



Brief Report: Trends in Health Economic Analysis and Evidence for the Impact of BODE³ Work on Epidemiological Modelling and Health Economics in Aotearoa New Zealand (up to 30 March 2021)

Prof Nick Wilson, Dr Nhung Nghiem

BODE³ Programme

University of Otago, Wellington

March 2021

Abstract

In this Brief Report we performed literature searches to identify trends in health economic analysis in Aotearoa New Zealand (NZ). We also searched for evidence for the impact of BODE³ Programme work on epidemiological modelling and health economics on policy-making processes and policy-maker thinking in NZ.

The numbers of published health economic analyses were found to have increased over time, with BODE³ work clearly contributing to this favourable trend. Based on citations and other evidence, BODE³ work appears to have had some impact in the domains of tobacco control, colorectal cancer screening, cancer control interventions in general, league tables of health interventions, and COVID-19 control. However, there have been other domains where there has yet to be clear evidence for use of BODE³ work in policy processes (albeit much of this work was still cited in work by other NZ researchers and international researchers). Some reasons for the lack of uptake are obvious eg, some modelled interventions were very hypothetical or would be politically contested such as food/sugar/alcohol tax increases. But for other interventions that would probably not be controversial (eg, improved access to medicines or vaccinations), the lack of uptake might have been due to limited health sector capacity and competing government priorities in non-health domains. Ultimately however, there is still much scope for further progress in NZ with epidemiological and health economic modelling. This can potentially make more efficient use of scarce health sector resources and also further maximise health gain and reduce health inequalities.

Introduction

When considering available interventions, policy-makers in the health sector should ideally have evidence on such issues as likely health gain and its impact on health inequalities, costs/cost-savings, and cost-effectiveness. These are important health economic related factors, although many other considerations apply to decision-making (eg, public and political acceptability of an intervention). In Aotearoa New Zealand (NZ), the use of health economics is well embedded in the decision-making of PHARMAC (albeit a completely in-house process with this government agency). But its use in other NZ government agencies at the central or DHB level is less routine and has waned at particular times (eg, with the end of the National Health Committee).

One of the goals of the BODE³ Programme (funded by the Health Research Council [HRC] and Ministry of Business, Innovation and Employment [MBIE]) was to raise the profile of epidemiological modelling and health economic thinking in the NZ setting and to better inform decision-making processes in the health sector. Some specific elements of this work have included the following:

- Establishing a methodologically compatible league table of health interventions for Australia and NZ.¹
- Having Māori vs non-Māori results for most analyses of interventions and consideration of the methodological aspects around this.²
- Producing online resources, including cost-effectiveness calculators.³
- Considering historical cost-effectiveness studies in NZ.⁴
- Comparing a whole spectrum of interventions within a disease category such as cancer (ranging from primary prevention, screening, treatment, to palliative care).⁵
- Exploring how uncertainty in results for health interventions changes after there is improvements in knowledge around key parameters (eg, dietary counselling⁶ and for tobacco control⁷).
- Regularly running summer school courses in health economic issues and health economic modelling.
- Training of medical students, masters and PhD candidates as well as upskilling BODE³ team members.
- Presenting results at conferences and doing presentations to government agencies.
- Engaging with the media (and via scholarly blogs eg, “Public Health Expert”) to raise health economic and disease modelling issues.

Given this background, this Brief Report aimed to briefly consider trends in NZ in the use of health economic analyses and to consider if there were identifiable impacts of the BODE³ Programme of work on policy-making and the work of other NZ and international researchers.

