HEALTHIER LIVES | He Oranga Hauora

National SCIENCE Challenges

Healthy Food and Physical Activity Environments

A stocktake of systematic review evidence, population-level policies and New Zealand research

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Author and acknowledgements

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Definitions and acronyms

BMI, Body mass index: body size measured as weight in kilograms divided by height in m^2

Food environment: The range of foods available, affordable, convenient and desirable to people in a given context (Herforth and Ahmed, 2015)

GIS, geographic information system: a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data

NCD, non-communicable disease (in this report, specifically: diabetes, cardiovascular disease and cancer)

NZ, New Zealand

Physical activity environment: Places where people can be physically active… Attributes of the built environment that can be affected by policies to contribute to the promotion of physical activity (Sallis and Glanz, 2009)

PRISMA, Preferred reporting in systematic reviews and meta-analyses (Moher, 2009)

RCT, Randomised controlled trial

UK, United Kingdom

US, United States of America

WHO, World Health Organization

Contents

Introduction

The Healthier Lives–He Oranga Hauora National Science Challenge

The Healthier Lives He Oranga Hauora National Science Challenge is a national collaborative research programme funded by the New Zealand Government. Its vision is of an Aotearoa New Zealand with equitable health outcomes and a substantially reduced burden of non-communicable diseases (NCDs). The Healthier Lives National Science Challenge Research Strategy 2019-2024 (Figure 1) proposed a new research area–healthy food and physical activity environments–aimed at scalable population-level interventions in order to meet the goal of improving equity of health outcomes as well as reducing the overall burden of disease arising from NCDs.

Figure 1: Healthier Lives Phase 2 Strategy Framework (Source: Healthier Lives - He Oranga Hauora, 2018)

Theme 1 (Population Scale) of the Healthier Lives National Science Challenge's Phase 2 examines how the world in which we live influences what we eat and how we move around, in different settings and at different stages of life. It will also examine how we might target food and physical activity systems to bring about a positive shift in health behaviours and reduce the overall burden of NCDs in New Zealand, particularly related to obesity, diabetes

and cardiovascular disease. Research will focus on evaluating and modelling the impact of population-level interventions and policy changes in relation to food and physical activity environments with a view to establishing an evidence base for policy and practice decision-making.

In order to inform Theme 1, this stocktake was undertaken to synthesize major areas of international research within the broad themes of 'healthy food environments' and 'healthy physical activity environments', and provide a short summary of significant evidence within each area, including research that may be currently underway in New Zealand.

Why focus on healthy food and physical activity environments?

Non-communicable diseases (NCDs), particularly heart disease, cancer, stroke and diabetes, are the leading cause of morbidity and mortality globally (WHO 2013 Global Action Plan for NCD). In New Zealand, 88% of all health loss (or disability-adjusted-life-years) is due to NCDs, with cancer contributing 17% to this figure, and cardiovascular diseases including diabetes another 17% (Ministry of Health, 2016).

Much of this premature mortality and disability is preventable. A poor diet is the leading cause of death in New Zealand, accounting for nearly 20% of deaths in 2017 (Figure 2). Many of the other common cause of death are related to poor diet, such as high blood pressure, high plasma glucose, body mass index, and high cholesterol (LDL in the diagram). In addition, low physical activity accounts for around 4% of deaths (Figure 2).

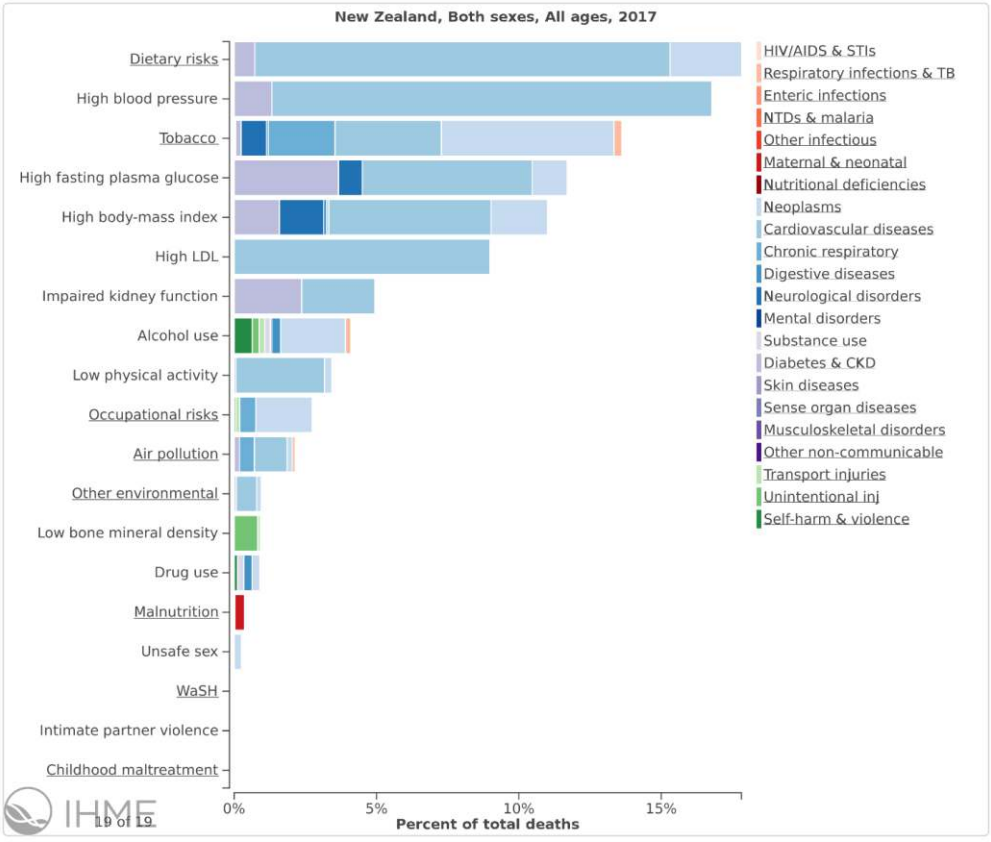

Figure 2: Cause of death in New Zealand, Both sexes and all ages, 2017
Source: Global Burden of Disease Study (Institute for Health Metrics and Evaluation, 2018)

Preventing premature deaths from NCDs is not simply a matter of targeting individual behaviour change; broader changes in social, economic, environmental and cultural contexts will be required. Decades of public health research have shown that interventions which target individual behaviour change are not as effective at improving population-level health statistics (Figure 3), particularly if they do not have universal reach or are ineffectively applied. Changing individual behaviours is difficult when we are socially conditioned to behave as others around us; it is much easier if social norms or the context and environment shift to enable healthy behaviours (Frieden, 2010).

