Public Health Monograph Series
No.15
ISSN 1178-7139

WHAT ARE THE PRIORITY HEALTH RISK FACTORS FOR RESEARCHING PREVENTIVE INTERVENTIONS AS PART OF NZACE-PREVENTION?

Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme

Technical Report: Number 1

Nick Wilson
Tony Blakely
Rachel Foster
David Hadorn
Theo Vos

November 2010

A technical report published by the Department of Public Health, University of Otago, Wellington

ISBN 978-0-473-18265-6

Acknowledgements

We thank other BODE^3 team colleagues for comments on early versions of this work, particularly Diana Sarfati. This project receives funding support from the New Zealand Health Research Council.

Competing interests

The authors have no competing interests.

Nick Wilson[1*], Tony Blakely[1], Rachel Foster[1], David Hadorn[1], Theo Vos[2]
[1] Department of Public Health, University of Otago, Wellington, New Zealand
[2] School of Population Health, University of Queensland, Herston, QLD 4006, Australia

* Contact Nick Wilson (Principal Investigator of the NZACE-Prevention component of the BODE^3 Programme, University of Otago, Wellington). Email: nick.wilson@otago.ac.nz

Table of Contents

List of Tables

Abstract

Aim: To identify the highest priority risk factor areas for further researching the effectiveness and cost-effectiveness of preventive interventions in New Zealand.

Methods: Using WHO data for high-income countries in the Western Pacific Region, the burden of disease in disability adjusted life years (DALYs) associated with leading risk factors was used as a starting point for identifying high priority areas for preventive research in New Zealand. Subsequent prioritising steps included the existence of effective and (likely) cost-effective preventive interventions for each risk factor, and the contribution of the risk factor to health inequalities.

Results: The process provided a systematic way to prioritise risk factor areas with consideration for New Zealand-specific issues. The top six major risk factors identified were: tobacco use, high blood pressure, high cholesterol, alcohol use, overweight/obesity and physical inactivity. All of these six risk factors contribute to ethnic health inequalities (Māori vs non-Māori). They are also all relevant to reducing the health burden for children/youth and older adults, and four of the risk factor areas were relevant to reducing health inequalities for socio-economically deprived New Zealanders. For all of the top six risk factor areas there are published studies indicating that one or more preventive interventions are cost-saving (to the health sector or society).

Conclusions: This process identified risk factor areas associated with high health burden and which are amenable to cost-effective preventive interventions. The next step is to work with stakeholders to select the range of interventions within each risk factor area that are of most interest for cost-effectiveness analysis in the New Zealand setting.

Introduction

Achieving value-for-money in the New Zealand health sector is becoming an increasingly critical concern. There are: (a) the constraints on the New Zealand economy arising from the global financial crisis; (b) a relatively high 6% per annum per capita growth rate in Vote:Health funding in the last decade; (c) on-going technological drivers such as more expensive pharmaceuticals, with associated rising citizens' expectations of access to these and other new treatments; and (d) intensive focus on constraining health costs e.g., as per the recent Ministerial Review Group Report.[1] Furthermore, we suspect there will be further long-term economic constraints for New Zealand arising from the challenges of global climate change and the need to transit to a low-carbon economy.

It is important to ensure we deploy scarce resources in a manner that maximises health gain and reduces inequalities, which requires choosing between options. Preventive interventions should be subject to cost-effectiveness considerations, just as other healthcare services are. Increasing resource allocation to prevention may be one way to improve value-for-money for the sector more widely. There has been recent work in Australia that indicates that many evidence-based and cost-effective preventive interventions exist, and quite a few of these are cost-saving. That is, cost-saving over the long-term and when using widely agreed discount rates (i.e., how much less you value something in a years time compared to now). The Australian "Assessing Cost-Effectiveness of Prevention" (ACE-Prevention) Project reported 23 cost-saving ("dominant") preventive interventions, 20 "very cost-effective" interventions and 31 "cost-effective" interventions (with the latter in the $A10,000 – $A50,000/DALY range).[2] (A DALY is a "disability adjusted life year", similar to a quality adjusted life year (QALY) except that disability weights are used to value different health states rather than utilities.) Some of this Australian work has been published in peer-reviewed journals in such topic areas as alcohol use,[3 4] overweight and obesity (particularly for children/adolescents),[5-11] skin cancer,[12] pre-diabetes[13] and physical inactivity.[14]

There would appear to be a need for such research to be applied to the New Zealand setting, taking into account New Zealand-specific burden-of-disease work and such priorities as reducing health inequalities. This is being undertaken as part of the Health Research Council-funded NZACE-Prevention Project, which is part of the Burden of Disease Epidemiology, Equity and Cost-Effectiveness (BODE^3) Programme (www.uow.otago.ac.nz/BODE3-info.html). To start the process, the work presented here details the selection of the highest priority risk factor areas for further researching potentially cost-effective preventive interventions in New Zealand.

Methods

Health burden from risk factors: Comparative risk assessment (CRA) methods allow one to assess the comparative impact of any risk factor on disease burden. Briefly, a burden of disease study is undertaken that quantifies the DALYs for all possible disease conditions. The DALY is a composite of years of life lost due to a given disease or injury state, and a morbidity component of years of life lived in disability (e.g., if living with stroke has a disability weight of 0.4, and the average number of years lived with stroke is 10 years, this is deemed equivalent to 4 years of lost life).

