

# Investing in public health

## An update

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**Canterbury**  
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Te Poari Hauora o Waitaha

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## Executive summary

Non-communicable diseases (NCDs), are the leading cause of health loss and health inequity in New Zealand, yet many risk factors associated with NCDs are largely preventable (Institute for Health Metrics and Evaluation, 2016; Ministry of Health, 2018a). There is considerable scope for health promotion and disease prevention through effective public health interventions. However, spending on prevention and public health is low and research suggests it has decreased over the past decade. In the context of pressure on governments and health agencies to get the best “value for money”, research demonstrating that public health interventions are cost-effective or even cost-saving can make an important contribution.

This report provides recently-published examples of cost-effective or cost-saving public health interventions that contribute to significant population health gains. In order to highlight the strengths and challenges that different types of interventions offer, this report has grouped interventions under three headings: health promotion, preventive interventions, and health protection. In addition to their cost-effectiveness and impact on equity, it is important to consider other benefits and challenges of different intervention types, such as acceptability to stakeholders, feasibility of implementation, strength of the evidence, potential for other consequences (positive and negative), and sustainability (Ananthapavan et al., 2018; Armstrong, 2010). The report also provides a brief overview of approaches to public health investment in selected overseas countries.

This update provides further evidence to support investment in public health for disease prevention and health promotion, particularly for diseases and risk factors that contribute to substantial health loss and inequity in New Zealand.

## Introduction

In 2009 Community & Public Health prepared a briefing paper for the Canterbury District Health Board which argued that investing in public health is a sensible economic strategy to improve population health (Community & Public Health, 2009). In 2015 the paper was updated, and further developed the argument for the cost-effectiveness of public health interventions for disease prevention and health promotion. This paper presents newly-updated evidence for a range of public health interventions, grouped into three functions: health promotion, preventive interventions and health protection.

### Health loss in New Zealand

In New Zealand, both life expectancy and health expectancy (the number of years lived in good health) have increased over the past two decades. While this is good news, life expectancy has increased at a faster rate than health expectancy, resulting in people living longer in poor health (Institute for Health Metrics and Evaluation, 2016; Ministry of Health, 2018a). Non-communicable diseases (NCDs), in particular cancers, vascular disease and musculoskeletal conditions, are the leading cause of health loss (measured by disability-adjusted life years (DALYs)) in New Zealand (Institute for Health Metrics and Evaluation, 2016; Ministry of Health, 2018a). The overall proportion of health loss from NCDs has increased over time from 82.5 percent in 1990 to 87.3 percent in 2016 (Institute for Health Metrics and Evaluation, 2016).

There are a number of related modifiable risk factors for poor health outcomes due to NCDs. Among individual risk factors, tobacco use is the leading contributor to health loss for death and disability combined, accounting for 9.7 percent of health loss, followed by unhealthy diet, high body mass index (BMI), high blood pressure and high glucose levels (Institute for Health Metrics and Evaluation, 2016). The relative contribution of different risk factors is likely to change over time: for example, tobacco use's contribution to health loss is decreasing (Institute for Health Metrics and Evaluation, 2016; Ministry of Health, 2018b), whereas increasing population BMI will mean increasing health loss attributable to high BMI (Institute for Health Metrics and Evaluation, 2016; Ministry of Health, 2013).

Within New Zealand, inequities in health outcomes at least partly reflect inequities in NCD risk factor distribution. There are significant health inequities between Māori and non-Māori. Health loss among Māori is almost 1.8 times higher than among non-Māori, with more than half of Māori health loss occurring prior to middle age (Ministry of Health, 2013). New Zealand health survey data (pooled from 2014 to 2017) indicated Māori were over twice as likely to be current smokers than non-Māori and the risk was three-fold among Māori women compared with non-Māori women (adjusted ratio 3.52) (Ministry of Health, 2018b). There were also significant inequities among New Zealand children: for example, Pacific and Māori children were less likely to eat breakfast at home every day than non-Pacific and non-Māori children, and Pacific children were more likely to have a fizzy drink and fast food more than three times a week, compared with non-Pacific children (Ministry of Health, 2018b).

As many NCD risk factors are potentially modifiable, there is considerable scope for disease prevention and health inequity reduction through effective public health interventions.

## Expenditure on public health

After several years of plateaued or decreased health spending in Organization for Economic Cooperation and Development (OECD) countries, overall health spending grew by the fastest rate in seven years during 2016, increasing by an average of 3.4 percent (OECD, 2018, 2019). This figure is still below growth rates prior to 2009, when health expenditure increased on average between 4 to 6 percent per year. The OECD predicted further growth in 2017, but a number of countries, including New Zealand, projected reduced growth compared with 2016 (OECD, 2018). Research from the New Zealand Institute of Economic Research and Victoria University found that real (inflation-adjusted) health expenditure per capita in New Zealand has plateaued since 2010 and the overall growth rates in the 2010s are significantly lower than previous years (Cumming, 2017). Reduced expenditure has affected spending categories to varying degrees, and many countries have reduced spending on prevention and public health services – by an average of 1.5 percent in 2010 and 1.7 percent in 2011 (OECD, 2013).

Although access to medical care is considered a less influential determinant of health outcomes than behaviour and the environment (Mokdad, Marks, Stroup, & Gerberding, 2004; University of Wisconsin Population Health Institute, 2018), health expenditure in most countries suggests otherwise. On average, OECD countries in 2015 dedicated a majority (80%) of health expenditure to treatment, followed by long-term care (13.7%) and health system administration (3.6%) (Gmeinder, Morgan, & Mueller, 2017). Spending on prevention and public health services among OECD countries averaged 2.8 percent of health expenditure in 2015. Similarly in New Zealand, spending on prevention and public health is low and Vote Health budgets suggest it has decreased over the past decade. In the 2017/18 financial year, it was intended that the Ministry of Health would use just over \$406 million (2.4% of Vote Health) to purchase public health services (The Treasury, 2018), compared with \$515 million (4% of Vote Health) in the 2009/2010 financial year (The Treasury, 2009).

## Allocating resources to public health

In the context of pressure on governments and health agencies to get the best “value for money”, investment in effective prevention has an important place as a cost-effective strategy to target modifiable risk factors, inequities, and overall health loss. Some public health interventions have been shown to be cost-saving, and many more have cost-effectiveness ratios more favourable than, or similar to, some health care interventions (Community & Public Health, 2009; Richardson, 2012; WHO, 2014). For example, a study assessing economic evaluations of public health interventions in the United Kingdom (UK) found nearly two-thirds were cost-effective<sup>1</sup> (Owen, Pennington, Fischer, & Jeong, 2017). Similarly, a recent systematic review that studied the return on investment (ROI) of public health interventions in the UK found they were generally cost saving; the median ROI for public health interventions was 14.3 to 1 (for every £1 spent on an intervention there was a return of £14.30) (Masters, Anwar, Collins, Cookson, & Capewell, 2017). However, cost-effectiveness varied for different types of interventions; for example, public health interventions that focused on health protection, public policy, or were delivered on a national level offered the largest benefits (ROI 34.2,

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<sup>1</sup> An intervention is generally described in the literature as cost-effective if the cost per health unit gained is below a defined “willingness to pay” threshold (WHO, 2015).

46.5, and 27.2, respectively) (Masters et al., 2017), while health promotion interventions and those delivered on a local level had smaller returns (ROI 2.2 and 4.1, respectively).

In addition to their cost-effectiveness, it is important to consider other benefits and challenges of different intervention types, such as acceptability to stakeholders, feasibility of implementation, strength of the evidence, potential for other consequences (positive and negative), equity, and sustainability (Ananthapavan et al., 2018; Armstrong, 2010). Reporting this range of evidence provides decision-makers with a comprehensive picture of the likely impact of an intervention as well as the practical challenges that may need to be overcome. For example, national policy or statutory interventions are often inexpensive to implement and reach a large proportion of the population, and so can have a large impact on population health. However, these types of interventions often only produce health gains in the longer term (i.e. longer than a political cycle) and may encounter commercial opposition (Ananthapavan et al., 2018; Vos et al., 2010).