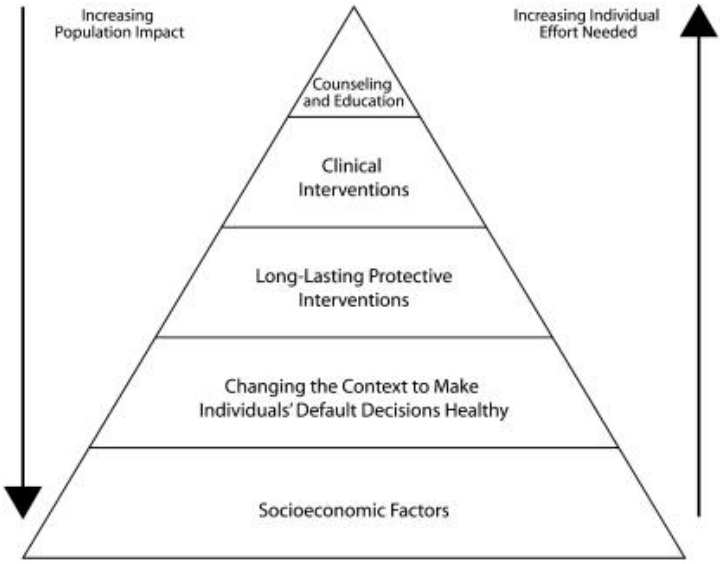

Figure 3: The health impact pyramid (Frieden, 2010)

Backholer et al. (2014) theorized that interventions requiring a high degree of individual effort–i.e. those which aim to improve individual behaviour through knowledge and skill development–not only had less impact at the population level, but may also be more likely to increase inequality due to the fact that privileged groups in society would able to mobilise the resources to make the most of the intervention. In contrast, interventions which were predominantly structural in nature (for example, smokefree legislation and fluoridation of water) were unlikely to increase inequality as there is an equal or greater benefit for lower socioeconomic groups. The authors conclude that to impact rising levels of obesity the "optimal default" must become the healthy behavioural choice around diet and exercise–taking less time, effort and thought for individuals–and that these interventions could range from 'nudges' of rewards or incentives, through to stronger regulatory measures (Backholer et al., 2014). Environmental change and policy interventions may be among the most effective strategies for creating equitable population-wide improvements in nutrition and activity.

However, public health interventions are not without risk or unintended outcomes, and usually have varying levels of restriction of individual freedom associated with them. The Nuffield ladder (Figure 4) was developed to assist in thinking about the acceptability and justification of different policies. With each step up the ladder, the intervention moves from individual freedom and responsibility toward state intervention. The decision to land on a particular 'rung' for a public health intervention is made by weighing the benefits to

individuals and society against the erosion of individual freedom. Economic costs and benefits would also need to be taken into account.

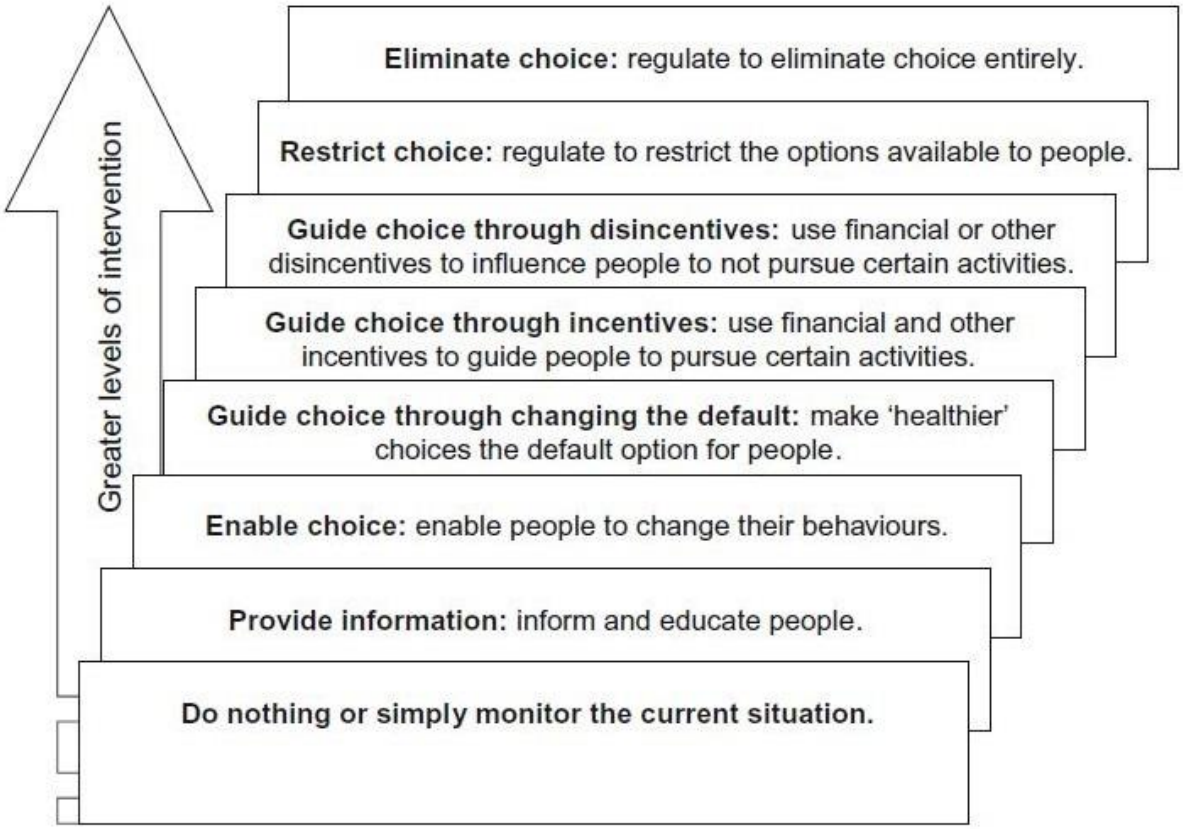

Figure 4: The Nuffield Intervention Ladder (Nuffield Council on Bioethics, 2007)

Given the considerable health burden which stems from poor diet and low physical activity, and the promising equitable effect of environmental approaches to impact upon large numbers of the population, the Healthier Lives National Science Challenge is looking to support scalable, population-level dietary and activity interventions, in order to meet the goal of improving equity of health outcomes as well as reducing the overall burden of disease arising from NCDs.

Aim and objectives of the stocktake

The aims of this stocktake were to identify and summarize:

- systematic reviews of international evidence on population-level interventions within food and/or physical activity environments that improve adult (18-64 year old) diets and physical activity, with the aim of reducing the overall burden of cancer, cardiovascular disease, diabetes and obesity;
- available evidence on which interventions will improve equity of health outcomes;
- monitoring systems of population-level policies aimed at improving food and/or physical activity environments to reduce the overall burden of disease arising from the four NCDs (cancer, cardiovascular disease, diabetes and obesity); and
- high quality NZ evidence, research and policies related to healthy food and physical activity environments, including key findings of research and evaluations where available.

The adult age group restriction used in this stocktake (only including research with a focus on 18-64 year olds) because the focus/target group of the Healthier Lives National Science Challenge is adults of this age. Other Challenges focus on children (A Better Start) and the elderly (Ageing Well). There may be possible spill over effects from interventions aimed at the younger or older population groups that have not been captured in this review, e.g. restrictions on advertising to children also influence the number and type of advertisements adults are exposed to, and it is likely that population interventions aimed at adults would also spill over to effect children or older people.

The stocktake has not attempted to be comprehensive but instead focused on identifying scalable interventions likely to achieve major impact across the adult population. Special attention was paid to research, policies and programmes likely to achieve the greatest gains for sections of the New Zealand population that currently experience the most inequitable health outcomes (Māori, Pacific, low income communities).

What types of evidence and research have been included in the stocktake?

This report details a stocktake of international systematic reviews and recent New Zealand research on population-level interventions that modify the food and/or physical activity environment to improve adult (18-64 year olds) diet and physical activity.