The next step involves calculating the health burden attributable to specific risk factors. For example in a CRA calculation of the burden that can be attributed to tobacco, all diseases that are caused by tobacco smoking are identified, the relative risks for the association between smoking and each disease assembled and the population distribution of smoking determined from surveys. One then posits a counterfactual and "deal but theoretically achievable" distribution of the risk factor – nil in the case of smoking, but for a continuous variable like blood pressure the counterfactual is a shifted and compressed distribution with a lower average than from the survey data. The data are then combined, using population-attributable risk types of analysis to calculate the percentage of, say, coronary heart disease DALYs due to smoking. Finally, one is able to compare the DALYs attributable to many risk factors, and rank risk factors accordingly.

Past work in New Zealand has used CRA methods to identify and rank major risk factors for poor health for the year 1996,[15] but rankings were based on numbers of deaths and not DALYs. The results of this previous work are also somewhat outdated as more recent meta-analyses and synthesis of relative risk information are now available. We therefore considered recently published global burden of disease work by the World Health Organization (WHO) for high-income countries in the Western Pacific Region collectively (Australia, Brunei, Japan, New Zealand, Singapore, and South Korea).[16]

Criteria for selecting risk factors for evaluation of preventive interventions: As a starting point we decided that the risk factors to be considered all had to be within the top 15 for causing lost DALYs for high-income countries in the Western Pacific Region.[16] We then assessed the risk factor against a number of criteria to further select and prioritise:

1. the risk factor is amenable to at least one preventive intervention for which there is a good evidence-base for effectiveness and likely cost-effectiveness.
2. the risk factor contributes to health inequalities in the New Zealand setting in terms of the gap between Māori and non-Māori.
3. the risk factor is given less priority if study of the effectiveness and cost-effectiveness of preventive interventions would be particularly demanding because of the need for complex new burden of disease data.

Literature searches: To inform the above process we performed literature searches around the 15 selected risk factors using Medline and Google Scholar. We also searched for local reports on websites, especially that of the New Zealand Ministry of Health. Similar searches were done to identify the role of each risk factor in terms of the Māori vs non-Māori health inequalities.

Results

Given our starting requirement for a risk factor to involve a major loss of DALYs, the list of the top 15 risk factors from WHO work are detailed in Table 1. The table also shows that there is some overlap between this list for high-income countries from the Western Pacific Region and past New Zealand work.

The last five risk factors in Table 1 are unlikely to exceed those higher in the list – they were also ranked more lowly in the previous New Zealand burden of disease study, and the difference in estimated DALYs with the top seven is too great to be plausibly attributable to error. Therefore we focused on the top 10 of these and detailed the preventive interventions that relate to each (Table 2). Effective and cost-effective preventive interventions (some of which have been reported as being cost-saving), were identified for each of these risk factors. We dropped the "occupational risk" category from further consideration as it calls for a multitude of occupation-specific interventions.

In the revised list (Table 3) it was apparent that most (8/9) of the risk factors clearly contribute to Māori vs non-Māori inequalities in health to some extent. Table 4 shows further considerations for the final prioritisation of the selected risk factors with down-grading certain areas for reasons of data complexity (i.e., alcohol) and also uncertain evidence around the persistence into the future of benefit from interventions (e.g., for overweight and obesity).

Although not explicitly considered part of the prioritisation process presented here, the potential impact of these risk factors for three other population groups designated as high priority by the NZ Health Research Council are shown in Table 5. This table takes all the six highest priority risk factor areas from Table 4 and presents evidence that all of them are potentially relevant for reducing other aspects of health inequalities (i.e., Pacific peoples) and burden by age group (i.e., for children/youth and older adults). Furthermore, four of the six risk factor areas are relevant to reducing health inequalities for socio-economically deprived New Zealanders. This is because this population has more adverse risk factor profiles in terms of: smoking, hazardous alcohol use, physical inactivity, and high body mass index (BMI)/obesity.[17]

Table 1: Top 15 risk factors for burden of disease in high-income countries in the Western Pacific Region in terms of disability adjusted life years (DALYs) lost in 2004 16

Risk factor	DALYs lost (thousands) – ranked	Percent-age of total DALYs	Deaths (thousands)	Percent-age of total deaths	Risk factor ranking (previous NZ Ministry of Health work)[a]
1) Tobacco use	1871	8.4	261	17.7	2
2) Alcohol use	1541	6.9	52	3.5	13 (with other drugs)[b]
3) High blood pressure	1273	5.7	200	13.5	5
4) High blood glucose	1077	4.8	86	5.8	8 (pre-diabetes)
5) Overweight and obesity	839	3.8	56	3.8	6
6) Physical inactivity	806	3.6	87	5.9	7
7) High cholesterol	570	2.6	52	3.5	4
8) Occupational risks	462	2.1	22	1.5	19
9) Low fruit & vegetable intake	299	1.3	40	2.7	10
10) Urban outdoor air pollution	231	1.0	47	3.2	12 (all air pollution)
11) Iron deficiency	210	0.9	1	0.1	Not listed
12) Child sexual abuse	197	0.9	3	0.2	14 (all violence)
13) Illicit drugs	155	0.7	3	0.2	See alcohol
14) Unsafe health-care injections	126	0.6	9	0.6	Not listed
15) Unsafe sex	125	0.6	6	0.4	20

Notes:

