NIE and % mediated



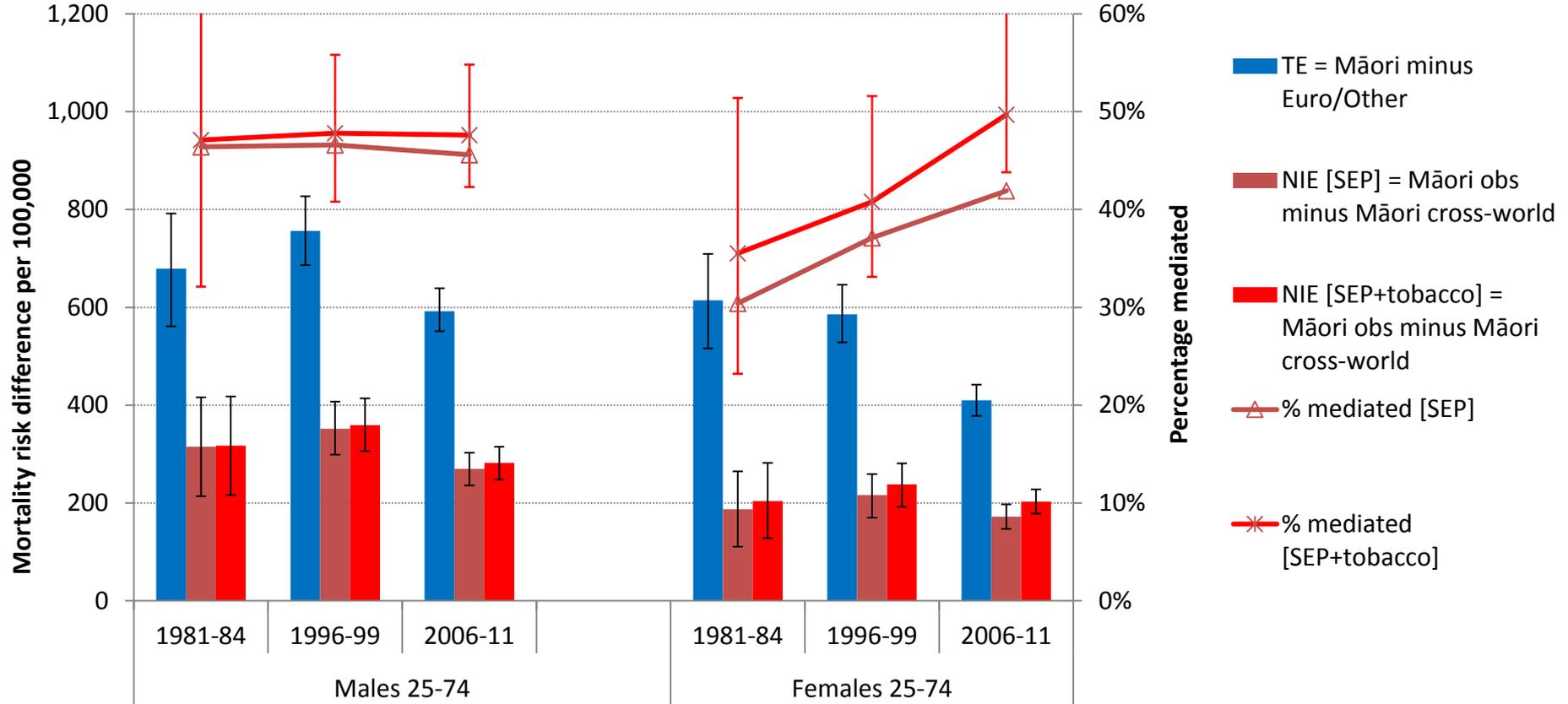
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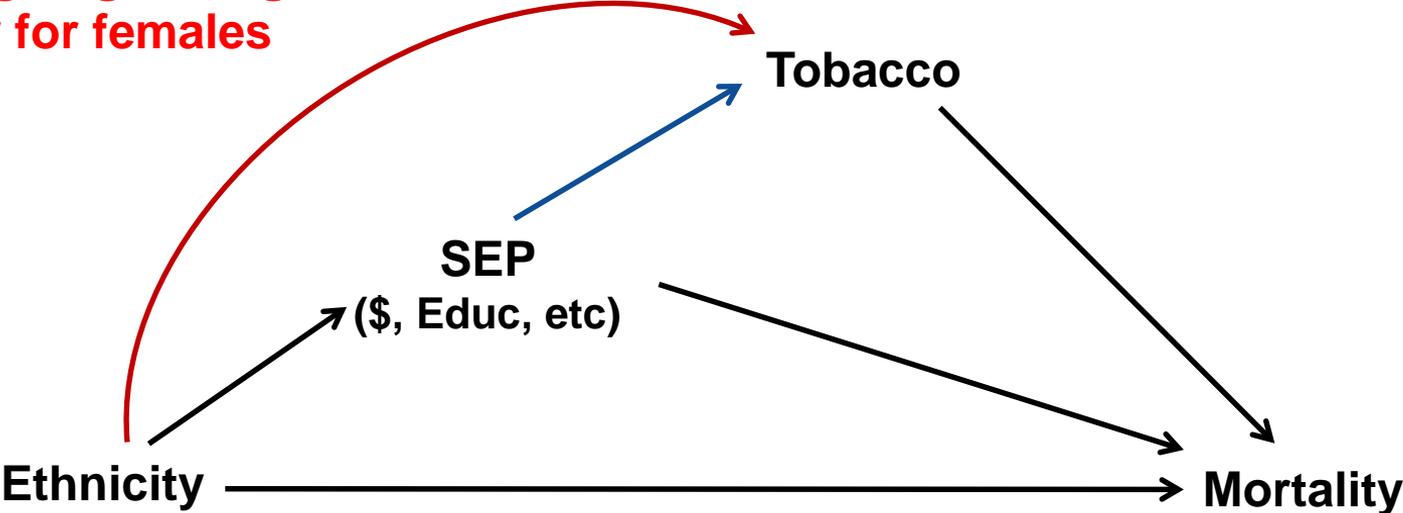