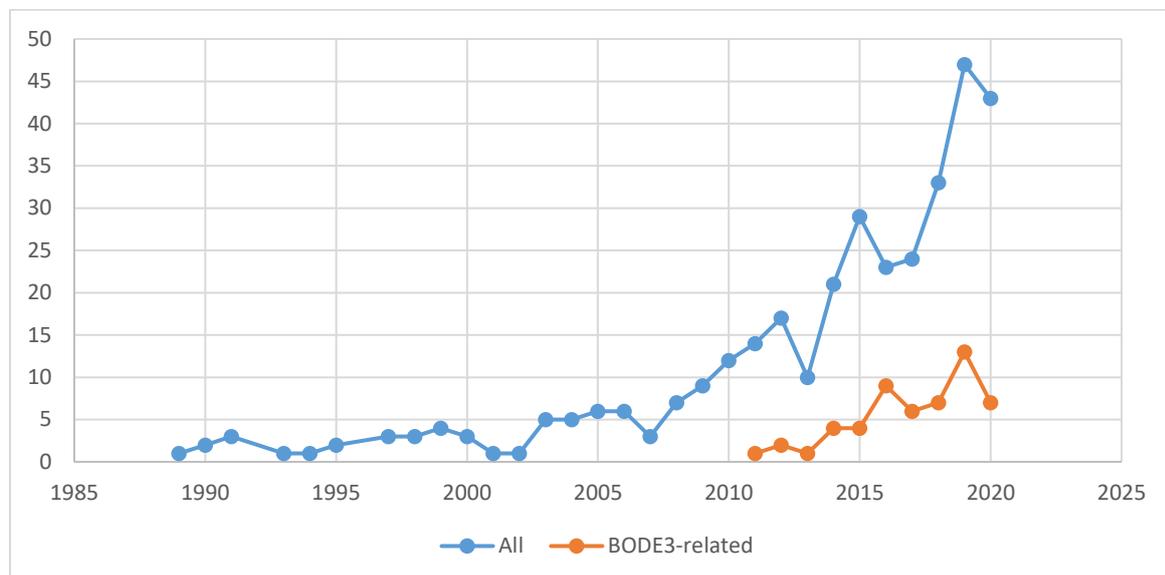
Methods

A range of literature searches were undertaken using PubMed and with health economic search terms on 3 March 2021. These searches were also focused on NZ-specific literature. The specific search terms used are detailed in the footnotes to the relevant graphs below. Google Scholar was also used to identify information on NZ central government websites eg, to identify specific regulatory impact statements. Case studies around specific aspects of BODE³ work were also performed.

Results – General trends in NZ in health economic thinking and analysis

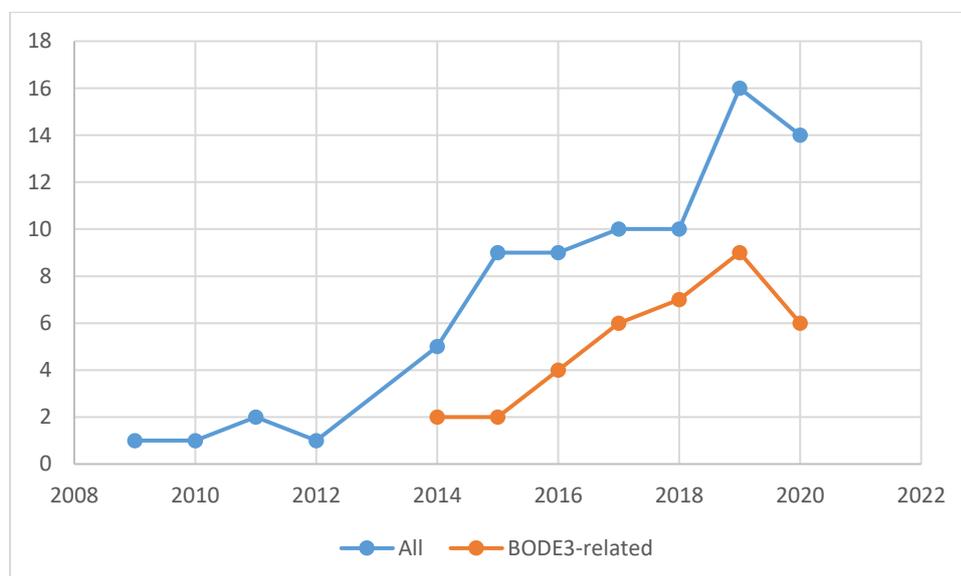
There has been an increase in peer-reviewed publications in the journal literature relating to NZ that uses the health economic measures of quality-adjusted life years (QALYs) or health-adjusted life years (HALYs) (Figure 1). BODE³ outputs have clearly contributed to this increase (Figure 1). In particular, BODE³ work (Figure 2) has contributed to considerations around uncertainty in the modelling results (at least based on inclusion of the word “uncertainty” in titles and abstracts of the published work).

Figure 1: Numbers of peer-reviewed publications in PubMed for the search term “Zealand and (QALYs or HALYs)” with the BODE³ related ones including one of the senior BODE³ authors “Blakely T” or “Wilson N”* (1989 to 2020)



* The great majority of BODE³ publications have the name of at least one of these two senior authors. But this approach is somewhat simplistic and may slightly underestimate the BODE³ contribution. Also of note is that some of these publications in the “All” category involve multiple countries, where NZ data is just one part of the analysis. In contrast, BODE³ work was just focused on NZ.

Figure 2: Numbers of peer-reviewed publications in PubMed for the search terms “Zealand” and “(QALYs or HALYs)” and “uncertainty” with the BODE³ related ones including one of the authors “Blakely T” or “Wilson N” (2009 [date of the first identified publication], to 2020)



Results – Case studies of potential BODE³ impact in specific domains

The table below (Table 1), details some of the key areas of BODE³ work and an assessment of its use in NZ policy-making and its citation by other NZ research teams. In summary, it

would appear that there has been some impact in the domains of tobacco control, colorectal cancer screening, cancer control interventions in general, league tables of health interventions, and COVID-19 pandemic control. However, there have been other domains where there was no clear evidence for use in policy processes identified (albeit much of this work was still cited in work by other NZ researchers). These domains covered HPV vaccination, cancer care coordinators, dietary interventions (including sodium and BMI), falls prevention, vaping/e-cigarettes, cardiovascular disease management, disease costing, and physical activity interventions.