This type of stocktake is sometimes called an ‘overview of reviews’ or an umbrella review (Tsagris and Fragkos, 2016). Systematic reviews collect and critically appraise multiple research studies or papers using objective and transparent standard techniques to ensure that all relevant research on a topic can be reviewed. Systematic reviews are typically lengthy and detailed, and are considered to be the highest quality research (Figure 4). In contrast, this stocktake is intended to be a brief overview; focusing on the methods, results and policy-relevant outcomes of the included systematic reviews. The value of a stocktake is that it collates evidence from many high-quality systematic reviews, giving weight to those findings that reoccur in multiple systematic reviews, thereby offering a useful reference for decision makers (Tsagris and Fragkos, 2016). A stocktake is also able to have a wider scope, as the

aim is breadth of coverage, rather than a systematic review, which will often concentrate on one specific outcome or association.

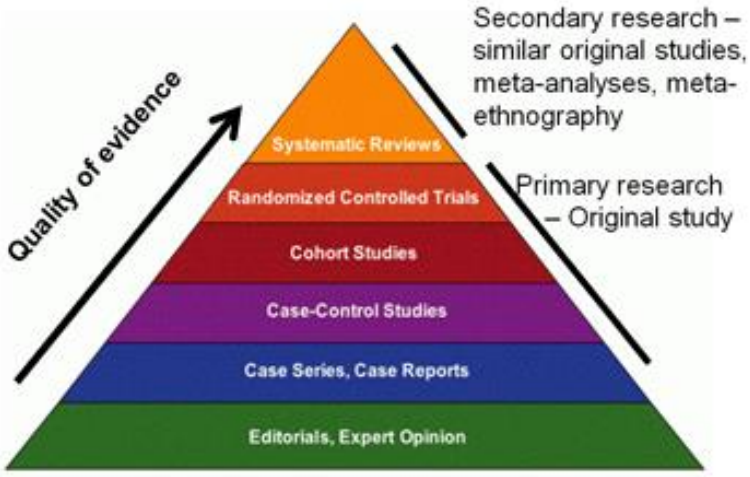

Figure 4: Levels of evidence in quantitative research

Randomized controlled trials (RCTs) are considered to be the highest quality of evidence in primary research (Figure 4) and form the basis for the majority of systematic reviews. However, RCTs can be impractical or unethical when researching population nutrition and physical activity (Allman-Farinelli et al., 2014, Katz et al., 2001). Very few RCTs are conducted for long enough periods to assess long term health outcomes like obesity and NCDs, and it is impossible in real-life settings to randomise policy decisions like a tax on unhealthy foods. Instead of RCTs, prospective cohort studies and natural experiments often provide more relevant evidence for the development of public health policy. Qualitative methods (e.g. interviews, focus groups, textual analysis) are also appropriate in public health research, particularly research that attempts to answer *how* and *why* questions (Isaacs, 2014). Systematic reviews of qualitative research have also been included in this stocktake as they can help to identify the underlying attitudes, perceptions, and culture that drive health-related behaviours.

Methods

Search methods and databases

Electronic searches were undertaken for the identification of systematic reviews in the Scopus database (includes Medline) and the Cochrane Library in November and December 2018, covering academic publications from 2007 to 2018. The searches were then repeated for all study types (not just systematic reviews) in Scopus with the term 'New Zealand' and in two additional databases: Index New Zealand (National Library) and NZresearch.org.nz. Grey literature such as technical reports from scientific agencies or scientific research groups, conference proceedings, abstracts, theses or dissertations were only considered if relevant to New Zealand. Search terms used for the different databases are listed in Appendix 1.

Inclusion and exclusion criteria for the stocktake

Studies were included if they helped to answer the following research questions:

1. How does the food and physical activity environment affect diet and physical activity levels that contribute to the risk of developing NCDs?
2. What changes could be made to food and/or physical activity environments that would impact on diet and physical activity, and thereby reduce the prevalence of obesity diabetes, cancer, or cardiovascular disease?

Box 1: Exclusion criteria

Studies were excluded from the stocktake if they were:

- a primary study (not a systematic review and/or meta-analysis), except if conducted in New Zealand
- the population of focus is aged under 18 years or over 65
- the outcome of interest is not dietary intake, physical activity, weight/obesity or a related-NCD (cancer, cardiovascular disease, diabetes)
- focused on individual (behavioural, clinical and/or medical) rather than population/group-level (community, environmental) interventions
- focused on non-modifiable aspects of the environment (e.g. weather, terrain)
- focused on behaviour change education, communication and messaging (e.g. dietary and activity guidelines, brochures/pamphlets, social marketing)
- focused on methods/tools for data collection or definitions
- focused on diseased, unhealthy or non-free living populations
- published before 2007
- focused on low to middle-income countries
- not reported in English language.

Selection of studies

The titles and abstracts of potential paper were screened for duplicates and then assessed for 'inclusion', 'exclusion' or 'potentially suitable' according to the criteria in Box 1. If the decision on inclusion or exclusion of a study based on review of the title and abstract was unclear, then the full text was obtained for review. Full texts for 'inclusion' and 'potentially suitable' were then assessed against the exclusion criteria. The reference lists of included studies were searched for additional relevant titles and abstracts of potentially eligible studies.

Diagrams based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Moher 2009) were produced for each search, detailing reasons for exclusion of those studies not included.

Data extraction

The following information about each systematic review was recorded:

- citation details
- objectives of the review
- type of review (systematic, narrative, umbrella)
- setting(s) and context (e.g. government or local policy, schools, early education services, workplaces)
- participant details (gender, life-stage/age-group, ethnicities or SES position)
- publication date range of studies included in the review
- number and type of studies (RCT, longitudinal, cross-sectional, experimental)
- country of origin of studies included in each review
- instrument used to appraise the primary studies and the rating of their quality
- population-level policies recommendations regarding changes to food/physical activity environment
- any information on differences in outcomes by socioeconomic position, age, gender, or ethnicity (equitable outcomes)
- future research directions indicated by the review

The following information about each New Zealand research or evaluation study was recorded:

- citation details, including affiliations of New Zealand authors
- title of the publication
- type of study (e.g. RCT, cross-sectional, qualitative interviews, process/outcome evaluation)
- main findings.

Policy implementation

A summary table was constructed to record which major policy recommendations emerging from the stocktake have been implemented in New Zealand, Australia, the US, the UK and Canada. The following monitoring tools were used to verify policy implementation:

World Cancer Research Fund NOURISHING database
www.wcrf.org/int/policy/nourishing-database

Records nutrition-related policies implemented by any country in the world (found in systematic searches and other means then verified with in-country experts), according to a comprehensive package of policies that promote healthier eating and prevent obesity and NCDs.

INFORMAS Government Healthy Food Environment Policy Index (Food-EPI)
https://sites.google.com/aucklanduni.ac.nz/informas

Uses an expert panel to assess the government's level of implementation of key policies for tackling obesity and creating healthier food environments. Currently includes reports from NZ, Australia and the UK. Only included in table if medium to high rating of implementation given.

World Health Organization's Global Database on the Implementation of Nutrition Action (GINA) www.who.int/nutrition/gina/en/

An interactive platform for sharing standardized information on nutrition policies and action, i.e. what are the commitments made and who is doing what, where, when, why and how (including lessons learnt).

Global Observatory for Physical Activity
www.globalphysicalactivityobservatory.com

Monitoring of physical activity surveillance, research, and policy worldwide.

Prevention Policies Directory
www.partnershipagainstcancer.ca/tools/prevention-policies-directory/

Current Canadian healthy public policies focused on cancer and chronic disease prevention.

Literature search results

In total, 50 systematic review articles were included in the stocktake after following the Preferred Reporting Items for Systemic reviews and Meta-analyses (PRISMA) process (Moher et al., 2009): 17 on physical activity environments and 33 on food environments. Details of the review process are in Appendix 2, and each systematic review is summarized in Appendix 3 (physical activity environment) and Appendix 4 (food environments).