[a] Not shown on this list, but in the top 15 for the top causes of death in NZ from previous work were: 1st – "diet (joint effect)"; 3rd – "deprivation"; 9th – "infection"; 11th – "adverse in-hospital health care events"; and 15th – "injury (non-traffic)".[15]

[b] The discrepancy between the rankings of the WHO result and the previous NZ work is likely to reflect improved methodologies e.g., compare the results for comparative risk assessment in Table 1 in Rehm et al.[18]

Table 2: Top 10 risk factors in terms of DALYs lost (see Table 1) and how they relate to the availability of effective and cost-effective preventive interventions

Risk factor	Available and effective preventive interventions (bolded interventions are those with evidence for being cost-saving)	Keep for further analysis (see Table 3)?
Tobacco use	Examples include: **tobacco taxation increases**,[2 19] mass media campaigns, expanding Quitline use and providing nicotine products for quitting. Australian work has found that a "National Tobacco Campaign" would be cost-saving.[20] In total there are now over 170 Cochrane systematic reviews with "tobacco or smoking" in the title with many of these interventions being effective. There is growing evidence that some tobacco control interventions can be pro-equity.[21]	Yes
Alcohol use	Examples include: **alcohol taxation increases** and **alcohol advertising restrictions.**[2 3 22] "Convincing evidence" exists for many regulatory interventions according to a systematic review by WHO.[23] Another systematic review rates a number of interventions as "effective"[24] e.g., licensing controls to restrict numbers of outlets. ACE-Prevention (Australia) work also found that raising the minimum **legal drinking age** to 21 years was cost-saving.[2]	Yes
High blood pressure[a]	Examples include: **community heart health programmes**, **reduction of salt in processed foods**[2 25-27] (voluntary and mandated options), improved access to anti-hypertensives and the use of a **polypill**[c] (depending on price and risk groups).[2 28]	Yes
High blood glucose	ACE-Prevention work in Australia found evidence that five out of seven interventions for "pre-diabetes" were cost-effective (i.e., <$A50,000 per DALY) but all at median levels of ≥$A21,000 per DALY.[2] There is also some overlap with physical inactivity interventions detailed below, which can both prevent and modify this risk factor.	Yes
Overweight and obesity	Examples include: **a 10% tax on unhealthy food**, **reduction of TV advertising** (high fat/high sugar foods & drinks), **traffic light nutrition labelling**, and diet and physical activity programmes.[2 5] Of the 13 interventions for children and adolescents considered in the Australian work,[5] six were found to be cost-saving (but we note that the evidence for interventions was not strong and assumptions around persisting intervention effects may have been unrealistic). Furthermore, the exact health impact from food subsidies or taxes, alone or in combination, is difficult to quantify and needs further research.[29]	Yes
Physical inactivity	Examples include: **mass media-based campaigns** and **community programmes to encourage use of pedometers**, "green prescriptions" from GPs and GP referral to an exercise physiologist (based on Australian work).[2 14] Modelling work suggests that social and environment change to achieve high active transport levels (walking and cycling) could achieve health gains.[30]	Yes
High cholesterol[a]	Examples include: **community heart health programmes**, promoting the use of food products with plant sterols, expanding the use of statins and use of a **polypill**[c] (depending on price and risk groups).[2] Modelling work around reducing agricultural emissions of greenhouse gases from ruminants (relevant for NZ's current emissions trading scheme law) is also suggestive of health benefits.[31]	Yes

Risk factor	Available and effective preventive interventions (bolded interventions are those with evidence for being cost-saving)	Keep for further analysis (see Table 3)?
Occupation-al risks	There are many effective workplace-specific interventions but these are generally occupation specific.[b] Although a population-wide ***SunSmart* programme** was considered to be cost-saving in Australia in ACE-Prevention work,[12] the applicability of such interventions to outdoor workers in NZ has some uncertainty (given country differences in sunlight and ultraviolet light levels). Thus, whilst there is much health gain possible through occupational programmes, they are not easily included in a risk factor-based modelling approach.	***No***
Low fruit & vegetable intake	There is some evidence favouring certain types of **community-based promotion activities** (in Australian work: one intervention was cost-saving, 3 cost-effective, but 19 were not cost-effective).[2] Also the evidence on financial incentives and disincentives and food intake[32] are relevant to enhancing fruit and vegetable intake. Similarly, there is some NZ-specific evidence around food pricing interventions.[33]	Yes
Urban outdoor air pollution	There is evidence that air pollution can be reduced via regulations on industrial emissions (and emissions trading schemes in the USA[34] and in Europe[35]); regulations around domestic fire places (e.g., as used in Christchurch); regulations around vehicle fuel efficiency and routine vehicle emissions testing. Furthermore, it is known that there can be declines in private vehicle use (and therefore probably emissions) as fuel prices increase and with improved access to public transport. A shift from fossil fuel powered vehicles to hybrids or electric-only vehicles would also plausibly reduce urban air pollution.	Yes

Notes:
[a] The ACE-Prevention work in Australia combined these topic areas.[2]
[b] One possible exception is smokefree workplaces, but there is limited scope for expanding this in the NZ setting (except perhaps around enforcement in some settings and for workers servicing outdoor bar/restaurant areas). Improved alcohol control may reduce occupational injury risk but this is more appropriately considered as part of alcohol control interventions.
[c] A low-cost polypill that combines three blood-pressure-lowering drugs and one cholesterol-lowering drug into one single pill.