Table 1: Evidence for impacts of BODE³ epidemiological modelling and health economic work in NZ policy-making or NZ-related research work (as identified in Google Scholar and specific agency website searches as per 3 March 2021)

Health domain	Study/studies	Actual or potential use in NZ policy-making processes	Total citations and those by other (non-BODE ³) research teams in NZ
<i>Some evidence of impact on policy-making and policy-makers</i>			
Tobacco control	Blakely et al 2015 ⁸	This study and related tobacco tax-related work was shared with the Ministry of Health (MoH) (who requested additional information) and BODE ³ presented on it to the Treasury. It may have strengthened the NZ Government's case for the Customs and Excise Act to be amended in 2016 to legislate annual increases in tobacco excise of 10 percent (the last one being in 2020). Related BODE ³ tobacco tax work ⁹ has been cited in a Parliamentary Service research brief. ¹⁰ Of note is that the BODE ³ Tobacco Model/E-cigarette model has been shared with the University of Melbourne and the University of Toronto, Canada.	N=114; Three NZ related: McCool & Bullen 2016; Laugesen & Grace 2016; Walsh & Wright 2020.
	Van der Deen et al 2018 ¹¹	Aspects of this tobacco endgame work have been used in a meeting with the Associate Minister of Health (Hon Dr Ayesha Verrall) in 2021 to consider a Tobacco Control Plan (especially retail reduction interventions).	N=58; Six NZ related: Rychert 2017; Signal et al 2020; Tomintz et al 2018; Marsh et al 2020; Sarfati & Jackson 2020; Edwards 2020.
	Un-published advice	The working relationship with the MoH on tobacco issues contributed to input into the process around successfully developing regulations for smokefree cars (eg, BODE ³ Researcher Wilson in 2018 in a Regulatory Impact Statement ¹²).	Not applicable.
Colorectal cancer screening	McLeod et al 2017 ¹³	There was close liaison between BODE ³ and the MoH which impacted programme design (regarding age-groups, ethnic inequalities and cost-effectiveness). The impact of BODE ³ work was detailed in a publication led by a MoH author: O'Hallahan et al 2020. ¹⁴	N=18 citations in total; Four NZ related: Gurney et al 2019; Gurney et al 2020; Sandiford et al 2018; Donachie et al 2021.
League table for health interventions	University of Otago & University of Melbourne 2019 ¹	Referred to by Te Aho o Te Kahu, the new Cancer Control Agency. ¹⁵ However, this online league table is not referred to by any other government agencies despite 5+ presentations to such agencies and it being referenced in many BODE ³ publications	N=5 (for ANZ-HILT); Nil NZ related

Health domain	Study/ studies	Actual or potential use in NZ policy-making processes	Total citations and those by other (non-BODE ³) research teams in NZ
		(eg, ⁴). Nevertheless, the key article describing this work is however, still in the publication process as of March 2021.	
COVID-19 pandemic control	Wilson et al 2020 ¹⁶	This Report was commissioned by the MoH and published on the MoH website. It was used to inform initial major decision-making regarding moving up Alert Levels by the Prime Minister and Cabinet in March 2020. Other COVID-related modelling work during 2020/2021 may have contributed to considerations around community testing strategies, ¹⁷ approaches to regaining elimination after outbreaks, ¹⁸ and mask requirements. ¹⁹ However, discussions have also been informed via scholarly blogs and media engagement.	N=11; Two NZ related: Gibson 2020; Hewitt 2021.
Cancer control interventions (selected)	Wilson et al 2021 ⁵	In regard to this league table of BODE ³ cancer control interventions, there was a favourable editorial written by authors at Te Aho o Te Kahu, Cancer Control Agency. ²⁰ Meetings were held between BODE ³ and this cancer control team. Of note is that the BODE ³ Physical Activity model has been shared with another UoO team (PI: Melissa McLeod), which may lead to future policy contributions.	No citations (only published in 2021)
No clear evidence of impact on policy-making (selected domains)			
Human papilloma virus (HPV) infection	Blakely et al 2014 ²¹	Nil identified. Nevertheless, there were discussions between BODE ³ and the MoH and there was subsequent expansion of HPV vaccination to cover boys, suggestive that the government was comfortable with the likely effectiveness and cost-effectiveness of this vaccination – though more critically, PHARMAC had also assessed these as well as BODE ³ . The only related background work by BODE ³ on HPV ²² is referred to in the MoH's Immunisation Handbook (2020 edition) and there is nothing on cost-effectiveness.	N=34 citations in total; Four NZ related citations: Oliphant et al 2017; Smith et al 2018 (Australian team studying NZ data on contract to MoH); Baker et al 2015 (Report); Light 2016 (Masters thesis).
	Pearson et al 2014 ²³	As directly above.	N=47 citations in total; Nil NZ related
Cancer care coordinators (selected)	Blakely et al 2015 ²⁴	It is possible that this BODE ³ work strengthened government commitment to funding such workers but there is no clear evidence for this. Only background work by BODE ³ ²⁵ was cited in a MoH commissioned report. ²⁶	N=12; One NZ related: O'Brien 2017.
Sodium (dietary salt) – selected	Nghiem et al ²⁷	Nil identified, despite new dietary guidelines for NZ published in 2020. ²⁸	N=65 (including in 5 systematic reviews); One NZ related: Lofthouse et al 2016.
	Nghiem et al 2016 ²⁹	As directly above	N=33; Nil NZ related.