The intervention type may also determine the degree to which an intervention lends itself to outcomes-focused research, as well as the nature of outcomes that can be measured (Ananthapavan et al., 2018; Rychetnik, Frommer, Hawe, & Shiell, 2002). For example, the ACE study (2018), which modelled the cost-effectiveness of sixteen obesity prevention interventions, found that program-based interventions (e.g. community-based nutrition and physical activity programmes) reported a higher strength of evidence for outcome effectiveness (e.g. change in BMI, physical activity and diet) than public policy interventions (Ananthapavan et al., 2018). Challenges in generating and interpreting the evidence include the difficulty of measuring outcomes in the longer term, and of measuring the effectiveness of an intervention on multifactorial health issues. For example, the impact of smoking taxation on cardiovascular disease is difficult to measure because many factors contribute over time to cardiovascular disease development. Nevertheless, an intermediate outcome such as tobacco sales can provide an important indicator of the short-term effectiveness of the tax.

Where real-world data is incomplete, particularly for novel interventions, economic modelling studies are widely used to provide decision-makers and health agencies with evidence on the likely cost-effectiveness of an intervention (Lal et al., 2017). Cobiac and colleagues (2017) explain that “by synthesising the best available evidence, modelling studies can give an indication of whether it is worthwhile implementing and evaluating a change in policy ... [they] can provide guidance on the design of the new policy and accompanying monitoring and evaluation strategies.” Although there are many benefits to modelling studies, there are also limitations to consider when interpreting this type of evidence. These include: limitations on extrapolating the findings to different populations, timeframes, or dosages; the availability of high quality epidemiological and costing data; the use of surrogate measures; and other potential impacts unaccounted for in the model (Ananthapavan et al., 2018). It is therefore important to understand both the type of intervention and the setting of the evidence when considering an intervention’s potential impacts within a New Zealand population.

## Methods

The following sections describe recently-published examples of cost-effective or cost-saving public health interventions that contribute to significant population health gains. Current literature on economic evidence for investing in public health was identified by conducting electronic searches through the Google and Google Scholar search engines, and OVID (all resources). The search terms “public health”; “health promotion”; “health education”; “early intervention OR education program OR prevention OR intervention program”; along with some individual health behaviours of interest, for example “alcohol prevention”; “smoking prevention”; “early detection” OR “screening”; AND “cost-benefit analysis OR costs and cost analysis OR return on investment” were applied to find relevant articles. Searches were limited to date range 2014-2019 (January) and English language articles. Further articles were found through examining citations and reference lists of key articles, and by conducting searches of principal researcher’s recent publications (for example, the University of Otago’s Burden of Disease, Epidemiology, Equity & Cost-effectiveness programme (BODE<sup>3</sup>)). Articles published in peer reviewed journals and reports published by government departments or non-government organisations (NGOs) were considered for inclusion. Abstracts of articles identified in the literature search were screened by one reviewer. Outcomes from economic modelling studies are highly sensitive to the specific intervention and population the model is applied to, as such, articles were screened and ranked with regards to the applicability to a New Zealand setting.

In order to highlight the strengths and challenges that different types of interventions offer, this report has grouped interventions under three headings: health promotion, preventive interventions, and health protection. Most types of public health intervention can be applied to a range of health determinants or health issues; this has been illustrated with evidence and examples for each intervention type, along with discussion of equity and practical considerations.

Finally, a brief overview is provided of approaches to public health investment in selected overseas countries.

## Health promotion

### Building healthy public policy

Public policy at national and local level can make important contributions to the wellbeing of individuals and society (Dalziel, Saunders, & Saunders, 2018). Healthy public policy can reach large populations and can therefore generate substantial health gains and cost-savings, often in the long-term (Ananthapavan et al., 2018; Masters et al., 2017). In the UK, legislative interventions demonstrated the highest ROI among a range of public health interventions, offering a £46 median return on every £1 spent (Masters et al., 2017).

Because public policy is so far-reaching, acceptability to the public, industry, politicians and other stakeholders (e.g. non-government sector) is an important factor. Factors influencing policy acceptability include impact on profit for the relevant industry, the time-frame of the projected health gains and cost-savings (for example, is it longer than a political cycle?), and how much an



individual will benefit from an intervention (Christensen, Doblhammer, Rau, & Vaupel, 2009; Vos et al., 2010).

As public policy is often cross-sectoral, successful implementation will require an integrated and balanced approach across a range of government sectors (Ananthapavan et al., 2018; Dalziel et al., 2018). Other challenges include the finance, effectiveness, time scale and impact on equity of implementing a national or local policy (Vos et al., 2010). Nevertheless, many public policy interventions are deemed feasible, particularly where there are real-world examples from other countries where a policy has been successfully implemented.

As discussed above, measuring the impact of policy change on a multifactorial health issue for a large population may also be challenging. However, studies are often able to use intermediate outcomes such as the sales of alcohol, tobacco or unhealthy food to demonstrate short to medium term effectiveness of the policy, and modelling studies are commonly used to evaluate public policies' cost-effectiveness.

### Taxation

Taxation is an established public health policy approach for reducing tobacco- and alcohol-related harm, and there is evidence that increased taxation changes smoking and drinking behaviours and reduces consumption (Burton et al., 2017; Cleghorn et al., 2018; Cobiac, Vos, Doran, & Wallace, 2009; Holm, Veerman, Cobiac, Ekholm, & Diderichsen, 2014; WHO, 2015). Within an Australian population, taxation of tobacco, alcohol and unhealthy foods were modelled as dominant interventions<sup>2</sup> potentially preventing the loss of 270,000, 100,000 and 110,000 DALYs per intervention (over the lifetime of the 2003 Australian population), respectively (Vos et al., 2010). In New Zealand several modelling studies have found that 10% annual tobacco tax increases could produce net cost savings to the health system and generate substantial health gains, particularly among Māori and the working age population (Blakely et al., 2015; Cleghorn et al., 2018; van der Deen et al., 2018). Similarly, modelling of the impact of taxation of alcohol in Australia and Denmark demonstrated the largest health gains and cost savings when compared with other alcohol control strategies, such as raising the drinking age, mass media campaigns, and advertising bans (Cobiac et al., 2009; Holm et al., 2014; Vos et al., 2010).

Taxation is less well-established for other risk factors, but there is early evidence for cost-effective prevention of dietary-related disease (Ananthapavan et al., 2018; Cobiac, Tam, Veerman, & Blakely, 2017; Gortmaker, Wang, et al., 2015). Recently over twenty countries, including the UK, Mexico and Ireland, have introduced taxes on sugar-sweetened beverage (SSBs) as part of efforts to improve nutrition and prevent obesity. Initial evidence from Mexico has shown that two years after the SSBs tax was implemented there had been an eight percent decrease in the sale of taxed beverages (Colchero, Rivera-Dommarco, Popkin, & Ng, 2017). Emerging international modelling studies suggest that taxing other unhealthy food and beverages may also reduce consumption and generate health gains and cost-savings within a population (Cobiac et al., 2017; Gortmaker, Wang, et al., 2015). For example, an Australian modelling study showed that a sugar tax would lead to the greatest improvement in population health (270,000 DALYs averted over the lifetime of the 2003 Australian

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<sup>2</sup> Dominant interventions produce health gains and save costs (Vos et al., 2010).

population), followed by taxation of excess salt, saturated fat and SSBs (Cobiac et al., 2017). Furthermore, all of the taxes were found to be cost-saving.