In addition to the International evidence, 62 New Zealand studies were found; 27 on physical activity environments (including 3 on community wide interventions to improve physical activity, nutrition and obesity) and 35 on food environments. Details of the review process and associated PRISMA diagrams are in Appendix 2, and each study is listed in Appendix 5 (physical activity environment) and Appendix 6 (food environments).

Sixteen topics emerged from the reviews (Box 2). The remainder of this results section is structured by topic with each subsection containing:

- A summary of the international evidence from systematic reviews of research, including key findings and any policy recommendations emerging from the evidence
- A statement about whether intervention effects differed by socio-demographic characteristics and if equity considerations were evident in the reviews.
- Recent NZ research on the topic and/or evaluation of any relevant policies.

Box 2: Topics from the review of systematic reviews

Physical activity environment	**Food environment**
1. Infrastructure for cycling and walking	8. Pricing strategies including taxes and subsidies
2. Residential density, walkability and street connectivity	9. Labelling on pre-packaged food and beverages
3. Public transport	10. Menu labelling in restaurants
4. Parks and playgrounds	11. Food/product reformulation
5. Recreation facilities	12. Portion size, plate and cutlery size
6. Perceptions of the built environment	13. Neighbourhood food environment
7. Community-wide multi-strategic interventions (included aspects of both the physical activity and food environment)	14. Availability and quality of healthy foods in-store
	15. Food advertising and promotions
16. Workplaces (included both physical activity and food environment)	

Physical activity environment themes

1. Infrastructure for cycling and walking

International evidence

Nine systematic reviews included consideration of whether changes to cycling and walking/footpath infrastructure improved physical activity (Macmillan et al., 2018, Stappers et al., 2018, Kärmeniemi et al., 2018, Smith et al., 2017, Malambo et al., 2016, Mayne et al., 2015, Ferdinand et al., 2012, McCormack and Shiell, 2011, Saelens and Handy, 2008). Most of these reviews reported difficulty in drawing robust conclusions to inform policy, due to limitations in study design (cross-sectional rather than quasi-experimental designs with comparison groups) and the wide array of outcome measures reported, only some of which were objective measures such as accelerometry.

Overall, improving walking and/or cycling infrastructure had inconsistent effects on overall physical activity, with about half of studies in the reviews reporting a statistically significant positive association (Kärmeniemi et al., 2018). More extensive changes to the built environment (such as the implementation of a bus lane with parallel walking and bicycling trail and traffic-free bridges) have also resulted in mixed results, with mainly non-significant effects (Stappers et al., 2018). Macmillan et al. (2018) concluded their review by stating "It would be surprising if the built environment were not an important standalone driver of physical activity and diet, but available evidence in the research literature thus far is not strong enough to lead to a definitive conclusion"; a sentiment also reported in Ferdinand et al. (2012), Mayne et al. (2015), Smith et al. (2017) and McCormack and Shiell (2011).

Despite methodological limitations, Kärmeniemi et al. (2018) concluded that creating new infrastructure for walking, cycling and public transportation could induce demand for walking and cycling, and Stappers et al. (2018) added that the most promising results were for cycling. Mayne et al. (2015) and Smith et al. (2017) concluded that studies found a strong, positive impact when interventions improved infrastructure for active transportation, or had a longer follow-up period.

Smith et al. (2017) was the only one of these reviews to examine whether intervention effects differed by ethnicity or socioeconomic status, finding four relevant studies. Smith et al. (2017) concluded that walking and cycling infrastructure use was lower among people of lower educational level and income, but there were no differences by ethnicity. Infrastructure improvements may predominantly benefit socioeconomically advantaged groups and this warrants further exploration in future studies.

New Zealand research

Cross-sectional self-reported data from the New Zealand Health and Lifestyles Survey 2012 and 2014 showed that adults who walk or cycle to their main activity were 76% more likely to meet physical activity guidelines compared to motor vehicle users (Shaw et al. 2017). However there has been a decline in active travel (walking and cycling) in NZ. A study in two NZ cities in the two NZ cities of New Plymouth and Hastings around 2011-2013 found this decline halted following improvements in infrastructure and associated programmes, compared to the control cities of Whanganui and Masterton (Keall et al. 2015). However, in terms of physical activity levels, there was little evidence of an overall change (Keall et al. 2015). Another study used systems dynamics simulation modelling to explore the kinds of

policies that could increase cycling (Macmillan et al. 2014). The authors suggest that transforming urban roads using best practice physical separation on main roads and bicycle-friendly speed reduction on local streets, would yield benefits 10-25 times greater than the costs. The greatest benefits accrue from reduced all-cause mortality due to population-level physical activity.

The phenomenon of 'bike lash' (organised opposition to cycle lanes) has been examined in two NZ studies: interviews with 12 stakeholders from three communities in New Zealand (Field et al. 2018), and a literature review (Wild et al. 2017). The authors highlight the importance of design and engagement in the process, as bike lanes have a community-wide impact, and challenge existing modal hierarchies and patterns of movement. They suggest that "countering bikelash requires an understanding of the roles of actors and coalitions at macro (national policy and regulation), meso (city and industry) and micro (community) scales in fostering bike lane development and countering opposition. For city planners, the challenge of bikelash requires committed leadership, design, planning, capacity-building and engagement that moves beyond business as usual processes, builds local coalitions, and aligns with community needs and aspirations for placemaking" (Field et al 2018).

A NZ modelling study investigated socioeconomic differences in active commuting in the Wellington region and forecasted changes in active commuter trips associated with changes in the built environment (Mackenbach et al. 2016). Results indicated high-income individuals were more likely to commute actively than individuals on low income. The authors concluded that regional level policies stimulating environmental factors that directly or indirectly affect active commuting may be a promising strategy to increase population level physical activity (e.g. active commuting increased following an increase in bus frequency and parking fees) but environmental changes could have a differential impact on high and low income individuals.

A controlled intervention study, Te Ara Mua-Future Streets, was implemented in Māngere Auckland in 2016-2017, investigating the health impacts of investment in active travel and street calming infrastructure. The main results of the intervention are forthcoming, but a paper details the challenges faced during the intervention with collaboration between residents, researchers, and transport design and policy practitioners (Witten et al. 2018).

2. Residential density, walkability and street connectivity

International evidence

Five systematic reviews considered whether residential density and street connectivity influenced physical activity (Kärmeniemi et al., 2018, Smith et al., 2017, Malambo et al., 2016, McCormack and Shiell, 2011, Saelens and Handy, 2008). An additional review (Valson and Kutty, 2018), considered the influence of gender on the relationship between the built environment and NCDs.

All reviews found that population density (or number of destinations) was associated increased walking behaviour and higher physical activity overall. McCormack and Shiell (2011) conclude that land use mix, composite walkability indices and neighbourhood type were consistently associated with higher physical activity levels even after controlling for neighbourhood self-selection. Smith et al. (2017) found strong evidence that multiple streetscape components (that is two or more of: crosswalk and sidewalk improvements, improved and covered bike parking, installation of traffic calming features such as raised platforms or zebra crossings, and parking bays; creating safe places to walk) would improve adult physical activity. Malambo et al. (2016) concluded that urban street connectivity improves neighbourhood walkability, and walkability was associated with a lower prevalence of high body mass index, diabetes mellitus and metabolic syndrome risk.

Saelens and Handy (2008) conclude that street calming techniques are important to make walking more attractive. This includes widening sidewalks, narrowing the width of streets at pedestrian crossings, adding landscaping, adding measures to slow vehicles such as speed bumps, altering road alignments, adding traffic circles, or installing pavement treatments, and regulations designed to increase street connectivity.