Health domain	Study/ studies	Actual or potential use in NZ policy-making processes	Total citations and those by other (non-BODE ³) research teams in NZ
Diet and sustainability (selected)	Wilson et al 2013 ³⁰	As directly above	N=141; Five NZ related: Bennett et al 2015; Macmillan et al 2014; Alzaabi 2020; Bennett et al 2014; Macmillan and Jones 2015;
	Drew et al 2020 ³¹	As directly above. A key BODE ³ researcher (Dr Cleghorn) had discussions with the MoH, but this appears to have had no direct impact as of yet. The BMedSci student who led this work was contracted by the MoH to produce an issues based document on "Healthy & Climate-friendly Food Choices" to go alongside the updated dietary guidelines, but this was subsequently not published.	N=14; Six NZ related. Macmillan 2021; Morris and Livesey 2020; Seltnerich 2020; Mackay et al 2020; Downie-Melrose 2020; Alzaabi 2020.
Other diet interventions (selected)	Blakely et al ³²	Nil identified for this work on food taxes and subsidies.	N=11; On NZ related: McKerchar et al 2021.
	Cleghorn et al 2019 ³³	Members of the BODE ³ Team meet with the Minister of Health (Hon David Clark) around this Report in 2019, but there was no subsequent policy work on this topic that we could identify. Of note is that the BODE ³ DIET Model has been shared with the University of Toronto, Canada.	N=1; Nil NZ related.
Falls prevention (selected)	Pega et al 2016 ³⁴	Nil identified, despite initial work being supported by Counties Manukau DHB. Nevertheless, all BODE ³ fall prevention studies (n=4) were detailed in a presentation to ACC and some are detailed on the Health Quality & Safety Commission website (eg, ^{34 35 36}).	N=26; Nil NZ related.
Vaping / e-cigarettes	Petrović-van der Deen et al ³⁷	Nil identified (although the relevant Regulatory Impact Statement was published at around the same time in 2019). This work was presented at a NZ Conference and covered in the media.	N=8; Nil NZ related.
Cardio-vascular disease (CVD) management	Nghiem et al 2019 ³⁸	Despite presenting this work to the relevant team in the MoH, there has been no use of it in any MoH guidelines on CVD management (but it is only recently [2018] that the MoH updated the relevant CVD management guidelines). PHARMAC has also not moved to encourage the pharmaceutical industry to provide relevant combination therapies (despite these being used in Australia).	N=2; Nil NZ related.
Physical activity	Mizdrak et al 2019 ³⁹	Nil identified. However, indirectly this body of work has resulted in government sector engagement in subsequent work with the involvement of a co-author from Sport NZ (ie, in Mizdrak et al 2021 ⁴⁰). A presentation of physical activity work has also been made to the Ministry of Transport (on	N=13; One NZ related: Curl et al 2020.

Health domain	Study/ studies	Actual or potential use in NZ policy-making processes	Total citations and those by other (non-BODE ³) research teams in NZ
		transport mode shifting). Of note is that the BODE ³ Physical Activity model has been shared with another UoO team (PI: Caroline Shaw), which may lead to future policy contributions.	
Alcohol control	Cobiac et al 2019 ⁴¹	Despite presenting this work to a government agency, there has been no evidence of any impact. However, additional alcohol work by a BODE ³ team member has been commissioned by ACC and the Health Promotion Agency.	N=12; One Report by a NZ NGO (Jackson 2020)
Disease costing (selected)	Blakely et al 2019 ⁴²	Nil identified despite presentations of this work to government agencies. We are aware of other teams using BODE ³ costing work eg, work by Heather McLeod on the Trajectories at end of life work for MoH and Hospice NZ; rheumatic fever modelling with another UoO group (involving William Leung, Julie Bennett and Michael Baker).	N=21; Five NZ related: Yeung 2020; Spencer 2021; Coppell et al 2019; Babashahi 2020; Alford 2020.
Aortic aneurysm screening	Nair et al 2019 ⁴³	Nil identified, but potentially it has informed some thinking at the DHB level given co-authors involved in this article were from a DHB.	N=3; One NZ related: Streat et al 2020.
Lung cancer screening	Jaine et al 2020 ⁴⁴	Nil identified, but model was used and updated by a DHB based team and this work was published. ⁴⁵	N=4; Two NZ related: McLeod et al 2020; Crengle 2020