# Total effect, NIE and % mediated



# Eth → SEP → tobacco → mortality

More is going through red pathway for females



# Research Question 2

**RQ 2:** If counter to fact New Zealand had been smoke free, how large would be Māori:European/Other inequalities?

Use controlled direct effects

# Mediation: controlled direct effect

$E[Y_{aM}]$  = expected mortality (risk) for Māori with the mediators Māori have when they are Māori

$E[Y_{a^*M^*}]$  = expected mortality (risk) for European/Other with the mediators Euro/Other have when they are Euro/Other

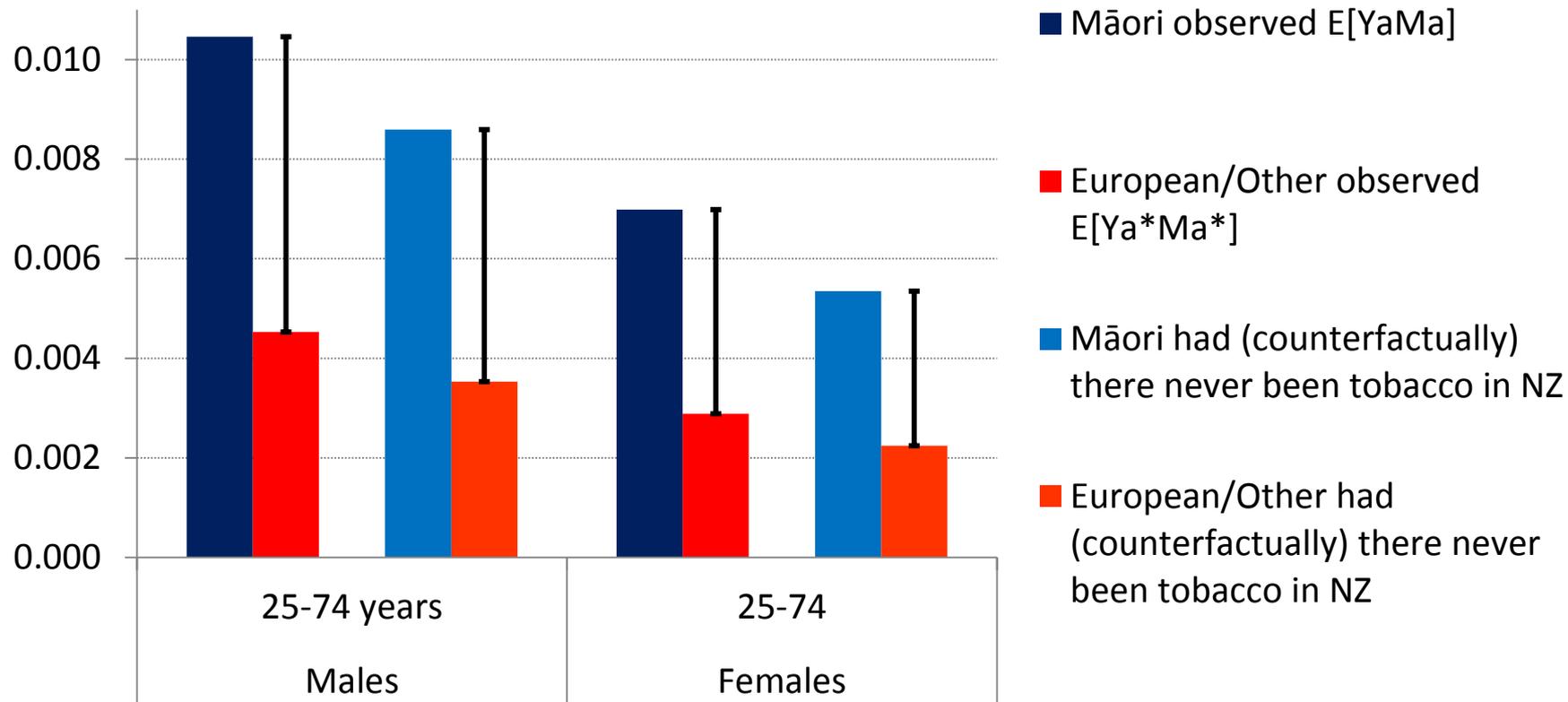
$E[Y_{aM_2=m}]$  and  $E[Y_{a^*M_2=m}]$ , the expected mortality risk for Māori (a) and European/Other with (counter to fact) tobacco ( $M_2$ ) set as 'never' for everyone