Table 3: Residual prioritised risk factors (see Table 2) and how they relate to Māori vs non-Māori health inequalities in New Zealand

Risk factor	Relevant ?	Further detail on how the risk factor relates to Māori vs non-Māori health inequalities
Tobacco use	Yes	Māori have higher smoking prevalences than non-Māori,[36] contributing to mortality inequalities between Māori and non-Māori.[37-39] This is linked to higher age-standardised mortality rates (compared to non-Māori) for: ischaemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease and tobacco-related cancers (i.e., lung, stomach and cervical).[40-42]
Alcohol use	Yes (hazard-ous use)	Māori have a more hazardous alcohol use pattern compared to non-Māori (based on higher AUDIT scores in Māori that reflect hazardous alcohol use[17]). Motor vehicle traffic crashes are a major cause of mortality and morbidity for Māori (especially young Māori)[43] and alcohol is a likely risk factor for a significant proportion of these crashes. From a chronic disease perspective, the alcohol risk factor may impact on quitting by Māori smokers because there is evidence that individuals who drink heavily on a regular basis have significantly lower quit rates[44]). There are also synergies between smoking and alcohol use in terms of increased cancer risk (i.e., for cancers of the oral cavity, pharynx, larynx and oesophagus[45]), which are probably relevant given the much higher smoking rates among Māori and very much higher lung cancer risk. Furthermore, Māori suffer disproportionately from chronic hepatitis B carriage,[46] and heavy alcohol use appears to increase adverse outcomes such as cancer.[47] However, for chronic disease processes where there is not an interaction of smoking and alcohol, and total amount consumed (rather than hazardous drinking) is the issue, then alcohol may not contribute to health inequalities (since total alcohol consumption for Māori appears to be lower than for European New Zealanders[48]).
High blood pressure	Yes	High systolic blood pressure levels contribute to more avoidable cardiovascular disease mortality (both ischaemic heart disease and stroke) among both Māori men and women (compared to non-Māori).[49]
High blood glucose	Yes	Diabetes is more prevalent among Māori than European New Zealanders.[17] (See also "physical inactivity" and "overweight and obesity" below, with the latter being a key component of higher mortality rates from diabetes in Māori[49]).
Over-weight and obesity	Yes	The age-standardised mortality attributable to BMI has been found to be relatively higher for Māori (compared to non-Māori).[49]
Physical inactivity	Yes	The prevalence of sedentary behaviour is about 15% to 20% higher among Māori compared to European/Other.[17] Nevertheless, there appear to be no difference in regular physical activity levels between Māori and non-Māori (i.e. for at least 30 minutes of physical activity per day on five or more days of the last week). Of note is that this risk factor can modify other risk factors in this table (high blood glucose and overweight) which are relevant to Māori vs non-Māori health inequalities.
High cholesterol	Yes	Cholesterol levels contribute to more avoidable cardiovascular disease mortality (both ischaemic heart disease and stroke) among both Māori men and Māori women (compared to non-Māori).[49]
Low fruit and vegetable intake	Yes	Māori women have statistically significantly lower daily vegetable and fruit intake compared to European/Other women.[17] Earlier survey data indicated lower intakes for both Māori men and women.[49] The possible role of green leafy vegetables in reducing diabetes risk[50] may also be relevant.
Urban outdoor air pollution	Possibly [a]	There appears to be no definitive data on the contribution of such air pollution to Māori vs non-Māori health inequalities (the largest air pollution study in NZ to date[51] did not address this issue). Nevertheless, one recent study has found a possibly stronger association of air pollution with mortality among Māori.[52] The possible role of fine particulate pollution in diabetes risk[53] may also be relevant.

Note: [a] Given this uncertainty, the air pollution risk factor was dropped from further consideration in our prioritisation process.

Table 4: Our final prioritised list of major risk factors for further research in the New Zealand setting

Risk factor	Rationale and comment
Highest priority	
Tobacco use	A major cause of disease burden and especially of inequalities in the NZ setting.
High blood pressure	A more important cause of lost DALYs than cholesterol, contributes to inequalities, and many effective interventions are available.
High cholesterol	This risk factor was upgraded in priority because interventions appear more promising than for most other risk factors in this list (and there is some overlap with the blood pressure interventions if an absolute risk approach is adopted e.g., for considering a polypill intervention).
Medium priority	
Alcohol use	This risk factor is important but is complex to study as there are over 200 ICD-10 three-digit disease codes in which alcohol is part of a component cause.[18] Intervention analyses therefore should follow the completion of the NZ Burden of Disease Study revision.
Overweight and obesity	An important risk factor, but there are issues of uncertainty around the persistence of intervention effects.
Physical inactivity	An important risk factor but the possible impact on health inequalities is indirect and there are uncertainties around the persistence of intervention effects (especially for interventions applied to children).
Lower priority	
Low fruit and vegetable intake	This risk factor is ranked relatively low as past work may have over-estimated the benefits of its reduction given the findings in a recent and very large cohort study.[54]
High blood glucose	This risk factor is of relatively lower priority given that interventions addressing blood glucose directly are not particularly cost-effective (see Table 2). Also this risk factor will be partly addressed by considering other risk factors e.g., “physical inactivity”, “overweight and obesity” (see above) and possibly vegetable intake.[50]