Evidence regarding the impact of taxation on equity is mixed. Modelling studies in New Zealand found a tobacco tax is likely to reduce health inequities for Māori and those on low incomes within New Zealand (Blakely et al., 2015; Cleghorn et al., 2018). Conversely, some evidence suggests that pricing policies such as taxation can have a larger financial burden for those on low-incomes, especially if consumption does not decrease (Sassi et al., 2018; WHO, 2015). Studies that modelled alcohol taxation in Australia and the United Kingdom suggested it could increase inequities, as it would increase the price of low cost alcohol, possibly affecting those on a low-income disproportionately (Ananthapavan et al., 2018; Burton et al., 2017). However, other analyses suggest that purchasing low priced alcohol is associated with drinking behaviour (i.e. heavy consumer) rather than income (Ananthapavan et al., 2018; Burton et al., 2017; Sassi et al., 2018). There is as yet insufficient real-world evidence on the impact on equity of taxes on unhealthy food or drink (Cobiac et al., 2017; Cobiac, Vos, & Veerman, 2010). However, a modelled SSBs tax in Australia suggests it would have a neutral impact on equity, as although people in the most deprived quintiles would pay a slightly greater annual tax per capita than the least deprived quintile, half of the health gains would also accrue to them (Lal et al., 2017).

Taxation interventions must respond to practical challenges such as acceptability and feasibility. In most cases the relevant industries are unlikely to welcome a policy that may reduce consumption and profit (Ananthapavan et al., 2018; Cobiac et al., 2017). However, the growing implementation of taxation on unhealthy food and beverages in other countries suggest there is increasing political and public support for this type of policy (Lal et al., 2017). Furthermore, as tobacco and alcohol are already taxed within New Zealand, tax increases are a feasible and sustainable intervention that can be expected to produce cost-savings and health gains in the long-term (Ananthapavan et al., 2018; Burton et al., 2017).

### Advertising regulation

Mandatory advertising regulation of alcohol and unhealthy foods and beverages (particularly targeting children), also show promise as cost-saving and health promoting public policies (V. Brown et al., 2018; Gortmaker, Long, et al., 2015; Magnus, Haby, Carter, & Swinburn, 2009; Vos et al., 2010).

There is evidence that increased advertising regulation on unhealthy food and beverages reduces consumption, particularly among children (Ananthapavan et al., 2018; Gortmaker, Long, et al., 2015). Within an Australian population, restricted advertising of unhealthy foods was modelled to gain 88,396 health-adjusted life years (HALYs) (for children 5-15 years) and produce total cost-savings of AU\$777 million for the total population (over the lifetime of the 2010 Australian population) (V. Brown et al., 2018). However, due to the lack of real-world interventions there is limited direct evidence of impact on health outcomes.

There is limited evaluation or real-world evidence on the effect of advertising restrictions on alcohol consumption (Cobiac et al., 2009; Holm et al., 2014). Modelling studies suggest that advertising regulation results in less consumption, with declining effectiveness as the policy moves from a complete ban to less restriction (Burton et al., 2017; Cobiac et al., 2009; Holm et al., 2014). A

complete restriction on alcohol advertising was modelled to avert 7,800 DALYs in the Australian population and save AU\$12 million (over the lifetime of the 2003 Australian population) (Cobiac et al., 2009). When compared with other modelled alcohol interventions (e.g. mass media campaigns, random breath testing or residential treatment), regulation of alcohol advertising showed greater cost savings and health gains, particularly when combined as an intervention package with alcohol taxation (Cobiac et al., 2009; Holm et al., 2014).

Evidence regarding the impact of mandatory advertising regulation on equity suggests a positive effect. Modelling studies from Australia and the United States (US) found evidence that increased advertising regulation on unhealthy food and beverages is likely to improve health equity for children living in the most deprived neighbourhoods (V. Brown et al., 2018; Gortmaker, Long, et al., 2015; Gortmaker, Wang, et al., 2015). This is because children from low socioeconomic households watch more television, and so may experience a greater effect of the reduction of advertising. Evidence on the impact of alcohol advertising regulation on equity is insufficient (Burton et al., 2017).

Advertising regulation faces similar practical challenges to taxation. Acceptability of advertising regulation to the food and beverage, media and advertising industries is low. However, in Australia acceptability to the public and government support are growing, particularly for a reduction on advertising of unhealthy food and beverages to children (V. Brown et al., 2018). A partial ban on advertising is more likely to be feasible in New Zealand than a complete ban, as there are few examples of complete bans from other countries. Once implemented, advertising restrictions are relatively sustainable.

### Nutrition content regulation

Nutrition content regulation is another public policy intervention with evidence suggesting good value for money in dietary-related disease prevention. Some experimental studies have demonstrated that people still consume the same amount of food and drink following the reformulation of food content (Ananthapavan et al., 2018). The evidence is weaker on the clinical effectiveness of food reformulation (e.g. on BMI reduction or body weight) (Crino et al., 2017), although there is evidence that a low sodium diet reduces the risk of several non-communicable diseases, including cardiovascular disease (CVD) (Beaglehole et al., 2011; Bibbins-Domingo et al., 2010; Nghiem, Blakely, Cobiac, Cleghorn, & Wilson, 2016; Wilson et al., 2016). Several modelling studies in Australia and New Zealand suggest that regulations that lower the salt content in food (through voluntary or mandatory regulations) are cost-effective, if not cost-saving, and beneficial to population health (Nghiem et al., 2016; Vos et al., 2010; Wilson et al., 2016). There are fewer studies demonstrating the cost-effectiveness of reduced sugar content in food and beverages. However, an Australian obesity prevention study modelled mandatory reduction of sugar/energy content in SSBs, and compared with no intervention, the intervention generated substantial health gains (144,621 HALYs) and cost savings (AU\$1.5 billion) over the lifetime of the 2010 Australian population (Crino et al., 2017).

Evidence suggests that food and beverage reformulation has a neutral or positive impact on equity. Multiple modelling studies in New Zealand found that salt reduction would reduce health inequities, particularly among Māori (Nghiem et al., 2016; Wilson et al., 2016). In regards to the mandatory

reduction of sugar/energy content in SSBs, the Australian modelling study found the intervention would positively impact equity as consumption of SSBs is higher among low socioeconomic groups (Crino et al., 2017).

The practical challenges of implementing nutrition content regulations are similar to other public policies. Industries are likely to find this intervention more acceptable if the regulations are voluntary, not mandatory. In Australia, it was predicted that a SSBs reformulation would have a high level of government support if the policy was voluntary (Crino et al., 2017). Reformulation of foods has been implemented in many countries and is both feasible and sustainable.

### Nutrition labelling

Improving nutrition labelling or providing endorsement label initiatives also have the potential to improve population health and be good value for money. Nutritional labelling on fast food and unhealthy food, and health-star rating systems on healthier foods reduce energy consumption, both through changes in consumer behaviour and product reformulation (to reduce energy content) (Ananthapavan et al., 2018; Hawkes et al., 2015). However, it is likely that nutrition labelling helps groups of people who already have healthy preferences and intend to have a healthy diet (Hawkes et al., 2015). The Heart Foundation's voluntary "Tick" endorsement label programme currently in place in New Zealand was modelled as a dominant intervention, potentially gaining 7,900 QALYs in the adult population (over the lifetime of the 2000 New Zealand population) and the gains from regulatory options were even greater (Nghiem, Blakely, Cobiac, Pearson, & Wilson, 2015). Some nutritional labelling programmes have been classified as health promoting and cost-saving, including the traffic-light labelling programme (Sacks, Veerman, Moodie, & Swinburn, 2011), menu kilojoule labelling on fast food, and supermarket shelf tags (Ananthapavan et al., 2018).

Few studies have evaluated the real-life impact of nutritional labelling on equity (WHO, 2015), however modelling studies in Australia suggest they may have a neutral or positive impact on equity (Ananthapavan et al., 2018). Nutrition labelling policies are often more feasible and acceptable to stakeholders than taxation or advertising regulation policies. The acceptability to the industry was assessed in the Australian ACE to be increasing, as five jurisdictions had recently implemented the policy (Ananthapavan et al., 2018). The study also reported these policies have strong public and government support, particularly if they are promoting a government-endorsed rating system. Once implemented, nutrition labelling is sustainable, given its regulatory nature.

### Mass media

Mass media campaigns are a form of health promotion used to disseminate population-wide messages about a particular health-related behaviour (Wakefield, Loken, & Hornik, 2010). The focus of campaigns varies, although some of the most common aim at tobacco, alcohol, road safety, heart-disease prevention and cancer-screening (Wakefield et al., 2010). Dissemination may be through a variety of media, such as television, radio, billboards, print media, and in recent years through the internet and social media (Freeman, Potente, Rock, & McIver, 2015; Wakefield et al., 2010). Several economic evaluations have found mass media campaigns on a range of health behaviours to be health promoting and cost-effective, if not cost-saving (Ananthapavan et al., 2018; Atusingwize, Lewis, & Langley, 2015; Nghiem et al., 2018).