Discussion

General trends in NZ in health economic thinking and analysis: The trends highlighted in the results are favourable and suggest that at least amongst researchers in NZ there is increased levels of health economic thinking and analysis. Some of this is clearly attributable to BODE³ – especially in the more technically sophisticated domains of estimating uncertainty around results. BODE³ work has also pushed the methodological boundaries with its consideration of equity,² costing analyses,^{46 47 42 48} and the cost-effectiveness of treatments in the domain of personalised medicine.⁴⁹

More anecdotally, our impression is that NZ policy-makers have generally become more aware of such terms as “QALYs” and “ICERs” (incremental cost-effectiveness ratios). Nevertheless, in the crisis situation around the COVID-19 pandemic, NZ policy-makers focused entirely on saving lives and preventing health system overload. They did not express a desire for information around “life-years saved” or QALYs gained, or the likely cost-effectiveness of different strategies (even though estimates for QALYs gained could have been provided by modelling work). Indeed, HALYs have been subsequently calculated for various COVID-19 elimination strategies in work by Blakely, Wilson and others, albeit for the Australian context.⁵⁰ Also, anecdotally policy-makers appear to dislike talking about uncertainty. Potentially this is because political leaders like to appear certain that the right decision is being made, given the adversarial nature of politics and scrutiny in the media.

In other recent health topics in the NZ news in recent years, we also note a marked lack of discussion around “cost-effectiveness” (eg, in discussions around new cancer drugs and the value of PHARMAC’s work). It seems that high-level decision-making in the health sector is still largely driven by political factors and public acceptability (albeit with much of this being appropriate in a democracy). Potentially politicians dislike discussions around cost-effectiveness as it can raise issues around “rationing” of resources and complex equity issues eg, that it can be less cost-effective to treat the elderly than youth when using metrics such as QALYs.

Case studies of potential BODE³ impact in specific domains: From the evidence in the Table 1, it appears that there are some domains where BODE³ work has contributed to policy-making processes or at least policy-maker thinking in NZ. These impacts were sometimes in areas where policy work was already underway eg, with pre-BODE³ health sector commitments to have a colorectal cancer screening programme, and for tobacco control (given the national smokefree 2025 goal). But BODE³ work has also contributed to emerging areas such as COVID-19 pandemic control and with the emergence of Te Aho o Te Kahu, Cancer Control Agency (see the table above).

There are however, various health domains where BODE³ work does not appear to have been utilised in the policy-making process in NZ. Much of this was completely expected from our perspective given that:

- Some of the work involved fairly hypothetical interventions that had never been used in any jurisdiction internationally before (eg, a smokefree generation or a sinking lid on tobacco sales). Even if such interventions are never utilised, modelling them is epidemiologically useful as it can define the potential total envelope of health gain (eg, modelling a sinking lid down to zero tobacco sales, largely defines the total scope of potential health gain from ending the tobacco epidemic).
- Some work was in highly politically contested domains (eg, alcohol tax, sugar tax, food reformulation etc) where advances in high-income countries are often infrequent.
- Governments face many challenges and so even within a decade they can typically only address a modest range of health issues with major legal, fiscal or campaign-based interventions. This reflects both social licence for progressive changes and the tight legislative agenda. Eg, for NZ Governments in the last decade there has been the competing issues of: the pandemic, recovery from the Canterbury earthquake, child poverty, housing and equity issues.

Nevertheless, it is less clear why there was zero apparent traction in certain domains where BODE³ has done modelling work. These included:

- The lack of substantive progress with lowering sodium in processed foods as this is widely used in other high-income countries and can be done with no noticeable impact on consumers (ie, consumers do not notice a change in taste of a 10% reduction in sodium intake over a year). Such an intervention could also reduce health inequalities (given higher cardiovascular disease burdens for Māori and Pasifika).
- The lack of sustainability being considered in new Ministry of Health food guidelines released in 2020, despite this being done by a growing number of countries and it being very important in terms of addressing climate change.
- The lack of work on further falls prevention eg, via low-cost roll-out of home safety assessment and modification programmes in low-income communities. This would have been a valuable “shovel ready” type pandemic recovery programme that would have delivered health gains. Other fall prevention interventions we modelled were

also ones that would be unlikely to be controversial (eg, expanded exercise programmes³⁶ and expedited cataract surgery⁵¹).

- The lack of work to improve the uptake of HPV vaccination amongst adolescents (given how suboptimal NZ coverage rates are compared to the UK and Australia). Progress in this domain could potentially reduce health inequalities, given the patterns of some relevant cancers for Māori eg, cervical cancer.
- The lack of progress with facilitating greater use of double therapy (ie, statins and anti-hypertensives) in the NZ setting. Many of the ways to improve access and uptake of these medicines appears to us to be very straightforward.⁵² Again, progress in this area could also reduce health inequalities given higher cardiovascular disease burdens for Māori and Pasifika.