Three high quality studies on walkability showed that moving to a neighbourhood with a high Walk Score was associated with much higher levels of physical activity, mostly due to increased walking to public transport (Kärmeniemi et al. 2018). Kärmeniemi et al. (2018) conclude that their findings "provide implications for zoning policy and support the creation of compact and diverse residential areas where housing is mixed with commercial, public and recreational destinations and the circumstances for daily living are located within walking and cycling distance."

Only Smith et al. (2017)–a New Zealand research team–considered the health equity implications of improving the streetscape, noting "Numerous limitations in the evidence base exist. In particular, the possibility that the benefits of infrastructure improvements may be inequitably distributed requires further investigation."

New Zealand research

The URBAN (Understanding the Relationship between Activity and Neighbourhoods) study was conducted in August 2008 to October 2010 in 48 neighbourhoods across four cities in New Zealand, the results of which have been published in seven papers (Hinckson et al. 2017; Oliver et al. 2015; Ivory et al. 2015b; Witten et al. 2012; Badland et al. 2012; Badland et al. 2010; Witten et al 2008). Just over 2,000 adults aged 20-65 years participated, with questionnaire, accelerometer and body mass index data collected, and the built environment was objectively assessed for each neighbourhood. The study found three objectively measured neighbourhood characteristics—street connectivity, neighbourhood destination access, and dwelling density—were positively associated with self-reported and

accelerometer-derived measures of PA (Witten et al. 2012). Furthermore, these associations were largely unchanged after adjustment for participants' desire to live in walkable or less walkable neighbourhood, suggesting that the PA environment is determining the level of activity (Witten et al. 2012). Street connectivity and neighbourhood destination accessibility were also significant predictors of body size, after adjusting for individual characteristics, neighbourhood preference and deprivation level (Oliver et al. 2015). Significant relationships with BMI were also found for streetscape and dwelling density. Mediation analyses revealed a significant mediating effect of physical activity on the relationships between body size and street connectivity and neighbourhood destination accessibility (explaining between 10.4 and 14.6 % of the total effect) (Oliver et al. 2015).

The extent to which streetscapes, neighbourhood destinations and street connectivity impacted on physical activity in the URBAN Study varied according to individual factors, notably ones that may be proxies for the strength of daily exposure to the neighbourhood through higher levels of engagement with and reliance on the residential environment, e.g. restricted car access and low income (Ivory et al. 2015b). The authors conclude that their findings reinforce the need to consider synergies between where people live and *who* they are when thinking about the role of the neighbourhood for living healthy active lives (Ivory et al. 2015b).

Time spent in sedentary behaviour was not correlated with the built environment in the URBAN study (Hinckson et al. 2017). However, neighbourhoods that included retail shops within a 500 metre neighbourhood buffer were associated with less sedentary time in women residents only, and in Christchurch higher street connectivity was associated with less sedentary time (Hinckson et al. 2017). It is possible that since sedentary behaviour is not the reverse of physical activity, the presence of walkable features may not influence the transition from sitting to walking, but these may be influenced by other social and cultural factors. The authors also point out that sedentary behaviour may have been influenced by built environment factors not measured in the study such as public transport (Hinckson et al. 2017).

Earlier findings from the self-reported questionnaires in the URBAN study (n=1616) found that most New Zealanders prefer to live in an urban (walkable) rather than suburban area, but 26% of adults lived in an area that was less walkable than they would like (Badland et al. 2012). Wellington is the city in NZ with the highest level of walking (27.5% of all trips) and public transport use (6.2% of all trips). A modelling study found that if Auckland, Tauranga, Hamilton, Christchurch and Dunedin had the same walking and public transport-mode share as Wellington there would be considerably increased physical activity (Shaw et al. 2018).

3. Public transport

International evidence

Two systematic review considered the effect of changes to public transportation on physical activity (Rissel et al., 2012, Kärmeniemi et al., 2018). Kärmeniemi et al. (2018) found moderate evidence from natural experiments that increasing public transportation increased active transport (walking or cycling to/from the public transportation stops). Rissel et al. (2012) found that walking to public transport added somewhere from 8 to 33 minutes of additional physical activity a day for commuters (with the majority of papers reporting 12–15 minutes). For some people, the addition of transport related walking is sufficient to achieve the recommended levels of physical activity.

Kärmeniemi et al. (2018) conclude that their findings "imply that behaviour is responsive to changes in the built environment and demand for active transportation can be induced, which would have direct implications for greater investments into high-quality infrastructure for these active modes of transportation in order to make the modal shift from private motor vehicles possible".

New Zealand research

New Zealand Household Travel Survey and GIS data on land-use and public transport facilities with the Wellington Integrated Land-Use, Transportation and Environment (WILUTE) model were used by researchers to assess the impact of urban land-use and public transport policies on active commuting (Mackenbach et al. 2016). They concluded that access to, and frequency of, public transport in the neighbourhood acted as a facilitator for a more active lifestyle among its residents without negatively affecting disadvantaged groups. Results from the logistic regression analysis also indicated that parking price and bus frequency were two important public transport variables related to active commuting (Mackenbach et al. 2016). A study of accessibility to public transportation in Auckland found that although 94% of the urban population live in areas with medium–high public transit and walking access, only 27% of the urban population also have an average transit frequency of two or more trips per hour per stop. Moreover, only 5% of the urban population live in areas with an average transit frequency of more than four services per hour per stop (Mavoa et al. 2011).

Kaupapa Māori research, interviewing 19 Māori in 2010, gathered Māori perspectives on transport (Raerino et al. 2013). The authors concluded that greater representation of Māori is required at multiple levels in both the development of regional transport strategies and local implementation of those strategies. Secondly, policy makers should empower the development of small community owned and operated public transport systems that reflect the specific needs of indigenous communities, including systems such as marae-based transport, which are a valuable alternative to travel by car. Although more general improvements in public transport that prioritise low income communities would also likely benefit Māori wellbeing, the issues raised by participants in this study highlight the need for more specific, Māori-centred strategies in order to achieve transport equity. In particular, the authors recommend transport strategies and policies are introduced specifically to address access for Māori youth to education and employment, through a combination of improved public transport services and programmes to support full driver licensing and safe vehicle ownership, in order to address the determinants of illegal driving, particularly for Māori men (Raerino et al. 2013).

4. Parks and playgrounds

International evidence
Three systematic reviews considered whether parks and playgrounds had an effect on adult physical activity levels (Kärmeniemi et al., 2018, Smith et al., 2017, Ferdinand et al., 2012). The two most recent reviews, Kärmeniemi et al. (2018), and Smith et al. (2017), found a consistent positive effect of provision of quality parks and playgrounds on physical activity. Kärmeniemi et al. (2018) detailed seven natural experiments which assessed park and playground upgrades, including signage, promotional incentives, outreach and support for group activities, recreational areas, walking paths, play equipment, seating, safety surfacing and waste facilities. Park and playground improvements were associated with higher physical activity in five of these seven studies.

Smith et al. (2017) noted that there were some interesting patterns whereby improvements in non-specific activity dimensions occurred, such as installation of fitness or playground equipment increasing active transport to that setting, and improving the streetscape for walking and cycling increasing physical activity behaviours beyond active transport. Positive impacts were observed for both children and adults.

Ferdinand et al. (2012) note that very little research has been done with a specific focus on minority populations especially with regard to their use of parks, and also rural populations.