This type of intervention is valuable because it exposes a large proportion of the population to a health message, and can be either stand alone or work-alongside another public health intervention, such as a clinical outreach or a recent change in public policy. Mass media campaigns can change behaviour through direct and indirect pathways. Mass media campaigns are more likely to be successful when they are a key component of a larger intervention (e.g. mass media campaign to promote quit smoking support services), are supported by policies that enable people to make the change, and when the target behaviour is a one-off rather than habitual activity (e.g. immunisation rather than physical activity) (Wakefield et al., 2010).

Mass media campaigns targeting tobacco display a strong level of effectiveness on health behaviour change, as well as cost-effectiveness. Mass media campaigns targeting tobacco have been associated with an increase in the number of adults stopping smoking and a decrease in young people starting (Atusingwize et al., 2015; Wakefield et al., 2010). In New Zealand, a package of a national Quitline service and its promotion in the mass media was modelled to estimate its impact on population health and cost-effectiveness. The study found that over one year of routine operation, the package (mass media and Quitline service) gained 4,200 QALYs and generated \$84 million in cost-savings (Nghiem et al., 2018). The largest health gains and cost-saving were predicted with a 20-year time horizon (estimated 54,000 QALYs gained and \$1.1 billion in cost-savings).

Beyond tobacco campaigns, evidence regarding the effectiveness of mass media campaigns on health outcomes or behaviour change is mixed. There is strong to moderate evidence of effectiveness of a number of campaigns, including campaigns focusing on driver safety, physical activity, nutrition, CVD prevention and some cancer screening (Wakefield et al., 2010; WHO, 2015). However, there has been weak, insufficient or inconclusive evidence on campaigns aiming to change health behaviours such as mental health, breastfeeding, skin cancer, and hazardous drinking. This may be partly due to the challenges of measuring the direct and indirect impacts of a mass media campaign (WHO, 2015). Nevertheless, several modelling studies have suggested that some mass media campaigns targeting health behaviours are cost-effective. For instance, mass media campaigns on drink-driving (Burton et al., 2017; Cobiac et al., 2009; WHO, 2015), sun exposure (Doran et al., 2016; Shih, Carter, Heward, & Sinclair, 2017a, 2017b), SSBs consumption (Ananthapavan et al., 2018), physical activity (Vos et al., 2010; WHO, 2015), and mental wellbeing (Vaithianathan & Pram, 2010) have all been reported to be cost-effective.

An example of a mental wellbeing campaign in New Zealand with evidence suggesting cost-effectiveness is "Like Minds", a public campaign to counter the stigma associated with mental illness. The estimated economic benefits of this campaign over five years (with regards to increased access to employment, hours worked, and increased use of primary care) was \$720 million and a calculated \$13 return for every dollar spent (Vaithianathan & Pram, 2010). Another example of a successful mass media campaigns is three combined skin cancer prevention campaigns implemented in New South Wales, Australia, from 2006-2013. The intervention was estimated to have prevented 13,000 cases of skin cancers, averted 112 deaths (over 2006-2013) and produced a benefit cost ratio of AU\$3.85 (i.e. for every \$1 invested a return of \$3.85 is gained) (Doran et al., 2016).

Evidence regarding the impact of mass media campaigns on equity is mixed. There is some evidence that mass media campaigns targeting tobacco (especially those that link smoking to serious health

conditions) are associated with an increase in smoking cessation among lower socioeconomic groups (Wakefield et al., 2010). In New Zealand, Nghiem and colleagues (2018) found a package of a mass media and Quitline service, would result in four times as much health gain per capita for Māori than for non-Maori. However, a modelled mass media campaign in Australia targeting SSBs consumption found no evidence that the effectiveness differed between demographic or socioeconomic groups, and would likely have a neutral impact on equity (Ananthapavan et al., 2018).

Mass media campaigns are generally considered feasible on a national scale, as most require a modest investment from government and encounter fewer issues with acceptability than a public policy change (Ananthapavan et al., 2018). Practical challenges encountered when implementing a mass media campaign include ensuring the health messages are grounded in accurate research and are suitable for the target population, securing sufficient and sustainable funding, and ensuring that the target population have adequate access to the services being offered or promoted in the campaign (Wakefield et al., 2010). Challenges in generating and interpreting the evidence include measuring the direct and indirect impacts of a mass media campaign within an entire population (WHO, 2015) and, in some cases, the lack of real-world data and reliance on models that represent the best estimate of price elasticity and a potential health effect from the intervention (Ananthapavan et al., 2018).

### Create supportive environments

Initiatives to create supportive environments include a wide range of policy or environmental changes that can support and sustain behavioural change (Ananthapavan et al., 2018; Masters et al., 2017). Although people's environment plays a large part in their behaviour choices, it can be challenging to isolate the effects of a specific environmental change on health outcomes. There are a modest number of studies evaluating the cost effectiveness of supportive environments and the evidence is more established for some settings than others. The examples considered here are health promotion in education settings, and improving the built environment to facilitate active transport.

Education settings are a key environment that can have a profound influence on the wellbeing of children and adolescents, across all socioeconomic groups. There is evidence that health promotion within school settings is effective in many areas of health such as improving nutrition and physical activity (Hawkes et al., 2015; Waters et al., 2011), reducing the uptake of student smoking (Thomas, McLellan, & Perera, 2013), promoting mental health and reducing depression (Mihalopoulos, Vos, Pirkis, & Carter, 2012; WHO, 2015), and reducing violence and substance abuse (Foxcroft & Tsertsvadze, 2011; Weare & Nind, 2011). An example from New Zealand is the WAVE (Wellbeing And Vitality in Education) programme implemented throughout education settings in South Canterbury. Evaluations of WAVE, have noted many benefits, including improved teaching of the health curriculum, an increase in the proportion of settings that had staff attend professional development in health related topics, and evidence of increasing partnership between schools and communities (Calder et al., 2017).

Several economic evaluations have found that school settings aiming to prevent dietary-related disease through healthy food choices and physical activity are health promoting and cost-effective (Ananthapavan et al., 2018; Gortmaker, Long, et al., 2015; Rush, Obolonkin, et al., 2014; WHO,

2015). An example from New Zealand is Project Energize, introduced in the Waikato region from 2006 and including initiatives such as promoting active transport and lunchtime games, and assisting schools with canteen “makeovers”. Project Energize has demonstrated a lower prevalence of overweight/obesity among children in participating schools (Rush, McLennan, et al., 2014; Rush et al., 2012). Economic analysis supports its relative cost-effectiveness (the increment in cost per QALY gained was \$30,438 for younger and \$24,690 for older children), and it appears more cost-effective than several other health promoting interventions currently in place in New Zealand (Rush, Obolonkin, et al., 2014).

School settings also show promise as an environment to promote mental health and reduce mental illness for children and adolescents (Mihalopoulos et al., 2012). Several economic evaluations have found that school settings that aim to promote mental health and reduce mental illness are effective and good value for money (Lee et al., 2017; Mihalopoulos & Chatterton, 2015; Mihalopoulos et al., 2012; WHO, 2015). The evidence suggests that these types of interventions are more effective when they: include a focus on positive mental health; balance universal and indicated approaches; start at a young age and continue promotion through to adolescence; work over a long time frame; and integrate the intervention within the whole school (e.g. curriculum, liaison with community, teachers and parents) (WHO, 2015).

Adapting the built environment to facilitate active transport is another example of creating a supportive environment. An inactive lifestyle contributes to a range of poor health outcomes including coronary heart disease, stroke and diabetes (Beaglehole et al., 2011). Investing in walking and cycling infrastructure helps to counteract physical inactivity, by building physical activity into people’s daily lives. There is limited direct evidence on the cost-effectiveness of this type of intervention, although recent modelling studies found investing in cycle and walking infrastructure was good value for money and could improve the lifestyle behaviours and health outcomes of a population (V. Brown, Diomedi, Moodie, Veerman, & Carter, 2016; Davis, 2014; Macmillan et al., 2014; NICE, 2018a).