Table 5: The relevance of the top six risk factors for other priority population groups in New Zealand (priority groups as defined by the Health Research Council of New Zealand, excluding people with disability)

Risk factor	Pacific peoples[a]	Children and youth	Older adults
Tobacco use	Increased risk of smoking overall[17]	The prevalence of exposure to second-hand smoke in children aged 0-4 is 7%.[17] Youth smoking is also a problem (15% of 15-17 year-olds)[17] and youth is when most smoking initiation occurs.	Older adults are the age group in which smoking is most likely to cause adverse acute health events, given their much higher background risk of cardiovascular and respiratory disease.
High blood pressure	Increased risk of high blood pressure[17 55]	Indirect – but poor nutrition in childhood can influence subsequent risk profiles in adulthood (blood pressure, obesity and lipids).[56-58]	The age group 65+ years has the highest prevalence of hypertension and medicated high blood pressure[17] (as well as cardiovascular events).
High cholesterol	Increased risk of adverse lipid profile[17 55 59]	As above (for high blood pressure). Boys aged 10–14 commonly consume "fast food" (10% had it 3+ times in the previous 7 days).[17]	The age group 65+ years has the highest prevalence of medicated high cholesterol levels[17] (as well as cardiovascular events).
Alcohol use	Increased risk of hazardous alcohol use,[17] (although not total consumption)	Hazardous drinking patterns are common for 15-17 year olds (21% males, 17% females)[17] and are related to risk of injury and unsafe sex. Younger children may be harmed from alcohol-related domestic violence and where alcohol misuse exacerbates poverty in families.	Although older adults have less hazardous drinking patterns, regular moderate consumption can still lead to disease consequences among a population with high background rates of (alcohol-sensitive) disease (e.g., increased bone fracture risk from alcohol-related falls and falls from alcohol-medication interactions, alcohol-related cancers, cardiac arrhythmias).
Overweight and obesity	Increased risk of high BMI/obesity[17 55]	Life-long behaviour patterns can be established in childhood (diet and physical activity) and "fast food" intake is relatively high (see above for cholesterol). Obesity at this age may also impede psycho-social development.	Mean BMI peaks in 55-64 year-olds for men and women[17] and this age group has relatively high rates of cardiovascular disease and diabetes.
Physical inactivity	Increased risk of physical inactivity[17]	This appears to be a priority age group for risk factor reduction because physical activity in youth contributes to the control of cholesterol and blood pressure and also to: physical development, coordination, bone density, energy balance and self-esteem.[60]	The age group 65+ years has the highest prevalence of physical inactivity[17] (and suffers from the highest rates of related disease events – cardiovascular disease, diabetes and cancer).

Note: [a] The increased risk described for Pacific peoples is relative to European New Zealanders. Of note is that there are some differences within different Pacific peoples in NZ (i.e., comparing Samoan, Tongan, Niuean and Cook Island populations) but the overall risk factor patterns for each population are more hazardous to health than for European New Zealanders.[55]

Discussion

Major findings and interpretation: The process used in this analysis for risk factor selection and prioritisation produces a plausible priority list. That is, the list is fairly compatible with past New Zealand work on risk factors[15] and is consistent with high profile areas for current public health action in New Zealand. For example, tobacco control is relatively high profile in New Zealand. Tobacco tax was raised in April 2010 on the basis of protecting health.[61] Various non-governmental organisations (NGOs) have a vision for advancing tobacco control,[62] as do some political leaders.[63] A Select Committee Inquiry in New Zealand on tobacco issues[64] was also performed in 2010 and attracted many public submissions. Alcohol control is also prominent in existing New Zealand regulation. A major Law Commission Report on advancing alcohol control was released in 2010.[65]

In terms of blood pressure and cholesterol control, the New Zealand health sector already invests substantially in providing pharmaceuticals to those at risk and NGOs are also active in promoting heart health. In terms of physical activity promotion, the government supports this in various ways e.g., the enhanced government funding for KiwiSport (sport in schools) in 2009[66] and work on a national cycleway. While nutrition interventions are not always high on the agenda of New Zealand governments, some interventions have been enacted at times (e.g., providing free fruit to school children). Also various non-government agencies have been working for many years on improving nutrition (e.g., the work by the Heart Foundation with the food industry to lower salt levels in bread).

The selection and ranking method used here purposely prioritised risk factor areas that should reduce Māori vs non-Māori health inequalities. It is notable how these risk factors are also particularly relevant to Pacific peoples, to children/youth, to older adults and to socio-economically deprived New Zealanders. Hence it is likely that an enhanced focus on these risk factor areas should have widespread public and political acceptability. This acceptability will be strengthened if interventions are found to be actually cost-saving in New Zealand and would therefore free up tax-payer funds for other uses in the health sector in the future. Fortunately, the international evidence suggests quite a number of cost-saving and relatively cost-effective preventive interventions are possible for these risk factors.[2] In particular, cost-saving interventions that raise revenue for government in the present (e.g., tobacco tax and alcohol tax) give governments the option of either cutting income tax or spending this revenue on additional health research and health protection. Of note is that a majority of New Zealand smokers actually support higher tobacco tax if the revenue is used for quitting support and health promotion.[67]

Strengths and limitations: A strength of this analysis is that the approach is strongly based on the DALYs metric that captures both morbidity and mortality. The additional steps in our prioritisation process are logical and transparent, albeit with scope for different views about the re-ordering performed in Table 4 for reasons around data complexity and concerns about the persistence of intervention effects.