New Zealand research
Using physical activity and BMI data from the 2002/03 NZ Health Survey and GIS of parks and beaches to calculate travel times, Witten et al. (2010) investigated the effect of access to open spaces on health outcomes. Neighbourhood access to parks was not associated with BMI, sedentary behaviour or physical activity, after controlling for individual-level socio-economic variables, and neighbourhood-level deprivation and urban/rural status. There was some evidence of a relationship between beach access and BMI and physical activity in the expected direction (Witten et al. 2010).

Concerns have been raised about the accessibility and usability of New Zealand parks, following a recent survey of 21 public parks and playgrounds in three metropolitan cities of New Zealand (Perry et al. 2018). However, earlier research in West Auckland found public parks located in more deprived neighbourhoods were more likely to have better safety infrastructure and a higher number of activities available (Badland et al. 2010).

5. Recreation facilities

International evidence
Two systematic reviews considered the effect of recreational facilities on adult physical activity (Smith et al., 2017, Malambo et al., 2016). Both found moderate evidence that the installation of fitness equipment and/or recreation facility density had a consistently positive effect on adult physical activity.

Malambo et al. (2016) found that recreational facilities improves neighbourhood walkability which may promote walking, leisure and transport related to physical activity which, consequently, lowers the incidence of CVDs.

New Zealand research
No research was found in New Zealand about the effect of recreation facilities on physical activity levels in the population.

6. Perceptions of the built environment

International evidence
Three systematic reviews considered how perceptions of the built environment impact on decisions about physical activity (Salvo et al., 2018, Kärmeniemi et al., 2018, Mccormack and Shiell, 2011) and one review (Valson and Cutty 2018) looked specifically at differences by gender in perceptions of the built environment and how this influenced phsyical activity. The two most recent reviews, Kärmeniemi et al. (2018) and Salvo et al. (2018) found moderate evidence that perceptions of safety and aesthetics (pleasantness and attractiveness of neighbourhoods) and 'destination' (the likelihood of social interactions/ perceived value of facilities) influenced physical activity. McCormack and Shiell (2011) found limited evidence for aesthetics supporting physical activity.

Valson and Cutty (2018) found that women's physical activity was influenced by their views of aesthetics and greenery in the neighbourhood, density of neighbourhoods, proximity of recreational facilities and safety from traffic. Young men gave greater priority to access to destinations, proximity to workspace and high street connectivity to engage in transport-related walking.

Salvo et al. (2018) found street connectivity and safety features (lighting or separating pedestrians, cyclists and motorized traffic) support activity, and that aesthetic features such as vegetation, waterfalls and beaches motivate people to be physically active and spend more time outdoors. Salvo et al. (2018) stress that physical infrastructure is important but not sufficient; when promoting physical activity, the sociodemographic profile of the neighbourhood (social, cultural and historical factors) must be considered.

Sociodemographic characteristics (age, sex, ethnicity, and socioeconomic status) contribute to perceptions of the built environment's enablers and barriers for physical activity. Neighbourhood features may be an enabler for some people while a barrier for others (e.g. visible police presence is reassuring for some and intimidating for others). Salvo et al. (2008) state that "a synergy is needed between transportation planning, urban design, landscape architecture, road engineering, parks and recreation, bylaw enforcement, and public health to create neighbourhood environments that support physical activity", and that citizens (particularly from all sociodemographic backgrounds) must have input into neighbourhood planning processes.

New Zealand research
Similar to overseas research, four focus groups in 2010 (two in Auckland and two in Wellington) found that not all residential settings equally provided motivation for residents to be physically active. Open spaces, good footpaths, and safety of the streets were important factors for promoting physical activity (Ivory et al. 2015a).

7. Community multi-strategic interventions

International evidence

One systematic review (Baker et al., 2015) evaluated the effects of community-wide, multi-strategic interventions on physical activity levels in populations. The review included studies where there were at least two physical activity interventions targeted to a whole community, half of which included environmental changes such as walking trails, policy and planning. Almost all of the interventions included a component of building partnerships with local governments or non-governmental organisations (NGOs). The interventions usually failed to provide a measurable benefit in physical activity for a population, mostly due to low participation/reach, although some studies with environmental components observed more people walking.

No systematic reviews were identified that investigated the influence of community-wide multi-strategic nutrition or obesity interventions on adults (all have considered the effect of these for children and adolescents, not adults).

New Zealand research

In New Zealand, there have been two community multi-strategic interventions aimed at improving the food and physical activity environment: Healthy Eating Healthy Action (2004-2008) and Healthy Families (2014-current). Healthy Eating–Healthy Action: Oranga Kai–Oranga Pumau (HEHA) was a government policy aimed to improve nutrition, increase physical activity and reduce obesity, delivered primarily through the District Health Boards but with actions in many sectors by many agencies. The evaluation of HEHA was never completed fully (McLean et al. 2009) but a stocktake of programmes/initiatives was undertaken in 2008/09 and repeated 2009/10 (HEHA Strategy Evaluation Consortium 2010). 1249 initiatives were identified in 2008/09: 20% focused on nutrition, 35% on PA and 44% both PA and nutrition, most implemented at a regional level. All three types of initiatives were targeted primarily at Māori, Pacific, low socioeconomic and family/whānau. By 2009/10, only 801 initiatives were running (a 36% decrease), with a major reduction in the number of initiatives targeting children, especially younger (0-5) and primary school children (6-12). The overall focus of HEHA was on creating supportive environments, strengthening community actions, developing personal skills and building healthy public policy.

Healthy Families New Zealand began in mid-2014 in ten communities around New Zealand and focuses on community-driven solutions to locally identified needs, employing a systems approach to preventing chronic disease. The interim and summative evaluation (Massey University Evaluation Team 2017; Matheson et al. 2018) state that the programme is being implemented with integrity and there is evidence of a shift toward focusing on relationships between settings, 'joined up' leadership and the wider determinants of health. There has also been a continued prioritisation and emphasis on Māori ownership and participation, as well as on equity. The authors of the evaluation conclude that it is too soon to see Healthy Families make a change to chronic disease risk factors. Healthy Families NZ locations combined showed more worsening than improving trends in the chronic disease risk factors groups, when compared to the Rest of New Zealand. While there has been worsening in adult obesity and overweight in all Healthy Families NZ locations compared to the total population, inequalities for Māori in adult obesity and overweight have improved compared to the Rest of New Zealand. Improvements in local data are needed. A key finding of the evaluation was that local action has been constrained by regulatory inaction. Eighteen recommendations are given in the summative evaluation to strengthen the programme.

8. Pricing strategies including taxes and subsidies

International evidence

Nine systematic reviews in the stocktake considered the effect of changing the price of food or beverage products for public health purposes through taxes and/or subsidies; four reviewed natural experiments and intervention studies (Redondo et al., 2018, Afshin et al., 2017, Sisnowski et al., 2015, Black et al., 2014), four reviewed modelled/simulation studies (Hyseni et al., 2017, Niebylski et al., 2015, Eyles et al., 2012, Andreyeva et al., 2010), and one included both intervention and modelling studies (Thow et al., 2014). Additionally, Olstad et al. (2016) considered the effect of universal policies (including taxes and subsidies) on socioeconomic inequities in obesity and obesity-related behaviours, and Backholer et al. (2016) considered the effect of a sugar-sweetened beverage tax according to socioeconomic position.