**This is an estimate of mortality in NZ had tobacco never arrived**

# Observed and counterfactual (NZ smoke free)

[Blakely et al, Epidemiology 2018]

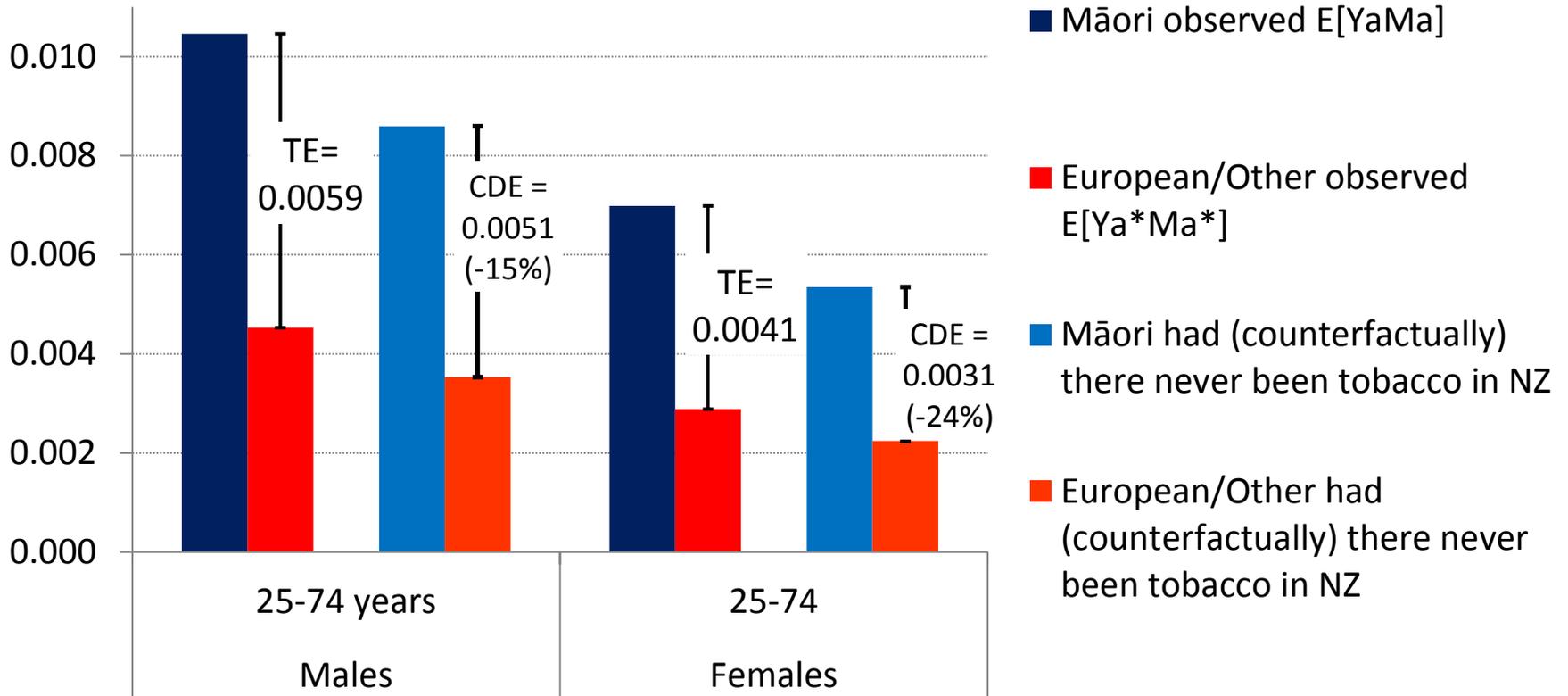