The UK Department of Transport reviewed the economic evidence for walking and cycling infrastructure projects implemented within the UK and found the average benefit to cost ratio was 5.6:1 (i.e. for every £1 spent a return of £5.60 is gained) (Davis, 2014). More recent British research found that these type of interventions could be cost-effective even if only modest numbers of people increased their physical activity. For example, an intervention that costs £10 per person in a population of 100,000, would be cost-effective if a further 1,000 people cycled an extra 30 minutes per week (NICE, 2018a). As the cost of an intervention increased a greater amount of physical activity was required for it to be good value for money (NICE, 2018a).

Because a ‘supportive environment’ can refer to variety of settings, the evidence on equity, feasibility and acceptability should be reviewed for each intervention and setting (NICE, 2018a). For instance, there is evidence that school based health promotion targeting obesity reduces health inequities (Hillier-Brown et al., 2014). Creating a built environment that supports modes of low-cost active transport could potentially increase equitable access to resources and jobs (Macmillan et al., 2014). Feasibility and acceptability also varies depending on the type of intervention and setting. For instance, further implementation of health promotion in schools seems feasible and acceptable as it

is already implemented throughout New Zealand schools (e.g. Health Promoting School model). The feasibility of investment in a healthy built environment is likely to depend on funding and the effectiveness of an intervention. In 2018, the New Zealand government demonstrated commitment to improving the availability and safety of this infrastructure by announcing a \$390 million package in walking and cycling infrastructure over three years (Twyford & Shaw, 2018).

## Preventive interventions

### Immunisation

Immunisation is an established public health approach for protecting infants and children from infections. Although NCDs contribute to the greatest health loss among New Zealanders overall, communicable, maternal, neonatal and nutritional diseases contribute to 4 percent of health loss (Ministry of Health, 2018a). Infectious diseases made up the greatest contribution to acute hospital admissions (of any cause) in New Zealand between 2004 and 2008 (Baker et al., 2012). Some vaccine-preventable diseases, such as human papillomavirus and hepatitis B, are also known causes of cancer and thereby also contribute to the non-communicable diseases burden. A substantial body of evidence indicates that immunisation is one of the most cost-effective public health interventions (WHO, 2013), and several childhood immunisations currently included in the New Zealand National Immunisation Schedule (Ministry of Health, 2017) such as against measles, mumps and rubella (Babigumira, Morgan, & Levin, 2013; Masters et al., 2017; Thompson & Odahowski, 2014), and *Haemophilus influenzae* type b disease (Chongmelaxme et al., 2017; Griffiths & Miners, 2009; Masters et al., 2017) have been shown to be cost-effective, if not cost-saving. Immunisation for infants against rotavirus was estimated in 2009 to be a cost-effective programme in New Zealand, whereby 1,191 hospitalisations, 2,442 Emergency Department-treated cases, 9,762 primary care consultations, and 0.8 deaths would be averted by the fifth year after the introduction of the programme (Milne & Grimwood, 2009).

Immunisation against Human Papillomavirus (HPV) to prevent cervical cancer and other HPV-related diseases has been introduced in many countries (Cervical Cancer Action, 2012), and providing these programmes to adolescent girls is deemed cost-effective (Brisson et al., 2013; Canfell et al., 2012; Pearson et al., 2014; Seto, Marra, Raymakers, & Marra, 2012). Analyses suggest that the programme implemented between 2008 and 2016 in New Zealand (i.e. three-dose immunisation regime for adolescent girls through school or primary care providers) had a cost-effectiveness of \$18,800 per QALY gained compared to no vaccination programme (Blakely et al., 2014). In 2017, the HPV programme was extended to include male and females aged 9-26 years (Ministry of Health, 2017). One modelling study reported that extending the New Zealand programme to include boys would be unlikely to be cost-effective, unless vaccine and administration costs were drastically reduced (Pearson et al., 2014). However, there may be other benefits to including males in the programme that are not considered in this model, such as normalising the vaccine among all adolescents and thereby increasing uptake among the female population.

A modest number of studies have reported the cost-effectiveness of the influenza vaccine, and recent evidence shows the vaccine is cost-effective, if not cost-saving, in high-income countries, (Newall, Chaiyakunapruk, Lambach, & Hutubessy, 2018; Newall, Jit, & Beutels, 2012; Peasah, Azziz-



Baumgartner, Breese, Meltzer, & Widdowson, 2013; Ting, Sander, & Ungar, 2017). The effectiveness of the influenza vaccine depends on a range of factors, including the efficacy of the vaccine against the virus circulating that season, and the age and immune competence of the individual receiving the vaccine (Ministry of Health, 2017). In New Zealand influenza vaccine effectiveness has been estimated to be 50% overall for preventing hospitalisation and visits to the general practice, for influenza A and B strains (Bissielo et al., 2016; Ministry of Health, 2017). Economic evaluations among high-income countries report that the influenza vaccine in most cases is cost-saving or highly cost-effective, particularly among targeted groups (e.g. children, elderly or pregnant woman) (Newall et al., 2018; Newall et al., 2012; Peasah et al., 2013).

Evidence regarding the impact of immunisation on equity suggests a positive impact on reducing inequities. For example, providing the HPV immunisation programmes in schools to adolescent girls will contribute to decreasing health inequities for Māori and Pacific female students (Blakely et al., 2014; Poole et al., 2012). However, inequities exist in uptake of immunisations, particularly between ethnic groups (Fisher, Audrey, Mytton, Hickman, & Trotter, 2014; WHO, 2015), and so immunisation programmes need to develop an effective plan to reduce barriers and increase the uptake of immunisations among priority groups (Ministry of Health, 2017).

Acceptability of immunisation is high among most stakeholder groups, including the public. For example, a majority (93%) of 8-month-old infants in New Zealand were fully immunised in 2016 (Ministry of Health, 2017). However, misconceptions about immunisation can result in active campaigns against certain vaccinations that may generate vaccine hesitancy. It is important that health agencies and health professionals address misconceptions and provide accurate information on immunisation (Ministry of Health, 2017). Practical challenges of implementing immunisation programmes may include the availability of the vaccine, achieving high levels of uptake and ensuring equitable uptake of immunisations.

## Lifestyle interventions

### Smoking cessation support services

Smoking cessation support services are a well-established approach to tobacco control, and are health promoting and cost-effective, if not cost-saving (NICE, 2018b; West et al., 2015; White, Skirrow, George, & Memon, 2018). Cessation support services can be provided in a variety of ways, and effectiveness differs by the type of cessation support and the delivery method. For example, individual behavioural support (face-to-face) may increase long-term (6-12 month) smoking abstinence rates between 4 and 8 percent compared with brief advice or written materials (Ministry of Health, 2014; West et al., 2015). Nicotine replacement therapy (NRT) can increase long-term abstinence rates by 5 to 7 percent (compared with placebo). Combining these methods (i.e. behavioural support and stop-smoking medicines) has an additive effectiveness and is reported as one of the most effective smoking cessation approaches (NICE, 2018b; West et al., 2015).

Economic evaluations have shown that most smoking cessation support services are cost-effective and many are cost-saving (Ministry of Health, 2014; NICE, 2018b; Vos et al., 2010; West et al., 2015; White et al., 2018; WHO, 2015). For example, a UK modelling study found that most interventions combining behavioural support and stop-smoking medicines were dominant when compared with a placebo and counselling service or no intervention (NICE, 2018b). Interventions that provide only

one service, such as stop-smoking medicines or face-to-face behavioural support, are still very likely to be cost-effective or dominant (NICE, 2018b; West et al., 2015). As discussed in the *Mass media* section, a package of a New Zealand's Quitline services and its promotion in the mass media was modelled to gain 4,200 QALYs and generate \$84 million in cost-savings (over one year of routine operation) (Nghiem et al., 2018).