All reviews found strong evidence that subsidizing healthful foods significantly increases their consumption, while taxation of unhealthful foods and beverages reduces their intake. However, Sisnowski (2017) stated that many of the interventions (both of taxes and subsidies) failed to achieve an effect on consumption that could plausibly be considered as clinically significant, i.e. as having an effect on individuals' nutritional intake to the extent that it would reduce the incidence of overweight, obesity, and related chronic diseases. Most of the other reviews on pricing strategies for public health outcomes have concluded that they could be effective (Black et al. 2012, Eyles et al. 2012). Afshin et al. (2017) noted that interventions promoting healthful behaviours (e.g. subsidies) generally have greater effect sizes compared with those targeting cessation of unhealthful behaviours (e.g. taxes).

Thow et al. (2014) reviewed studies where the subsidies on healthy foods ranged from 1.8% to 50%, with all having an increase in consumption of targeted foods (which were classified within healthy food categories or were fruit and vegetables) of at least half the magnitude of the tax applied. The effect of subsidies on total calorie intake was unclear. Three modelling studies found that subsidies paired with taxes in the range of 10–20% (sugar tax with fruit, vegetable and fish subsidy; fat tax with fruit and vegetable subsidy; unhealthy food tax with fruit and vegetable subsidy) could reduce total calories by a small amount (approx. 1%). Thow (2014) concluded that soft drink taxes and subsidies appear most effective in inducing consumption change, with strong evidence from robust modelling studies and one RCT, although there is some evidence that subsidies can increase overall calorie consumption. Black (2012) also considered only the effect of food subsidies, with most of the included studies reporting on the Special Supplemental Nutrition Program for Women, Infants and Children in the USA. Food subsidy programme participants (mostly pregnant or postnatal women) were shown to have 10– 20% increased intake of targeted foods or nutrients, with targeted fruit and vegetable subsidies with nutrition education able to increase fruit and vegetable intake by 1– 2 serves/day in women. The authors note that the improved intake of targeted nutrients and foods, such as fruit and vegetables, could potentially reduce the rate of non-communicable diseases in adults, if the changes in diet were sustained.

Price elasticity of demand, the likelihood that a pricing change will result in a change in purchasing behaviour, is the main way taxes and subsidies are thought to influence health. Higher elasticity estimates suggest greater changes in population purchases as prices shift.

Andreyeva et al. (2010) found the highest price elasticities were for food away from home, soft drinks, juice, meats, and fruit, and the most inelastic demand was for eggs, confectionery and cheese. From a public health perspective, more elastic demand for food is encouraging if change in demand is a priority (e.g., decreased intake of sugar-sweetened beverages and increased consumption of fruits and vegetables). Eyles et al. (2012) review of simulation modelling studies concluding that taxes on carbonated drinks and saturated fat, and subsidies on fruits and vegetables would be associated with beneficial dietary change, with the potential for improved health. Thow et al. (2014) noted that price elasticity may not be the only reason why a tax is effective. Taxes reinforce efforts to educate consumers and raise public awareness about the amount of sugar, salt or fat in products and this may discourage purchases. Additionally, industry may respond by reformulating products so that they contain less of the taxed nutrients (see topic 12 for more information on reformulation effects).

Niebylski et al. (2015) concluded that in order to maximize success and effect, food or beverage taxes and subsidies should be a minimum of 10 to 15% and preferably used in tandem. Eyles et al. (2012) concluded that a 10% increase in the price of soft drinks could decrease consumption by -0.6% to -24.3%; conversely, a 10% decrease in the price of fruits and vegetables could increase consumption by between 2.1% to 7.7%. Hyseni et al. (2017) looked at the effect of tax on salt in order to reduce population sodium intakes, and noted that salt is cheap, so a substantial tax of at least 40% might be needed to reduce consumption by just 6%.

Most studies and reviews to date on food and beverage taxes have been theoretical estimations from modelling analysis. In contrast, Redondo et al. (2018) synthesized evidence from real-world taxes and other empirical approaches related to the impact of taxes on the consumption, purchase, and sales of sugar-sweetened beverages (SSB). Redondo et al. (2018) found a significant reduction in sales/purchasing or intended purchasing due to tax on SSBs, and conclude that SSB taxes have the potential to reduce calorie and sugar intake, but further research is needed to evaluate effects on overall diet quality. An tax on SSBs that would result in a sales price increase to the consumer of 20% to 25%, seems to be the most appropriate measure; however, the type of tax and whether it should be adopted as a single or joint measure (with other interventions, such as a public message campaign or subsidising healthy foods) still need to be established. The reductions in purchasing and/or consumption were higher in low socioeconomic settings (in the US and Mexico), leading Redondo et al. (2018) to conclude that there would be a positive impact of taxes on vulnerable social classes, which also have a higher prevalence of obesity.

Andreyeva et al. (2010) noted that there was evidence to suggest that low-income populations may be more sensitive to price changes than the overall population. Olstad et al. (2016) review of five studies where there had been a tax-related fiscal intervention at the community level, found consistently positive or neutral impacts on inequities in anthropometric and behavioural outcomes. Eyles et al. (2012) review of modelling studies found 11 out of 14 estimated that fiscal policies would result in absolute improvements in dietary outcomes for lower socio-economic groups, although only four studies estimated relatively greater health benefits for lower compared with higher socio-economic groups, and thus improved health equity. Findings for the two moderately high quality studies were mixed, and several authors noted that taxes would be regressive whereby low-income households pay a greater proportion of their income in additional tax. Eyles et al. (2012) concluded that if price elasticities are greater among low-income population sub-groups, then negative financial implications will be at least partially offset by greater improvements to health and an overall

effect of decreasing health inequities (as has been observed for tobacco taxes). Backholer et al. (2016) concluded that a sugar-sweetened beverage (SSB) tax is regressive but the monetary burden would be small, with relatively minor differences between high and low-income households. Backholer et al. (2016) conclude that an SSB tax is likely to be effective in reducing consumption of SSBs and will have a similar or greater effect on low-income household consumption compared to high-income households, and therefore pro-equity, or, at the minimum, neutral in reducing inequity.

New Zealand research

A sugar-sweetened beverage (SSB) tax has been thoroughly researched in New Zealand. Ni Mhurchu et al. (2014) modelled the effect of a 20% tax on all carbonated drinks, finding it would reduce daily energy intakes, avert or postpone 0.2% of all deaths in NZ a year, and reduce diabetes and obesity. The impact would be larger in Māori and Pacific populations due to their greater responsiveness to food price changes, and among children and young people due to their higher consumption of SSB. The authors note that a 20% tax on fizzy drinks would generate $40 million in revenue a year, even allowing for reduced consumption. Signal (2018) interviewed 20 politicians, bureaucrats, public health experts, food industry leaders and consumer representatives about the likelihood of taxes and subsidies on foods being introduced in the next 5-10 years in New Zealand. There appears to be little appetite for taxes of foods high in saturated fat or salt, but widespread agreement that a SSB tax and/or a fruit and vegetable subsidy are both feasible and would be accepted.

Ni Mhurchu et al. (2015) have also modelled the effects of other food taxes and subsidies. A 20% subsidy on fruit and vegetables would result in 560 deaths prevented or postponed every year. A 20% tax on major dietary sources of saturated fat would prevent or postpone 1500 deaths a year, and a 20% tax on major dietary sources of sodium would prevent or postpone 2000 deaths a year. Combining these two taxes and the fruit and vegetable subsidy would result in 2400 deaths a year prevented or postponed. Māori and low-income New Zealanders would benefit the most due to a greater burden of diet-related disease, and because they are more responsive to changes in food prices (Ni Mhurchu et al. 2015), echoing findings from an earlier modelling study which found Māori and low-income households have greater sensitivity to food price changes (Ni Mhurchu et al. 2013).