25-74 year olds 2006-11, by sex



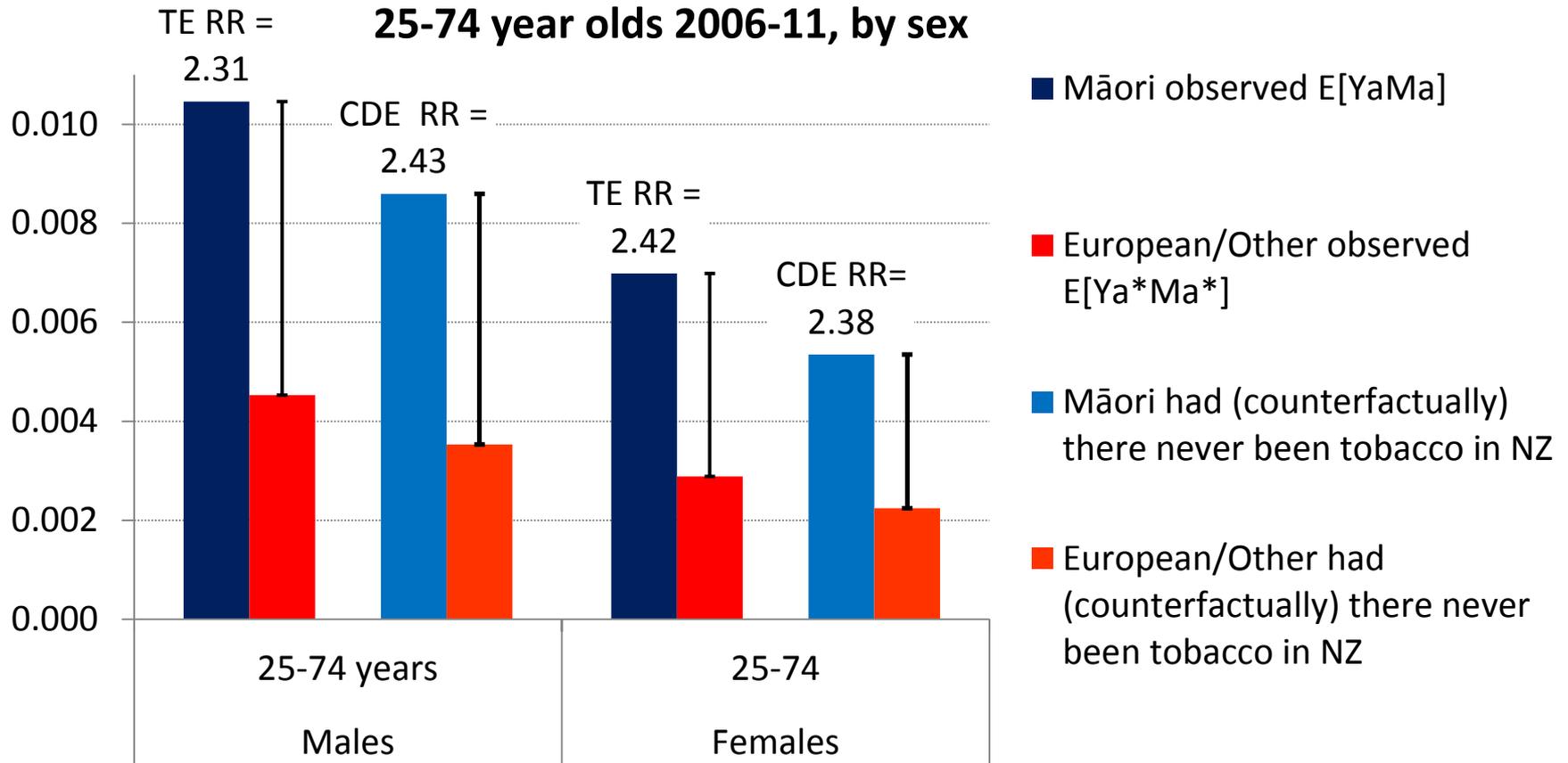
# Obs and counterfactual; absolute TE and CDE

[Blakely et al, Epidemiology 2018]