Despite these findings, much of this BODE³ work has been cited internationally so it may have benefits outside of NZ. Furthermore, if such other countries ever provide evidence of success with operationalising new interventions – then NZ policy-makers might reassess the issue of adoption in this country in future decades. Ultimately however, there is still much scope for further progress in NZ with epidemiological and health economic modelling and building the relevant workforce. This can potentially make more efficient use of scarce health sector resources and also further maximise health gain and reduce health inequalities.

Acknowledgements

Thanks to the funders of the BODE³ Programme: the Health Research Council (HRC) of New Zealand and the Ministry of Business, Innovation and Employment (MBIE). Thanks to those BODE³ staff who commented on a draft of this document: Dr Cristina Cleghorn, Dr Jennifer Summers, Dr Anja Mizdrak and June Atkinson. Thanks also to all those other current and former BODE³ team members who have contributed to BODE³ work, much of which is detailed in the references below: Professor Tony Blakely (Director then Co-Director), Professor Cliona Ni Mhurchu (Co-Director), Professor Diana Sarfati (Co-Director), Dr Amanda Jones, Dr Amber Pearson, Dr Andrea Teng, Anna Davies, Courtney Steele, Dr Eamonn Deverall, Dr Frank Pega, Dr Frederieke Petrović-van der Deen, Dr Giorgi Kvizhinadze, Heather McLeod, Hilary Day, Dr Jono Drew, Kate Sloane, Kendra Telfer, Lani Teddy, Dr Leah Grout, Leilani Freeman, Dr Linda Cobiac, Dr Lucy Collinson, Dr Melissa McLeod, Dr Muhammad Irfan, Dr Naomi Brewer, Dr Nisha Nair, Rachel Foster, Rex Liao, Dr Richard Jaine, Sian Ryan, Tal Sharrock, William Leung.

References

1. University of Otago & University of Melbourne. ANZ-HILT: Australia and New Zealand Health Intervention League Table (Vers 2.0) 2019 [Available from: <https://league-table.shinyapps.io/bode3/>].
2. McLeod M, Blakely T, Kvizhinadze G, Harris R. Why equal treatment is not always equitable: the impact of existing ethnic health inequalities in cost-effectiveness modeling. *Popul Health Metr* 2014;12:15.
3. Kvizhinadze G, Wilson N, Nair N, McLeod M, Blakely T. How much might a society spend on life-saving interventions at different ages while remaining cost-effective? A case study in a country with detailed data. *Popul Health Metr* 2015;13:15.

4. Wilson N, Davies A, Brewer N, Nghiem N, Cobiac L, Blakely T. Can cost-effectiveness results be combined into a coherent league table? Case study from one high-income country. *Popul Health Metr* 2019;17:10.
5. Wilson N, Grout L, Summers J, Jones A, Mizdrak A, Nghiem N, Cleghorn C, Blakely T. Should prioritising health interventions be informed by modelling studies? The case of cancer control in Aotearoa New Zealand. *N Z Med J* 2021;134(1531):101-13.
6. Cleghorn C, Jones A, Freeman L, Wilson N. Updated Cost-effectiveness Modelling of a Behavioural Weight Loss Intervention Involving a Primary Care Provider. Wellington: University of Otago, October 2020.
<https://www.otago.ac.nz/wellington/otago757860.pdf>.
7. Nghiem N, Leung W, Cleghorn C, Blakely T, Wilson N. Mass media promotion of a smartphone smoking cessation app: modelled health and cost-saving impacts. *BMC Public Health* 2019;19:283.
8. Blakely T, Cobiac LJ, Cleghorn CL, Pearson AL, van der Deen FS, Kvizhinadze G, Nghiem N, McLeod M, Wilson N. Health, health inequality, and cost impacts of annual increases in tobacco tax: Multistate life table modeling in New Zealand. *PLoS Med* 2015;12:e1001856.
9. van der Deen FS, Wilson N, Blakely T. A continuation of 10% annual tobacco tax increases until 2020: Modelling results for smoking prevalence by sex and ethnicity. *N Z Med J* 2016;129(1441):94-7.
10. Parliamentary Service. Progress towards a Smokefree Aotearoa 2025. Parliamentary Service, 2020. <https://www.parliament.nz/en/pb/library-research-papers/research-papers/library-research-brief-progress-towards-a-smokefree-aotearoa-2025/#PDF>.
11. van der Deen FS, Wilson N, Cleghorn CL, Kvizhinadze G, Cobiac LJ, Nghiem N, Blakely T. 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.
12. Ministry of Health. Prohibiting smoking in motor vehicles carrying children under 18 years of age (Regulatory Impact Statement). Ministry of Health, 2019.
13. McLeod M, Kvizhinadze G, Boyd M, Barendregt J, Sarfati D, Wilson N, Blakely T. Colorectal cancer screening: How health gains and cost-effectiveness vary by ethnic group, the impact on health inequalities, and the optimal age range to screen. *Cancer Epidemiol Biomarkers Prev* 2017;26:1391-400.
14. O'Hallahan J, Church E, Shaw C. Cancer screening in New Zealand. *Journal of Cancer Policy* 2020;23:100203.
15. Te Aho o Te Kahu Cancer Control Agency. He Pūrongo Mate Pukupuku o Aotearoa 2020. The state of cancer in New Zealand 2020. Wellington: Te Aho o Te Kahu Cancer Control Agency, 2021.
16. Wilson N, Telfar Barnard L, Kvalsvig A, Baker M. Potential health impacts from the COVID-19 pandemic for New Zealand if eradication fails: Report to the NZ Ministry of Health. Wellington: University of Otago Wellington, 2020.
https://www.health.govt.nz/system/files/documents/publications/report_for_moh_-_covid-19_pandemic_nz_final.pdf.
17. Wilson N, Schwehm M, Verrall AJ, Parry M, Baker MG, Eichner M. Detecting the re-emergent COVID-19 pandemic after elimination: modelling study of combined primary care and hospital surveillance. *N Z Med J* 2020;133:28-39.
18. Wilson N, Parry M, Verrall A, Baker M, Schwehm M, Eichner M. When can elimination of SARS-CoV-2 infection be assumed? Simulation modelling in a case study island nation. medRxiv 2020;(20 May).
<https://medrxiv.org/cgi/content/short/2020.05.16.20104240v1>.