The equity evidence on smoking cessation suggests that uptake is higher and more effective in higher socioeconomic groups, potentially resulting in further health inequities for lower socioeconomic groups (T. Brown, Platt, & Amos, 2014; WHO, 2015). Evidence from the UK found that although lower socioeconomic status smokers were more likely to access cessation services, they were less likely to quit and set up quit dates, and more likely to be lost during follow-up (T. Brown et al., 2014). Therefore, a practical challenge of this type of intervention is ensuring uptake of the service is higher in priority groups (for example, pregnant or breastfeeding women, Māori, Pacific people, and users of mental health services). This type of intervention is a relatively inexpensive way of generating health gains and in some case cost-savings in the long-term. Smoking cessation support services are already widely provided and monitored within New Zealand and as such, this intervention is feasible, acceptable and sustainable in New Zealand.

### Screening and early detection

Screening for diabetes, CVD, and some cancers has been shown to be cost-effective and health promoting (Love, Poynton, & Swansson, 2016; Mernagh, Paech, & Weston, 2010). Health screening is the process of testing apparently healthy individuals to detect asymptomatic diseases or precursors to those diseases in order to improve health outcomes and prognosis (International Agency for Research on Cancer, 2016). Health screening can be conducted through a formal screening programme (e.g. national programmes) or opportunistically in health settings such as primary care. Screening programmes tend to be more expensive to implement than other public health interventions such as taxation, due to their complexity and high use of health system resources. However, there is evidence that some screening programmes generate benefits that far outweigh their harms and are cost-effective (Health Quality & Safety Commission, 2018; Kitchener et al., 2014; Lew et al., 2017; Love et al., 2016; Simms et al., 2016). For example, there is strong evidence that bowel cancer screening can reduce bowel cancer-related mortality by 16 to 22 percent (Love et al., 2016).

Several cancer screening programmes currently conducted by the National Screening Unit have been shown to be cost-effective, for example, mammography screening for breast cancer (International Agency for Research on Cancer, 2016; WHO, 2017), screening for bowel cancer (Lew et al., 2017; Love et al., 2016; Sarfati, Shaw, McLeod, Blakely, & Bissett, 2016) and cervical or HPV screening (Kitchener et al., 2014; Lew et al., 2016; Simms et al., 2016; WHO, 2017). Love and colleagues (2016) modelled a national bowel cancer screening programme in the New Zealand population aged 50-74 years and estimated it would be highly cost-effective (likely cost-saving) and generate health gains, when compared with no screening.

Screening at-risk populations for other non-communicable diseases may also be cost-effective. For example, screening for chronic kidney disease (especially individuals with diabetes) (Jha et al., 2013; Vos et al., 2010), pre-diabetes (followed by drug such as metformin or lifestyle change) (Bertram,

Lim, Barendregt, & Vos, 2010; Vos et al., 2010), and low-bone mineral density in elderly woman (Vos et al., 2010) all demonstrated favourable cost-effectiveness. An Australian modelling study showed that screening for pre-diabetes in general practice followed by diet and exercise combined had a cost-effectiveness ratio of AU\$22,500 per DALY averted (Bertram et al., 2010).

The equity evidence on screening programmes suggests that uptake is higher in those from less deprived areas and with a better health literacy and understanding of the health system (Banks et al., 2001; Health Quality & Safety Commission, 2018; Tin et al., 2018; WHO, 2015). This could result in further health inequities for those groups underrepresented in screening programmes. Currently in New Zealand several national screening programmes are reporting lower uptake among Māori and Pacific populations; often these populations, particularly Māori have higher incidence of cancer and cancer related mortality (Ministry of Health, 2018a; Tin et al., 2018). For example, Māori women in New Zealand were less likely to be diagnosed with breast cancer through screening and had a higher risk of breast cancer-related mortality than other ethnic groups (Tin et al., 2018). To mitigate this, screening programmes need to adopt an equity-led approach, building equity into the entire programme including the leadership and governance, specific resources, and equity-related performance indicators (Health Quality & Safety Commission, 2018; WHO, 2015). If equitable access and uptake of screening programmes are achieved, they are likely to positively impact equity (Mernagh et al., 2010). For example, a bowel cancer screening programme in New Zealand Māori (aged 50-74) was modelled to be highly cost-effective, costing a low \$381 per QALY gained, when compared to no screening (Love et al., 2016).

There are a number of clinical, practical and ethical challenges associated with screening requiring careful consideration before a programme is implemented. Screening programmes must be based on high quality and robust evidence, demonstrating both the efficacy of the programme in experimental studies and its effectiveness as part of a population-wide screening programme. Effectiveness of a screening programme can be influenced by key factors such as the eligible population, participation rates, follow-up appointments, and treatment of any diagnosed health conditions (International Agency for Research on Cancer, 2016; Love et al., 2016). Acceptance and use of screening programmes will differ for each programme, but are likely to be influenced by similar factors such as the cost and potential harms versus benefits and effectiveness of the programme.

## Health protection

### Preventing contamination of public water supply or food

Investing in robust health protection systems for food and water supplies reduces the risk of infectious disease outbreaks (WHO, 2014). Examples include implementing compliance standards on food and monitoring the quality of public water supplies. Evidence on the cost-effectiveness of health protection activities is scarce. However, some studies have quantified the health burden and costs associated with outbreaks of food- and waterborne diseases. For example, in August 2016 a significant outbreak of campylobacteriosis resulted from the contamination of a public water supply in Havelock North. It is estimated that 5,500 residents in Havelock North (resident population of 14,000) became ill with campylobacteriosis, although only 1,000 cases of gastroenteritis were

notified (Moore, Drew, Davies, & Ripp, 2017). The outbreak was estimated to cost \$21 million. The majority (\$12.4 million) of costs fell to households, due to sourcing safe drinking water, taking time off normal activities, and boiling water. The remaining costs were mainly attributed to local government (\$4.1 million), healthcare-related (\$2.5 million) and businesses (\$1.3 million) (Moore, Drew, et al., 2017).

Conversely, a cost benefit analysis of raising the quality of New Zealand's networked drinking water concluded that it would be economically beneficial to require compliance of networked drinking water supplies with the bacteriological standard (except for the smallest water supplies) (Moore, Black, Valji, & Tooth, 2010). The authors estimated that compliance of all large water supplies in New Zealand with the standard would generate a net economic benefit of \$105 million over forty years.

In other overseas instances, the total costs associated with an outbreak of cryptosporidiosis related to the municipal water supply affecting approximately 403,000 residents of Milwaukee (Wisconsin, USA) in 1993 was estimated at US\$96.2 million (Corso et al., 2003), and the cost of lost workdays alone resulting from a waterborne gastroenteritis outbreak affecting a projected 8,453 residents in Nokia, Finland in 2007 was estimated to be between €1.8 and 2.1 million (Halonen et al., 2012; Laine et al., 2011).

Foodborne disease transmission contributes to a large health and economic burden globally. Investing in systems to minimise the outbreak of foodborne disease demonstrates good value for money (Devleeschauwer, Bouwknegt, Mangen, & Havelaar, 2017; Lake, Cressey, Campbell, & Oakley, 2010). Illness from campylobacteriosis (and its sequelae) was estimated to have the greatest impact in New Zealand, when compared with six other foodborne diseases (Lake et al., 2010). In New Zealand, the annual economic cost to society as a result of foodborne infectious disease was estimated at approximately \$86 million; 90% of this cost was attributed to campylobacteriosis (Lake et al., 2010). An example of a health protection system that reduced the outbreak of foodborne disease was the implementation of campylobacter compliance standards in New Zealand. In response to the *Campylobacter* epidemic in New Zealand, new standards were enacted in the poultry industry in 2007, and by 2008 there was a 58% reduction in campylobacteriosis notifications in New Zealand (Duncan, 2014). Investing in the compliance standards was estimated to generate a substantial benefit-cost ratio of 25.74:1 (Duncan, 2014).