25-74 year olds 2006-11, by sex



# Obs and counterfactual; relative TE and CDE (*not much change*) [Blakely et al, Epidemiology 2018]



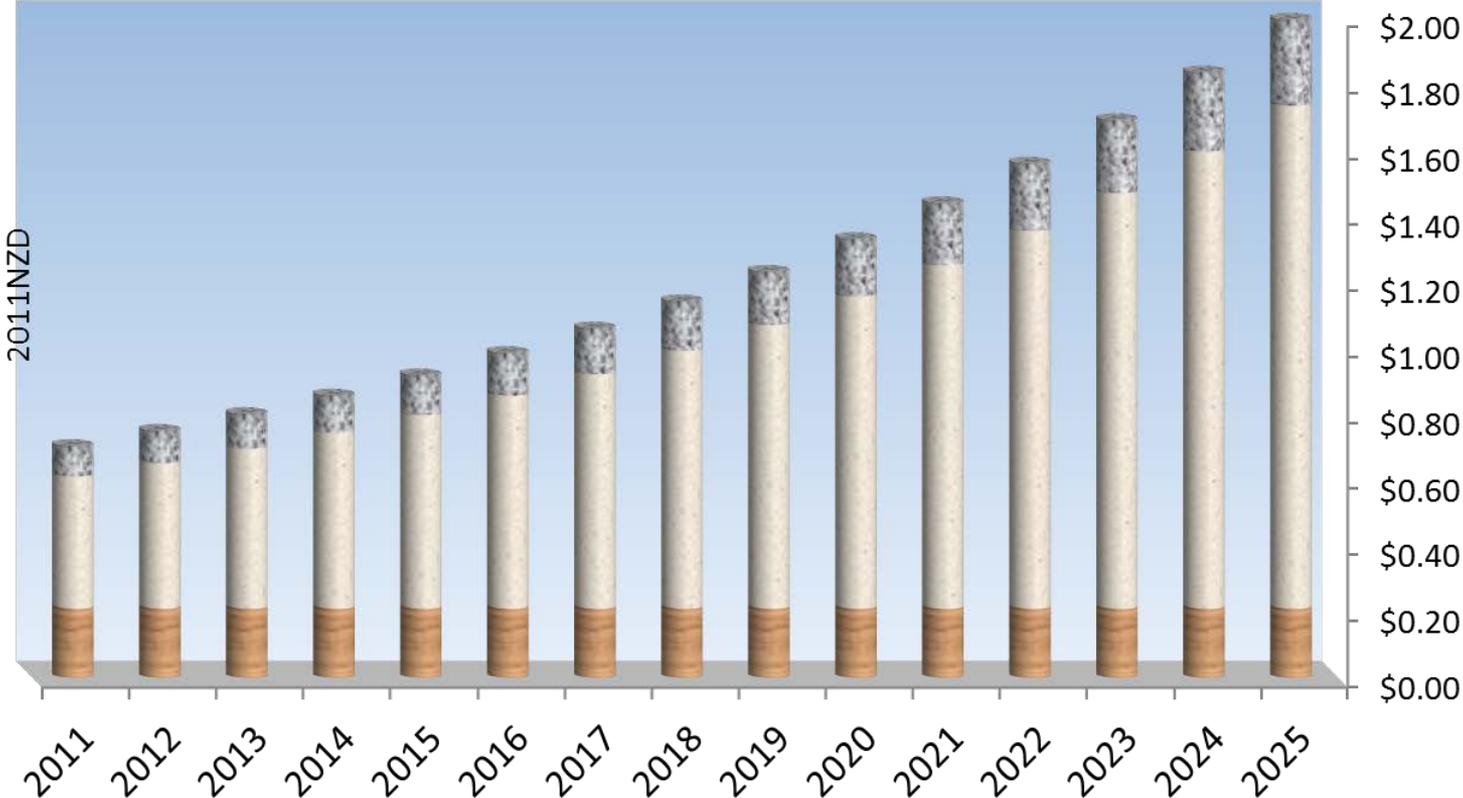
# The past 30 to 40 years - Summary

1. Epidemiology is increasingly using counterfactual and 'potential outcomes approaches' that increase internal validity and speak more to policy relevance
2. Unsurprisingly, socio-economic position and tobacco explain much of ethnic inequalities – but with nuances:
  - Empirically about half of inequalities are due to socio-economic position, but due to measurement error that proportion is likely to be more than 2/3rds
  - Colonisation and other social forces are 'behind' these mediation explanations
  - Eradicating tobacco will improve everyone's mortality risk, and lower absolute inequalities in mortality... but probably not change relative inequalities in health. Is that good enough?
3. Modelling in our BODE<sup>3</sup> programme so far is consistent with population wide interventions that lower risk factors (e.g. sodium or sugar in food chain) having 'good' health inequality reduction impacts.

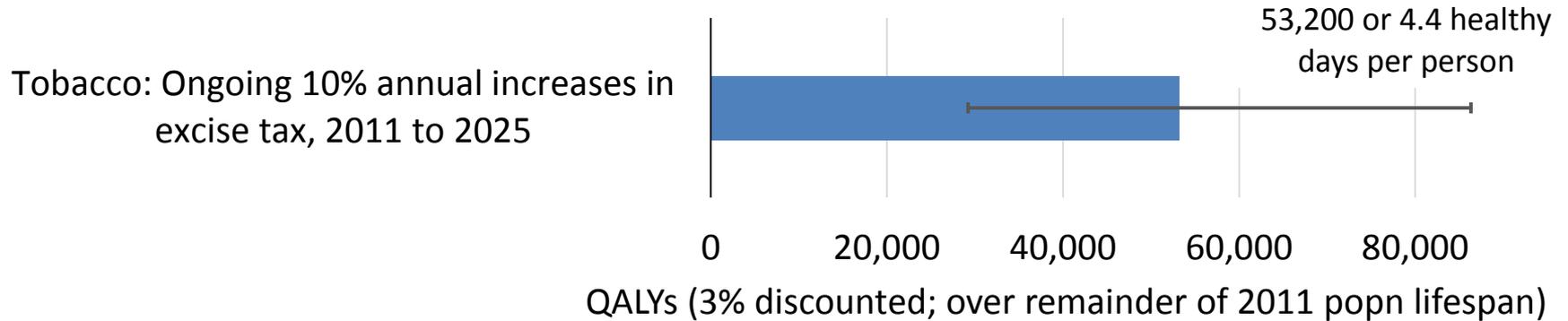
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3. **The future = an example of epidemiological simulation of future health:**
  - **Tobacco tax, salt interventions, and more....**