19. Wilson N, Baker M, Eichner M. Estimating the impact of control measures to prevent outbreaks of COVID-19 associated with air travel into a COVID-19-free country: A simulation modelling study. medRxiv 2020;(17 June). <https://www.medrxiv.org/content/10.1101/2020.06.10.20127977v3>.
20. Sarfati D, Nair N, Mako M. Modelling: one tool in the decision-making toolkit. *N Z Med J* 2021;134;(1531):8-10.
21. Blakely T, Kvizhinadze G, Karvonen T, Pearson AL, Smith M, Wilson N. Cost-effectiveness and equity impacts of three HPV vaccination programmes for school-aged girls in New Zealand. *Vaccine* 2014;[E-publication 21 March]. <http://dx.doi.org/10.1016/j.vaccine.2014.02.071>.
22. Wilson N, Morgan J, Baker MG. Evidence for effectiveness of a national HPV vaccination programme: national prescription data from New Zealand. *Sexually transmitted infections* 2014;90:103.
23. Pearson AL, Kvizhinadze G, Wilson N, Smith M, Canfell K, Blakely T. Is expanding HPV vaccination programs to include school-aged boys likely to be value-for-money: a cost-utility analysis in a country with an existing school-girl program. *BMC Infect Dis* 2014;14:351.
24. Blakely T, Collinson L, Kvizhinadze G, Nair N, Foster R, Dennett E, Sarfati D. Cancer care coordinators in stage III colon cancer: a cost-utility analysis. *BMC Health Serv Res* 2015;15:306.
25. Collinson L, Foster RH, Stapleton M, Blakely T. Cancer care coordinators: what are they and what will they cost? *N Z Med J* 2013;126:75-86.
26. Litmus. The Cancer Nurse Coordinator Initiative Evaluation. Final report. (Prepared for the Ministry of Health). 2016.
27. Nghiem N, Blakely T, Cobiac LJ, Pearson AL, Wilson N. Health and economic impacts of eight different dietary salt reduction interventions. *PLoS One* 2015;10:e0123915.
28. Ministry of Health. Eating and Activity Guidelines for New Zealand Adults. Wellington, Ministry of Health, 2020.
29. Nghiem N, Blakely T, Cobiac LJ, Cleghorn CL, Wilson N. The health gains and cost savings of dietary salt reduction interventions, with equity and age distributional aspects. *BMC Public Health* 2016;16:423.
30. Wilson N, Nghiem N, Ni Mhurchu C, Eyles H, Baker MG, Blakely T. Foods and dietary patterns that are healthy, low-cost, and environmentally sustainable: a case study of optimization modeling for New Zealand. *PLoS One* 2013;8:e59648.
31. Drew J, Cleghorn C, Macmillan A, Mizdrak A. Healthy and Climate-Friendly Eating Patterns in the New Zealand Context. *Environ Health Perspect* 2020;128:17007.
32. Blakely T, Cleghorn C, Mizdrak A, Waterlander W, Nghiem N, Swinburn B, Wilson N, Ni Mhurchu C. The effect of food taxes and subsidies on population health and health costs: a modelling study. *Lancet Public Health* 2020;5:e404-e13.
33. Cleghorn C, Blakely T, Jones A, Kvizhinadze G, Mizdrak A, Nghiem N, Ni Mhurchu C, Wilson N. Feasible diet intervention options to improve health and save costs for the New Zealand population. Wellington, New Zealand: Department of Public Health, University of Otago, 2019. <https://www.otago.ac.nz/wellington/otago715115.pdf>.
34. Pega F, Kvizhinadze G, Blakely T, Atkinson J, Wilson N. Home safety assessment and modification to reduce injurious falls in community-dwelling older adults: cost-utility and equity analysis. *Inj Prev* 2016;22:420-26.
35. Wilson N, Kvizhinadze G, Pega F, Nair N, Blakely T. Home modification to reduce falls at a health district level: Modeling health gain, health inequalities and health costs. *PLoS One* 2017;12:e0184538.