Nevertheless, there are limitations of relying on the WHO data on DALYs for high-income countries. For example the relative importance of the cholesterol risk factor in New Zealand is probably higher than other high-income countries in the Western Pacific Region given that this country has one of the most atherogenic and thrombogenic diets in the OECD.[68]

Another potential limitation with this prioritisation process was that it focused primarily on Māori vs non-Māori inequalities, and was limited by what data were available to quantify this gap for each risk factor. But as shown in Table 5, it is likely that a focus on these six risk factor areas will also benefit Pacific peoples, children/youth and older adults. Similarly, four of these risk factors are relevant to socio-economically deprived New Zealanders.

This analysis also didn't consider the potential non-health benefits of the preventive interventions, which may enhance their cost-effectiveness from a societal perspective. Selected examples are:

- The economic benefits of tobacco and alcohol interventions on reduced absenteeism and premature death of those in the workforce.
- The additional family income (especially low-income families) that could arise from reduced expenditure on tobacco and alcohol.
- The benefits of reduced crime and vehicle/property damage from improved alcohol control.
- The benefits in terms of greenhouse gas emissions reduction as a result of any promotion of active transport (e.g., walking and cycling as commuting options) and reduced use of private vehicles.[30 69] Similarly, dietary interventions to reduce cholesterol levels that resulted in less meat and dairy product intake would tend to reduce methane emissions associated with ruminant-based agriculture.[31]

Implications for further work: Given that the six top risk factor areas are likely to be of relatively high interest to health sector policy-makers, our next step will be to develop a list of potential interventions that are of most interest to study within each risk factor area, as part of NZACE-Prevention Project. This list will then be subject to critique and further revision by stakeholders. Ideally, such stakeholders will include representatives of major health agencies, of District Health Boards, of the primary care sector and experts in Māori health, Pacific health and child health. They will be asked their views on the relevance of the proposed interventions to current policy-making and likely long-term public and political acceptability in the New Zealand context. Consideration of other specific criteria for intervention selection detailed by ACE-Prevention workers in Australia[5] and the issue of obtaining public input may also be considered.

Despite the above process, there is still a case for immediate consideration by central and local government and health authorities of preventive interventions for which there is already strong international and/or New Zealand evidence for effectiveness and cost-effectiveness. For instance, further use of the many evidence-based tobacco and alcohol control interventions would appear to be strongly justified on public health grounds, and need not await additional

information prior to implementation in this country. Similarly, there is a need to act now to build up the evidence-base for New Zealand-specific interventions by funding well-evaluated pilot studies for culturally appropriate services (e.g., iwi-provider based programmes in such areas as tobacco control and improved nutrition).

References

1. Ministerial Review Group. Meeting the Challenge: Enhancing Sustainability and the Patient and Consumer Experience within the Current Legislative Framework for Health and Disability Services in New Zealand. Wellington: Ministerial Review Group to the Minister of Health, 2009.
2. Vos T, Carter R, Barendregt J, et al. Assessing Cost-Effectiveness in Prevention (ACE–Prevention): Final Report: University of Queensland, Brisbane; and Deakin University, Melbourne, 2010. www.sph.uq.edu.au/bodce-ace-prevention.
3. Cobiac L, Vos T, Doran C, et al. Cost-effectiveness of interventions to prevent alcohol-related disease and injury in Australia. Addiction. 2009;104:1646-1655.
4. Byrnes JM, Cobiac LJ, Doran CM, et al. Cost-effectiveness of volumetric alcohol taxation in Australia. Med J Aust. 2010;192:439-43.
5. Carter R, Moodie M, Markwick A, et al. Assessing cost-effectiveness in obesity (ACE-obesity): an overview of the ACE approach, economic methods and cost results. BMC Public Health. 2009;9:419.
6. Moodie ML, Carter RC, Swinburn BA, et al. The Cost-effectiveness of Australia's Active After-school Communities Program. Obesity (Silver Spring). 2010;18:1585-92.
7. Moodie M, Haby M, Galvin L, et al. Cost-effectiveness of active transport for primary school children - Walking School Bus program. Int J Behav Nutr Phys Act. 2009;6:63.
8. Haby MM, Vos T, Carter R, et al. A new approach to assessing the health benefit from obesity interventions in children and adolescents: the assessing cost-effectiveness in obesity project. Int J Obes (Lond). 2006;30:1463-75.
9. Moodie M, Haby M, Wake M, et al. Cost-effectiveness of a family-based GP-mediated intervention targeting overweight and moderately obese children. Econ Hum Biol. 2008;6:363-76.
10. Magnus A, Haby MM, Carter R, et al. The cost-effectiveness of removing television advertising of high-fat and/or high-sugar food and beverages to Australian children. Int J Obes (Lond). 2009;33:1094-102.
11. Cobiac L, Vos T, Veerman L. Cost-effectiveness of Weight Watchers and the Lighten Up to a Healthy Lifestyle program. Aust N Z J Public Health. 2010;34:240-7.
12. Shih ST, Carter R, Sinclair C, et al. Economic evaluation of skin cancer prevention in Australia. Prev Med. 2009;49:449-53.
13. Bertram MY, Lim SS, Barendregt JJ, et al. Assessing the cost-effectiveness of drug and lifestyle intervention following opportunistic screening for pre-diabetes in primary care. Diabetologia. 2010;53:875-81.
14. Cobiac LJ, Vos T, Barendregt JJ. Cost-Effectiveness of Interventions to Promote Physical Activity: A Modelling Study. PLoS Med. 2009;6:e1000110.
15. Ministry of Health. Looking upstream: Causes of death cross-classified by risk and condition, New Zealand 1997. Wellington: Ministry of Health,