# Vignette: 10% tobacco tax increases 2011-25

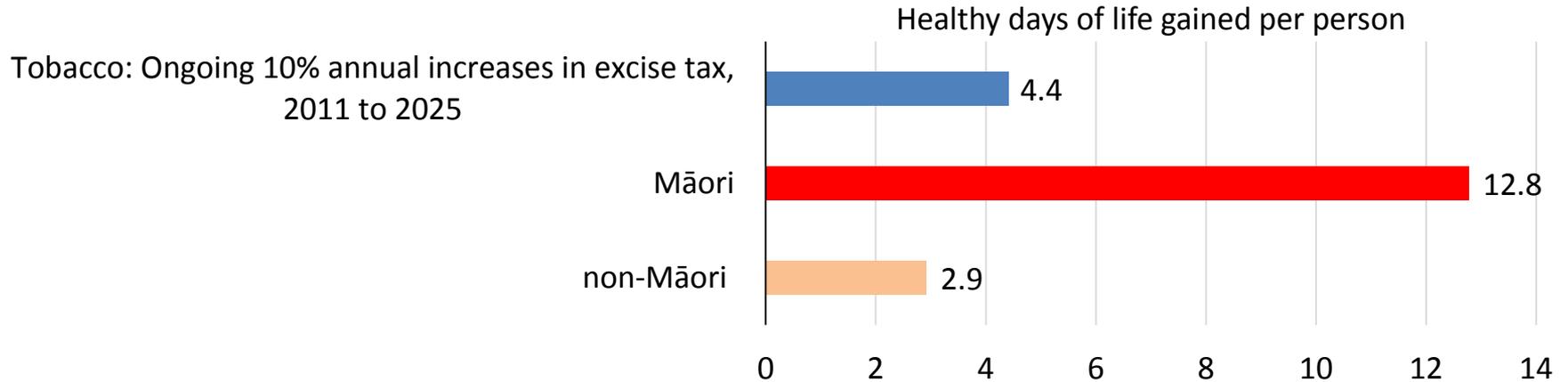


# Vignette 1: 10% tobacco tax increases 2011-25



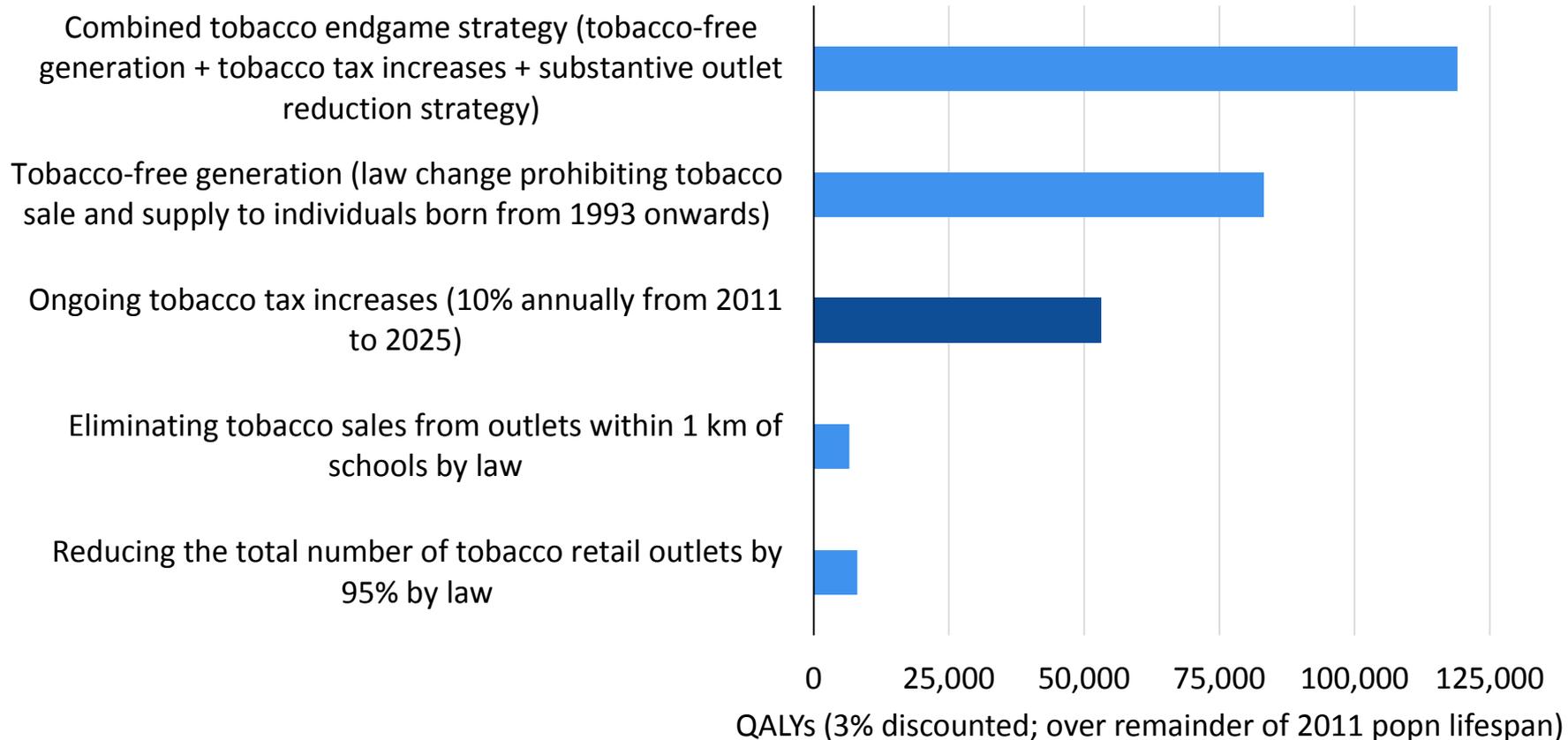
This is about 15% of all health gain had we eradicated tobacco in 2011 – which is pretty good