36. Deverall E, Kvizhinadze G, Pega F, Blakely T, Wilson N. Exercise programmes to prevent falls among older adults: modelling health gain, cost-utility and equity impacts. *Inj Prev* 2018;(E-publication 23 January).
37. Petrović-van der Deen FS, Wilson N, Crothers A, Cleghorn CL, Gartner C, Blakely T. Potential country-level health and cost impacts of legalizing domestic sale of vaporized nicotine products. *Epidemiol* 2019;30:396-404.
38. Nghiem N, Knight J, Mizdrak A, Blakely T, Wilson N. Preventive Pharmacotherapy for Cardiovascular Disease: A Modelling Study Considering Health Gain, Costs, and Cost-Effectiveness when Stratifying by Absolute Risk. *Sci Rep* 2019;9:19562.
39. Mizdrak A, Blakely T, Cleghorn CL, Cobiac LJ. Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: A modelling study. *PLoS One* 2019;14:e0219316.
40. Mizdrak A, Ding D, Cleghorn C, Blakely T, Richards J. Hitting the Target but Missing the Point? Modelling Health and Economic Impacts of Different Approaches to Meeting the Global Action Plan for Physical Activity Target. *Sports Med* 2021.
41. Cobiac LJ, Mizdrak A, Wilson N. Cost-effectiveness of raising alcohol excise taxes to reduce the injury burden of road traffic crashes. *Inj Prev* 2019;25:421-27.
42. Blakely T, Kvizhinadze G, Atkinson J, Dieleman J, Clarke P. Health system costs for individual and comorbid noncommunicable diseases: An analysis of publicly funded health events from New Zealand. *PLoS Med* 2019;16:e1002716.
43. Nair N, Kvizhinadze G, Jones GT, Rush R, Khashram M, Roake J, Blakely A. Health gains, costs and cost-effectiveness of a population-based screening programme for abdominal aortic aneurysms. *Br J Surg* 2019;106:1043-54.
44. Jaine R, Kvizhinadze G, Nair N, Blakely T. Cost-effectiveness of a low-dose computed tomography screening programme for lung cancer in New Zealand. *Lung Cancer* 2020;144:99-106.
45. McLeod M, Sandiford P, Kvizhinadze G, Bartholomew K, Crengle S. Impact of low-dose CT screening for lung cancer on ethnic health inequities in New Zealand: a cost-effectiveness analysis. *BMJ Open* 2020;10:e037145.
46. Blakely T, Atkinson J, Kvizhinadze G, Wilson N, Davies A, Clarke P. Patterns of cancer care costs in a country with detailed individual data. *Medical care* 2015;53:302-9.
47. Blakely T, Atkinson J, Kvizhinadze G, Nghiem N, McLeod H, Davies A, Wilson N. Updated New Zealand health system cost estimates from health events by sex, age and proximity to death: further improvements in the age of 'big data'. *N Z Med J* 2015;128(1422):13-23.
48. Wilson N, Nghiem N, Foster R, Cobiac L, Blakely T. Estimating the cost of new public health legislation. *Bull World Health Organ* 2012;90:532-9.
49. Leung W, Kvizhinadze G, Nair N, Blakely T. Adjuvant Trastuzumab in HER2-Positive Early Breast Cancer by Age and Hormone Receptor Status: A Cost-Utility Analysis. *PLoS Med* 2016;13:e1002067.
50. Blakely T, Thompson J, Bablani L, Andersen P, Ait Ouakrim D, Carvalho N, Abraham P, Boujaoude M-A, Katar A, Akpan E, Wilson N, Stevenson M. Determining the optimal COVID-19 policy response using agent-based modelling linked to health and cost modelling: Case study for Victoria, Australia. medRxiv 2021:2021.01.11.21249630.
<https://www.medrxiv.org/content/10.1101/2021.01.11.21249630v1>.
51. Boyd M, Kvizhinadze G, Kho A, Wilson G, Wilson N. Cataract surgery for falls prevention and improving vision: modelling the health gain, health system costs and cost-effectiveness in a high-income country. *Inj Prev* 2019.

52. Wilson N, Jones AC, Nghiem N, Blakely T. Preventing cardiovascular disease in New Zealand: making better use of statins but also tobacco control, changing the food supply and other strategies. *N Z Med J* 2018;131:61-67.