There is limited evidence on the impact on equity of the prevention of contamination of public water supply or food. All members of society benefit from high-quality food and water supply standards. As such, there is likely a high acceptability of this type of intervention among stakeholder groups. There may be some practical challenges encountered when implementing new compliance standards and changing practices among industries, including implementation costs. For example, the initial cost of implementing the new compliance standards by the poultry industry in New Zealand was significant; around \$2 million of capital investment and \$0.88 million for increased operating costs. There were also further annual compliance costs on the government, estimated as \$0.95 million (Duncan, 2014). However, once new standards are implemented they are likely to be sustainable.

### Preventing person to person spread of communicable disease

Other effective health protection interventions to prevent the spread of communicable disease include case and contact follow-up, screening of migrants and needle exchange programmes. Evidence of cost-effectiveness of case and contact follow-up is limited. However, in countries such as New Zealand where the incidence of tuberculosis is relatively low and a large proportion of cases are born overseas (Das, Baker, & Calder, 2006; ESR, 2015), case and contact tracing of tuberculosis is likely to be cost-effective (Dasgupta & Menzies, 2005; Ministry of Health, 2010). Targeted screening of migrants from high incidence countries for tuberculosis or latent tuberculosis has been modelled in some settings to be cost-effective, including in Canada (Oxlade, Schwartzman, & Menzies, 2007), the UK (Pareek et al., 2011) and other OECD countries (Zenner, Hafezi, Potter, Capone, & Matteelli, 2017).

Needle and syringe exchange programmes are effective at reducing the incidence of Human Immunodeficiency Virus (HIV) and hepatitis C virus (HCV) among injecting drug users (Abdul-Quader et al., 2013). Furthermore, there is strong evidence that these programmes are very cost-effective and in some cases cost-saving (Atkin, 2003; Masters et al., 2017; Sweeney et al., 2019; Vos et al., 2010). An Australian modelling study found the needle and syringe exchange programme (NSEP) in Australia had a cost-effectiveness that ranged from AU\$416 to \$8750 per QALY gained, when compared with no programme (Kwon et al., 2012). An evaluation of the NSEP in New Zealand between 1988 and 2001 estimated that every \$1 spent on the programme saved \$3.35 in healthcare costs (Atkin, 2003). In 2017, the New Zealand needle exchange programme distributed 3.75 million packs of sterile injecting equipment and only one case of HIV was contracted from injecting drugs (New Zealand Drug Foundation, 2019).

There is limited evidence on the impact on equity of these types of interventions. Given that needle and syringe exchange programmes target a marginalised community, they are likely to have a positive impact on equity. However, programmes need to ensure access to clean needles and syringes is equal in all communities, particularly those in rural areas (Commonwealth Department of Health and Ageing, 2002).

Communicable disease control interventions may have to overcome barriers such as feasibility and acceptability. For example, the success of screening programmes will depend on the method of screening used, participation rate, availability of follow-up appointments, and treatment of any diagnosed health conditions (Dasgupta & Menzies, 2005). Acceptability of needle exchange programmes has previously been a barrier to overcome (Commonwealth Department of Health and Ageing, 2002), but many countries now have nation-wide programmes, indicating growing acceptability.

### Water fluoridation

Community water fluoridation is a well-established public health intervention. Fluoridation helps to prevent tooth decay, and demonstrates cost effectiveness (Moore, Poynton, Broadbent, & Thomson, 2017; Ran, Chattopadhyay, & Force, 2016; Wright, Bates, Cutress, & Lee, 2001). Dental caries are the most common chronic disease in New Zealand, disproportionately affecting vulnerable groups, including Māori, Pacific peoples and low socioeconomic groups (Bardsley, 2014). There is strong evidence that an optimal concentration (between 0.7 ppm and 1.0 ppm) of fluoride in community

water supply prevents dental caries in the population (Bardsley, 2014; Ran et al., 2016). CWF has been described as the most effective public health intervention to prevent tooth decay (Bardsley, 2014). The effectiveness of CWF is partly due to the passive nature of the intervention; it requires policy and environmental changes instead of individual behavioural change (Centers for Disease Control and Prevention, 2019a). There is no evidence that CWF at the levels recommended in New Zealand causes any adverse effects of significance (Bardsley, 2014).

A substantial number of economic evaluations, within New Zealand and internationally, have found CWF to be cost-effective, if not cost-saving (Bardsley, 2014; Campain et al., 2010; Centers for Disease Control and Prevention, 2019a; Moore, Poynton, et al., 2017; Ran et al., 2016; Wright et al., 2001). Within a New Zealand population, implementing CWF in all populations over 500 (including setting up and operational costs) was modelled over twenty years to avert 459,000 untreated dental caries, over 3 million restorations and 4 million extractions (Moore, Poynton, et al., 2017). Furthermore, it is estimated to produce national net savings of \$1,401 million, a majority of which would be experienced by private individuals (reduction in private dental care) as well as savings to the health budget. These findings are consistent with evidence from Australia showing that even in an era of declining levels of dental decay and supplementary sources of fluoride (e.g. fluoride toothpaste), CWF continues to be a cost-effective preventive measure at a community level (Campain et al., 2010).

Evidence regarding the impact of water fluoridation on equity is positive (Bardsley, 2014; Moore, Poynton, et al., 2017; Ran et al., 2016). Although there may be relatively small health gains for an individual, the benefits to the overall population and vulnerable groups of fluoridating water supplies are substantial (Bardsley, 2014). Within New Zealand, CWF would reduce the burden of poor oral health among all ethnic and socioeconomic groups (Moore, Poynton, et al., 2017). Furthermore, there would likely be a greater absolute health gain for vulnerable groups (including Māori and low socioeconomic groups), due to their higher rates of dental caries.

Water fluoridation interventions need to respond to practical challenges such as acceptability and feasibility. Acceptability for CWF is mixed, although an Australian survey on water fluoridation found that a majority of respondents were supportive of CWF (Bardsley, 2014). In the United States, 75% of the national population has access to CWF (Centers for Disease Control and Prevention, 2019a), displaying a high acceptability among the public. However, some members of the public remain opposed to water fluoridation (Bardsley, 2014). Feasibility of implementing CWF may be influenced by the infrastructure available, costs of implementation, and political context.

## Prioritising investment in public health

While approaches to investing in public health differ between countries, there is currently a particular focus on the prevention of NCDs and addressing their major modifiable risk factors. This section provides a brief overview of approaches to public health investment in selected overseas countries.

### Australia

The National Partnership Agreement on Preventive Health was announced by the Council of Australian Government on 29 November 2008, and was to provide AU\$872 million over 6 years from 2009/2010, with a variation in 2012 to extend it to 2018. This represented the largest ever investment made by an Australian Government towards disease prevention. As part of the partnership, the Australian National Preventive Health Agency was established on 1 January 2011 to provide national capacity to drive preventive health policy and programmes, with a particular focus on alcohol, tobacco and obesity. Evaluation of the National Partnership Agreement on Preventive Health was being conducted in several stages from January 2013 to June 2015. However, as part of its 2014 Budget the Australian Government introduced several changes to preventive health arrangements, and as of 30 June 2014 essential functions of the Australian National Preventive Health Agency were transferred to the Department of Health, and the National Partnership Agreement on Preventive Health terminated.

In 2013–14, AU\$2.2 billion, or 1.4% of total health expenditure, went to public health activities, which included prevention and health promotion (Australian Institute of Health and Welfare, 2016). Similar to other OECD countries, the proportion of health expenditure allocated to public health has been declining in Australia since it peaked in 2007–08 (2.2%). In 2017, the National Strategic Framework for Chronic Conditions was released by the Council of Australian Government, with a focus on health determinants, risk factors and multimorbidity, rather than a disease-specific approach (Australian Health Ministers' Advisory Council, 2017). Equity was another priority identified in this strategy, in particular improving the health outcomes of priority groups including Aboriginal and Torres Strait Islander people. In addition to this strategy, health advocates in Australia have recently welcomed the announcement by the Federal Health Minister that plans for a new Preventive Health Strategy are underway. It has been a decade since the previous strategy was established, and the Health Minister has said the new strategy will not take a narrow focus, and will prioritise action on the determinants of health, including climate change and poverty.