2004.
16. World Health Organization. Global Health Risks: Mortality and burden of disease attributable to selected major risks. Geneva: The World Health Organization, 2009.
17. Ministry of Health. A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey. Wellington: Ministry of Health, 2008. http://www.moh.govt.nz/moh.nsf/indexmh/portrait-of-health.
18. Rehm J, Mathers C, Popova S, et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet. 2009;373:2223-33.
19. Kahende JW, Loomis BR, Adhikari B, et al. A review of economic evaluations of tobacco control programs. Int J Environ Res Public Health. 2009;6:51-68.
20. Carter R, Vos T, Moodie M, et al. Priority setting in health: origins, description and application of the Australian Assessing Cost-Effectiveness Initiative Expert Rev Pharmacoeconomics Outcomes Res. 2008;8:593-617.
21. Main C, Thomas S, Ogilvie D, et al. Population tobacco control interventions and their effects on social inequalities in smoking: placing an equity lens on existing systematic reviews. BMC Public Health. 2008;8:178.
22. Chisholm D, Rehm J, Van Ommeren M, et al. Reducing the global burden of hazardous alcohol use: a comparative cost-effectiveness analysis. J Stud Alcohol. 2004;65:782-93.
23. WHO Regional Office for Europe. Evidence for the effectiveness and cost-effectiveness of interventions to reduce alcohol-related harm. Copenhagen: WHO Regional Office for Europe, 2009. http://www.euro.who.int/document/E92823.pdf.
24. Anderson P, Chisholm D, Fuhr DC. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. Lancet. 2009;373:2234-46.
25. Asaria P, Chisholm D, Mathers C, et al. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. Lancet. 2007;370:2044-53.
26. Bibbins-Domingo K, Chertow G, Coxson P, et al. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010;362:590-9.
27. Joffres MR, Campbell NR, Manns B, et al. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. Can J Cardiol. 2007;23:437-43.
28. Yusuf S, Pais P, Afzal R, et al. Effects of a polypill (Polycap) on risk factors in middle-aged individuals without cardiovascular disease (TIPS): a phase II, double-blind, randomised trial. Lancet. 2009;373:1341-51.
29. Nnoaham KE, Sacks G, Rayner M, et al. Modelling income group differences in the health and economic impacts of targeted food taxes and subsidies. Int J Epidemiol. 2009;38:1324-33.
30. Woodcock J, Edwards P, Tonne C, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport.

Lancet. 2009;374:1930-43.
31. Friel S, Dangour AD, Garnett T, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: food and agriculture. Lancet. 2009;374:2016-25.
32. Hawkes C. Financial incentives and disincentives to encourage healthy eating. London: Which? Ltd, 2009. http://www.which.co.uk/documents/pdf/financial-incentives-and-disincentives-to-encourage-healthy-eating---which---report-192940.pdf.
33. Ni Mhurchu C, Blakely T, Jiang Y, et al. Effects of price discounts and tailored nutrition education on supermarket purchases: a randomized controlled trial. Am J Clin Nutr. 2010;91:736-47.
34. Chestnut LG, Mills DM. A fresh look at the benefits and costs of the US acid rain program. J Environ Manage. 2005;77:252-66.
35. Ellerman A, Convery F, de Perthuis C, et al. Pricing Carbon: The European Union Emissions Trading Scheme. New York: Cambridge University Press, 2010.
36. Ministry of Health. Tobacco Trends 2008: A brief update of tobacco use in New Zealand. Wellington: Ministry of Health, 2009. http://www.moh.govt.nz/moh.nsf/pagesmh/9081/$File/tobacco-trends-2008.pdf.
37. Blakely T, Fawcett J, Hunt D, et al. What is the contribution of smoking and socioeconomic position to ethnic inequalities in mortality in New Zealand? Lancet. 2006;368:44-52.
38. Carter KN, Blakely T, Soeberg M. Trends in survival and life expectancy by ethnicity, income and smoking in New Zealand: 1980s to 2000s. N Z Med J. 2010;123(1320):13-24.
39. Blakely T, Carter K, Wilson N, et al. If nobody smoked tobacco in New Zealand from 2020 onwards, what effect would this have on ethnic inequalities in life expectancy? N Z Med J. 2010;123(1320):26-36.
40. Ministry of Health. Mortality: 2005 (final) and 2006-2008 (provisional). Wellington: Ministry of Health, 2010. http://www.moh.govt.nz/moh.nsf/Files/mortdemo/$file/mort05to08-mar09.pdf.
41. Blakely T, Tobias M, Atkinson J, et al. Tracking Disparity: Trends in ethnic and socioeconomic inequalities in mortality, 1981-2004. Wellington: Ministry of Health, 2007.
42. Tobias M, Blakely T, Matheson D, et al. Changing trends in indigenous inequalities in mortality: lessons from New Zealand. Int J Epidemiol. 2009;38:1711-22.
43. Sargent M, Begg D, Broughton J, et al. Motor vehicle traffic crashes involving Maori. N Z Med J. 2004;117:U746.
44. Kahler CW, Borland R, Hyland A, et al. Alcohol consumption and quitting smoking in the International Tobacco Control (ITC) Four Country Survey. Drug Alcohol Depend. 2009;100:214-20.
45. IARC. Tobacco smoke and involuntary smoking (volume 83). Lyon, France: International Agency for Research on Cancer (IARC), 2004. http://monographs.iarc.fr/ENG/Monographs/vol83/index.php.
46. Robinson T, Bullen C, Humphries W, et al. The New Zealand Hepatitis B Screening Programme: screening coverage and prevalence of chronic hepatitis B infection. N Z Med J. 2005;118:U1345.