# Vignette 1: 10% tobacco tax increases 2011-25

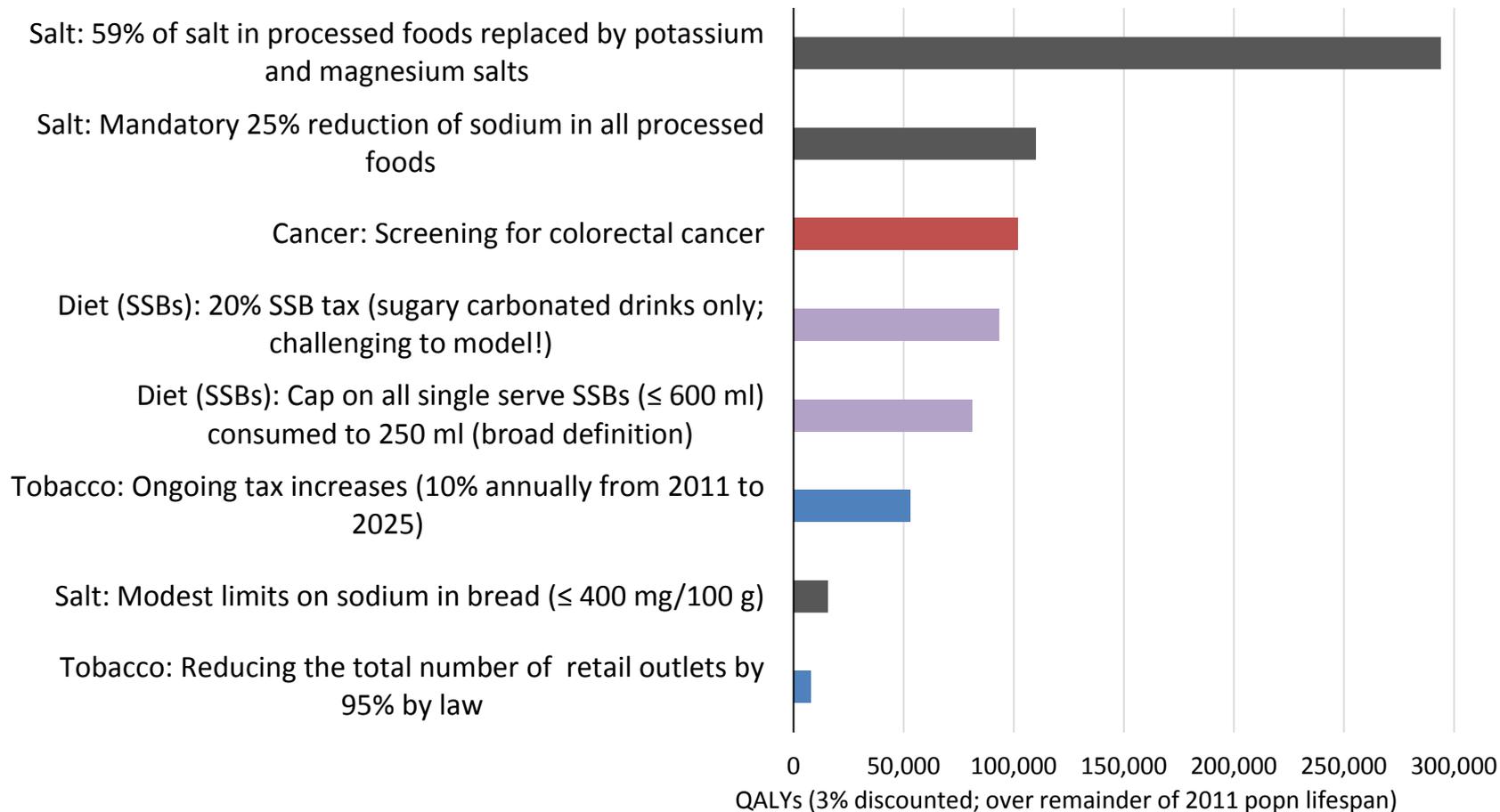


Gains much more per capita for Māori

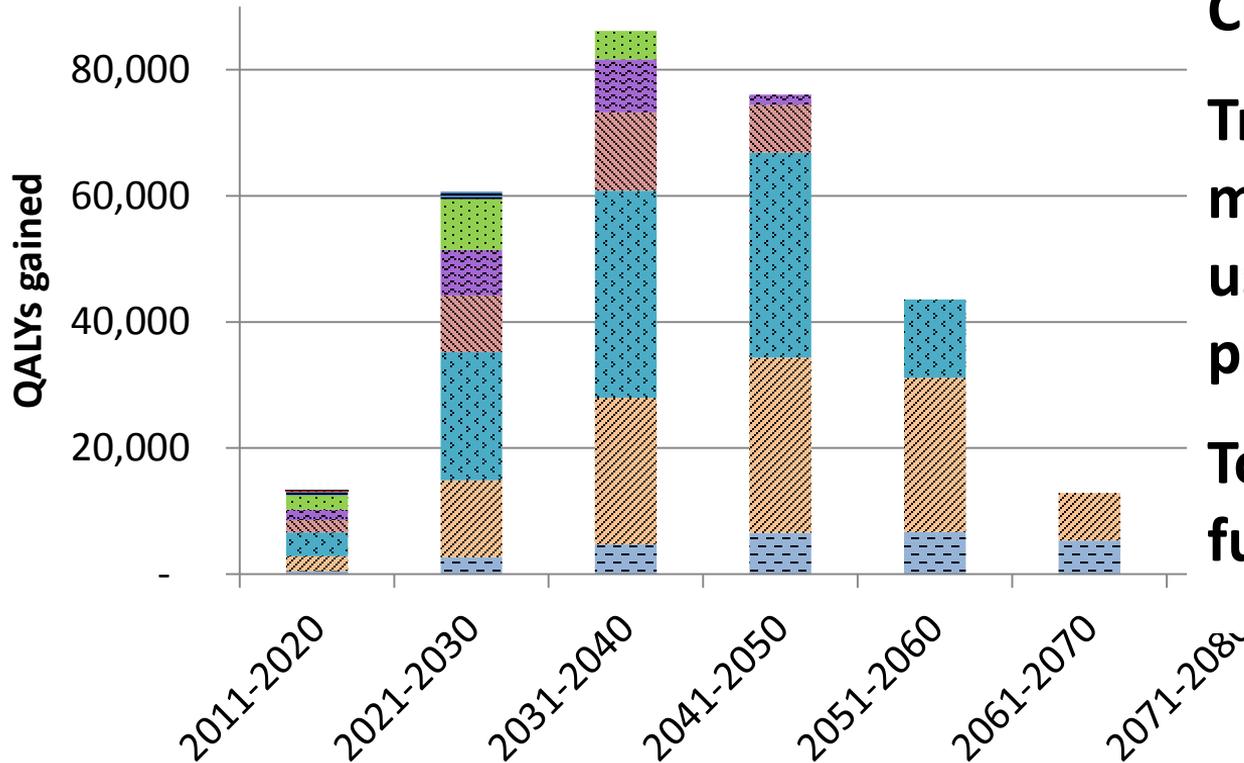
# Tax compared to other tobacco interventions: QALYs



# And comparing across domains....



# How soon do we get these health gains? Example of salt substitution (NaCl for KCl)



**CRC screening earlier**

**Treatments usually much earlier (but usually smaller than prevention)**

**Tobacco control maybe further into future**

# The future – Summary so far!

1. There are large potential health gains to be realized through prevention.
2. Moreover, if interventions are population wide they are usually going to gain more health gain per capita for Maori – lessening absolute inequalities
  - But may or may not lessen relative inequalities
3. These health gains, however:
  - Often take decades to materialize
  - Will be more concentrated among older ages (it is where – in black and white life expectancy and HALY terms – the gains are to be had)

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