### United Kingdom

Past research has highlighted low spending on prevention in the UK (Wanless, Appleby, Harrison, & Patel, 2007; Wanless & Health Trends Review Team, 2002). For example, the Wanless review published by the Treasury in 2002 suggested that if prevention was not made a priority there would be a sharp rise in the burden of avoidable illness (Wanless & Health Trends Review Team, 2002). In 2014, the NHS published the Five Year Forward View, which outlined the a five-year direction for the NHS (NHS, 2014a, 2014b). This report acknowledged the lack of progress on disease prevention in previous years, and described the inclusion of a “radical upgrade” in prevention and public health with targeted action on obesity, smoking, alcohol, and other major health risks.

In 2018, the Department of Health and Social care signalled that prevention would be a top priority with the release of its 'Prevention is better than cure' policy paper (Department of Health & Social Care, 2018). The paper outlined the need for greater investment in prevention, particularly focusing on obesity, mental illness, multimorbidity, and the ageing population. However, research from the King's Fund estimated that between 2014/15 and 2019/20 local authority spending per head on key prevention services may fall by almost a quarter in real terms (Buck, Baylis, Dougall, & Robertson, 2018).

In 2019, the NHS released its long-term plan, committing to the development of more action towards prevention and health inequalities (NHS, 2019). According to Chapman and Middleton (2019), this was the first time the NHS acknowledged its role in reducing inequalities. The Global Burden of Disease study ranked the top five risk factors leading to premature death in England as smoking, high blood pressure, obesity, poor diet, and drug and alcohol use. As a result, the NHS plan identified these risk factors as priority areas, as well as air pollution and physical inactivity. The plan acknowledges that the NHS cannot achieve its aims by itself, but relies on action from national and local government as well. As described by Chapman and Middleton (2019) the NHS "seeks to contribute what is within its compass"; however if it is to deliver on these preventative actions, further investment in local government public health is needed.

### Canada

In the 2018/19 fiscal year, the federal budget allocated CA\$589 million to the Public Health Agency of Canada (PHAC), a net increase of approximately CA\$17 million from the previous year (Treasury Board of Canada, 2018). In 2018, the report on the State of Public Health in Canada identified reducing chronic diseases and health inequities as continued goals for the year ahead, as well as preventing problematic substance use in youth (PHAC, 2018). In recent years, the PHAC have been developing and implementing innovative economic analysis to measure health outcomes and to make a case for investment in public health, from a range of sectors. For example, in the Centre for Chronic Disease Prevention strategic plan 2016-2019, priority areas included harnessing technology, engaging across sectors, and using financial instruments as policy levers (PHAC, 2015). The latter priority is being achieved by developing and refining social and behavioral economic approaches and utilising a social return on investment methodology. The aim of this outcomes-focused economic analysis is to inform multi-sectoral partnerships, policy and interventions, in the context of public health.

### United States of America

In 2011, the National Prevention Strategy was released by the US Department of Health and Human Services (HHS), and included four strategic directions based on healthy and safe community environments, clinical and community preventive services, empowered people, and the elimination of health disparities (NPC, 2011). Priority areas for the strategy included tobacco, alcohol, nutrition, physical activity, injury and violence, reproductive health, and mental wellbeing. For each of these areas, recommendations were provided for different sectors (such as state and local governments, businesses, employers, education providers, community organisations, and individuals). The recent HHS Strategic Plan (2018-2022) highlighted similar strategic directions, for example protecting the health of all Americans in a variety of environments (e.g. work, home, and education). The strategy



suggested that this would be achieved through empowering people to live a healthier life, robust health protection systems, reducing the impact of mental and substance use disorders, and effective public health emergency response systems (U.S. Department of Health and Human Services, 2018).

These strategies are informed by high-quality research on effective public health approaches or interventions. An example of this is the Health Impact in 5 Years (HI-5) initiative, developed by the Centers for Disease Control and Prevention (CDC) to identify approaches that prevent or reduce the impact of a range of health conditions (Centers for Disease Control and Prevention, 2018a). The initiative includes non-clinical, community-wide approaches that have demonstrated effectiveness and results within five years, and cost-effectiveness over the lifetime of the population. Some examples of these approaches are school-based programmes to increase physical activity and prevent violence, pricing strategies for alcohol products, and tobacco control interventions (Centers for Disease Control and Prevention, 2018b).

Similar to other OECD countries, research suggests that public health spending has declined in the US. In 2014, public health's share of total health expenditure was 2.6%, and it is projected by 2023 this will fall to 2.4% (Himmelstein & Woolhandler, 2016). An example of this decline in public health spending is the funding cuts to the Prevention and Public Health Fund (PPHF). The PPHF is a mandatory fund established in 2010 and financed by the Affordable Care Act (ACA) to expand and sustain investment in prevention and public health programmes (American Public Health Association, 2019). The ACA authorised over US\$18 billion for the fund between fiscal years 2010 and 2022. However, since 2012 Congress has passed several bills that have cut and redirect the money from the fund, to non-public health legislation. These cuts passed by Congress included US\$6 billion (over nine years) in 2012, US\$3.5 billion (over seven years) in 2016 and most recently \$1.35 billion (over six years) in 2018 (American Public Health Association, 2019). A majority of the PPHF's annual funding is appropriated to the CDC (for example, US\$804 million in FY 2019) to support public health activities such as vaccine coverage, responding to outbreaks of foodborne infections and programmes targeting the leading causes of death and disability such as, cancer, heart disease and diabetes (Centers for Disease Control and Prevention, 2019b). The remainder of the annual funding is distributed between other agencies and organisations, such as, the Administration for Community Living (US\$27 million) to provide prevention and management programmes in the community.

## Discussion and conclusions

This update provides further evidence to support investment in public health for disease prevention and health promotion, particularly for diseases and risk factors that contribute to significant health loss and inequity in New Zealand. Despite evidence to support the equitable, cost-effective and often cost-saving nature of many public health interventions, several reasons for the relatively low level of investment in public health have been suggested.

Firstly, there is sometimes an expectation that public health programmes should be cost-saving, rather than cost-effective, and these programmes may be subject to a higher level of economic scrutiny than those in other health areas (Community & Public Health, 2009; Richardson, 2012). The ethical, equitable and efficient allocation of limited health resources requires that public health interventions are assessed using comparable criteria for cost-effectiveness as health care interventions.

The extended timeframes associated with public health interventions can be a challenge where there is a need for short-term outcomes delivered within limited policy cycles, acknowledging that costs are often incurred immediately while benefits may occur years in the future (Community & Public Health, 2009; Hemenway, 2010; Owen et al., 2012; Richardson, 2012). This focus on short-term health outcomes ignores the huge potential of public health interventions to prevent future poor health. While the long-term health goals of some public health interventions may take some time to eventuate, numerous positive health outcomes also occur in the short-term. For example, although a decrease in the incidence of cervical cancer associated with HPV immunisation may take decades to eventuate, since the introduction of the national programme in New Zealand in late 2008 the incidence of genital warts among young adults, and prescriptions for related medications, have decreased significantly in a relatively short time period (ESR, 2014; Oliphant & Perkins, 2011; N. Wilson, Morgan, & Baker, 2014). Placing an emphasis on public health as an investment for the future, as well as highlighting the short-term health effects that these interventions bring, could go some way to addressing this barrier (Community & Public Health, 2009; Richardson, 2012).

There is a belief among some decision-makers that prevention may prove more costly in the long-term, due to people living longer and generating greater health costs in the future (Community & Public Health, 2009; Richardson, 2012). However, this argument could also be applied to many treatment interventions, and does not acknowledge that public health interventions can also contribute to longer, healthier lives. While recent analyses suggest that New Zealanders are living longer, the small expansion in poor health (mostly due to chronic diseases) projected between 2006 and 2016 highlights the need to prioritise health strategies that reduce morbidity as well as premature mortality (Ministry of Health, 2013).

Concerted investment in cost-effective and cost-saving public health interventions in New Zealand will have an integral part to play in addressing the growing health burden associated with NCDs and modifiable risk factors such as tobacco use, alcohol use and obesity.

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