47. McMahon BJ. The natural history of chronic hepatitis B virus infection. Hepatology. 2009;49:S45-55.
48. Metcalf PA, Scragg RR, Schaaf D, et al. Dietary intakes of European, Maori, Pacific and Asian adults living in Auckland: the Diabetes, Heart and Health Study. Aust N Z J Public Health. 2008;32:454-60.
49. Lawes C, Stefanogiannis N, Tobias M, et al. Ethnic disparities in nutrition-related mortality in New Zealand: 1997-2011. N Z Med J. 2006;119:U2122.
50. Carter P, Gray LJ, Troughton J, et al. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. BMJ. 2010;341:c4229.
51. Fisher G, Kjellstrom T, Kingham S, et al. Health and air pollution in New Zealand (HAPiNZ). Wellington: Health Research Council of New Zealand, Ministry for the Environment, Ministry of Transport, 2007. http://www.hapinz.org.nz/.
52. Hales S, Blakely T, Woodward A. Air pollution and mortality in New Zealand: cohort study. J Epidemiol Community Health. In press.
53. Pearson JF, Bachireddy C, Shyamprasad S, et al. Association between fine particulate matter and diabetes prevalence in the U.S. Diabetes Care. 2010;33:2196-201.
54. Boffetta P, Couto E, Wichmann J, et al. Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). J Natl Cancer Inst. 2010;102:529-37.
55. Sundborn G, Metcalf PA, Gentles D, et al. Ethnic differences in cardiovascular disease risk factors and diabetes status for Pacific ethnic groups and Europeans in the Diabetes Heart and Health Survey (DHAH) 2002-2003, Auckland New Zealand. N Z Med J. 2008;121:28-39.
56. Bao W, Threefoot SA, Srinivasan SR, et al. Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: the Bogalusa Heart Study. Am J Hypertens. 1995;8:657-65.
57. Deshmukh-Taskar P, Nicklas TA, Morales M, et al. Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. Eur J Clin Nutr. 2006;60:48-57.
58. Nicklas TA, von Duvillard SP, Berenson GS. Tracking of serum lipids and lipoproteins from childhood to dyslipidemia in adults: the Bogalusa Heart Study. Int J Sports Med. 2002;23 Suppl 1:S39-43.
59. Gentles D, Metcalf P, Dyall L, et al. Serum lipid levels for a multicultural population in Auckland, New Zealand: results from the Diabetes Heart and Health Survey (DHAH) 2002-2003. N Z Med J. 2007;120:U2800.
60. US Department of Health and Human Services. Physical activity and health: A report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
61. New Zealand Government. Excise and Excise-equivalent Duties Table (Tobacco Products) Amendment Act 2010 No 23, Public Act. Wellington: New Zealand Government, 2010. http://www.legislation.govt.nz/act/public/2010/0023/latest/viewpdf.aspx.
62. Smokefree Coalition. Tupeka kore/Tobacco Free Aotearoa/New Zealand

by 2020. Wellington: Smokefree Coalition, 2009.
63. Gifford H, Bradbrook S. Recent actions by Māori politicians and health advocates for a tobacco-free Aotearoa/New Zealand, A brief review (Occasional Paper 2009/1). Wellington: Whakauae Research Services; Te Reo Mārama; Health Promotion and Public Health Policy Research Unit (HePPRU), 2009. http://www.wnmeds.ac.nz/itcproject.html.
64. New Zealand Parliament. Inquiry into the tobacco industry in Aotearoa and the consequences of tobacco use for Maori, 2009. http://www.parliament.nz/en-NZ/PB/SC/BusSum/e/1/6/00DBSCH_INQ_9591_1-Inquiry-into-the-tobacco-industry-in-Aotearoa-and.htm.
65. New Zealand Law Commission. Alcohol In Our Lives: Curbing the Harm (NZLC R114). Wellington New Zealand Law Commission, 2010. http://www.lawcom.govt.nz/ProjectReport.aspx?ProjectID=154.
66. Key J. Kiwisport initiative good for young people (media release, 11 August): NZ Government. http://www.beehive.govt.nz/release/kiwisport+initiative+good+young+people, 2009.
67. Wilson N, Weerasekera D, Edwards R, et al. Characteristics of smoker support for increasing a dedicated tobacco tax: National survey data from New Zealand. Nicotine Tob Res. 2010;12:168-73.
68. Laugesen M, Swinburn B. The New Zealand food supply and diet--trends 1961-95 and comparison with other OECD countries. Organisation for Economic Co-operation and Development. N Z Med J. 2000;113:311-5.
69. Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. Lancet. 2009;373:1693-733.