The SHOP randomised controlled trial in 8 supermarkets in the lower North Island of NZ in 2007-2009 tested the effect of price discounts on healthier supermarket foods, tailored nutrition education promoting healthier products, and a combination of price discounts and nutrition education, against a control with no intervention. Neither the discounts nor the education had a significant effect on saturated fat purchase or any nutrient outcomes considered. However, price discounts of 12.5% (the same as a removal of GST) did have a significant effect on healthy food purchases at 6 months, with a 10% greater increase in fruit and vegetable purchases (Ni Mhurchu et al. 2010). Results for Māori in the trial were not as expected, with Māori having a weaker and null effect compared to European/Pakeha, which may have been due to a higher attrition rate (Blakely et al. 2011).

The need for an adjustment of food prices through taxes and subsidies has been shown in several NZ studies. Since the 1970s, the Department of Human Nutrition at the University of Otago has undertaken an annual survey of supermarket food costs in five NZ cities (reduced to four since 2016), to estimate the cost of a basket of supermarket food designed to meet dietary needs of men, women, adolescents and children, producing basic, moderate and liberal diet cost options. The food costs do not include takeaways etc. and assumes some food

preparation and cooking skills. The chances of consuming an inadequate diet increase as the amount spent to purchase food falls below the basic costs; which in 2018 were $266 a week for a family consisting of one male adult, one female adult, one adolescent girl and one adolescent boy (Department of Human Nutrition, 2018). Vandevijvere et al. (2018b) modelled the cost of different NZ diets, finding healthy diets were on average more expensive than current (usual) diets. However, Māori and Pacific families, because of their high current energy intakes, had current diets which were $40-60 more expensive a week than healthy diets. The authors suggest that a subsidy (removal of GST) on fresh and frozen vegetables and an SSB tax would reduce the cost of a healthy diet bringing the average healthy diet toward current diet costs. Mackay et al. (2018) found that a considerable portion of income is need to purchase a healthy diet or the current diet in NZ, particularly if the household was receiving minimum wage or income support. The authors conclude that in order for the NZ population to consume a healthy diet, policies are required that lower the cost of healthy food or ensure households have adequate incomes after fixed expenses to buy food (Mackay et al. 2018).

9. Labelling on pre-packaged food and beverages

International evidence

Six systematic reviews considered the effect of nutrition labelling on food products on purchasing decisions and population health outcomes (Shangguan, et al. 2018, Kliemann et al. 2018, Hyseni et al. 2017, Kaur et al. 2017, Cecchini and Warin 2016, Campos et al. 2011). All reviews supported the implementation of food labelling as a key tool to tackle unhealthy diet and obesity, finding that there was an association between use of nutrition labels and healthier diets. Consumers perceive nutrition labels to be a highly credible source of information, and many consumers reported using nutrition labels to guide their selection of food products. Shangguan et al. (2018) found labelling reduced consumer consumption of total energy and total fat, while increasing consumption of vegetables. Food labelling did not significantly alter consumer intakes of other dietary targets, including sodium, total carbohydrate, protein, saturated fat, fruits, or whole grains. Their meta-analysis also found evidence that food labelling altered industry formulations for sodium and trans fat, but did not significantly affect product formulations for total energy, saturated fat, dietary fiber, or other healthy/unhealthy dietary components (Shangguan,et al. 2018). Hyseni et al. (2017) found that nutrition labelling for sodium levels could be effective, as demonstrated in Finland and Brazil, as it allows consumers to make informed choices whilst also putting pressure on the food industry to reformulate.

Kliemann et al. (2018) looked at nutrition labelling regarding serving size. Most countries with mandatory food labelling require that serving size be presented on food labels, but allow manufacturers to determine the serving size which leads to variability and compromises the comparability between similar products. Moreover, studies indicate that food companies may vary serving sizes as a marketing strategy to stimulate sales by reporting lower values of certain adverse nutrients or lower energy values on nutrition information labels. Klienmann et al. (2018) found that higher energy density food products tend to report smaller serving sizes than the reference size. Consequently, individuals may overconsume high energy density foods without being aware of doing so. Moreover, in some countries (e.g. USA), the reference serving size represents the portion size customarily consumed in one eating occasion. Although this could potentially help the understanding and correct estimation of

serving sizes, it does not facilitate the promotion of healthy eating behaviours. The inclusion of nutrition information per 100g or mL alongside serving size (as on Australian/New Zealand labels), and number of servings may help address this and assists with comparison between products.

Health-related claims are statements regarding the nutritional content of a food (nutrition claims) and/or indicate that a relationship exists between a food and a health outcome (health claims). Kaur et al. (2017) found that health-related claims on packaging have a substantial effect on dietary choices. However, this finding was based on research mostly conducted in artificial settings. Findings from natural experiments have yielded smaller effects. The authors conclude that it is important that health-related claims are regulated properly to ensure their validity so that only foods with a better nutritional composition may carry claims given the increasing prevalence of health-related claims and concerns over unwarranted 'health halos'.

There is growing evidence that consumer-friendly 'interpretive' symbols and front-of-pack (as opposed to side or back of packages) labels are more effective, both due to the fact that they make nutritional information more accessible and because of a widespread desire for more 'prescriptive' information (e.g. this is healthy or not healthy) rather than information that requires interpretation (e.g. grams of sugar) (Campos et al. 2011, Cecchini and Warin 2016, Hyseni et al. 2017). However, Shangguan et al. (2018) did not find consistent differential effects according to label type, placement, intervention duration, or mandatory versus voluntary labelling. They suggest the type of labelling may be less quantitatively relevant than the general presence or absence of information to consumers.

Some reviews raised concerns that interpretation of labels depends on health literacy and different labelling systems may confuse consumers, and reinforce inequalities (Hyseni et al. 2017, Campos et al. 2011). Shangguan et al. (2018) undertook a meta-analysis and did not identify a consistent gradient in responses by SES, age, or sex. They suggest that "determinants of potentially varying effects of labelling require further studies, and conventional wisdom on modifying effects of population demographics should not be considered a tautology."

New Zealand research

Nutrition labelling on food products and beverages has been well researched in New Zealand. A large randomised controlled trial (The Starlight Trial) in 2014/15 compared traffic light labels (similar to those on UK products), the Health Star Rating (now introduced in Australia and NZ) with the standard nutrition information panel using an app on mobile phones which allowed participants to scan the barcodes of packaged foods to receive their allocated labels while shopping. Neither traffic light labels or the Health Star Rating influenced the healthiness of purchases compared to the control nutrition panel label. However, participants randomly allocated to the traffic light and health star rating labels reported that they found them useful and easy to understand, and their nutrition knowledge improved (Ni Mhurchu et al. 2017a). Labels were viewed for about one-fifth of purchases overall, but frequency of use deceased over the four week trial. Label reading had a significant positive association with the healthiness of products purchased, which suggests labels may influence healthier food purchasing for those who use them (Ni Mhurchu et al. 2018).

Analysis of food composition data before and two years after the introduction of the voluntary Health Star Rating System (HSR) in 2014, showed that the labelling system may be

driving healthier reformulation of some products (Ni Mhurchu et al. 2017b). However, two years following the HSR introduction only 5.3% of packaged foods and beverages displayed the label, with cereals, convenience foods, packaged fruit and vegetables, sauces and spreads, and 'other' (predominantly breakfast beverages) the most likely categories to have a HSR label. The most recent data from the 1st quarter of 2018, found the HSR on 21% of eligible foods in the Nutritrack Database, with 77% of these for products with a 3-5 star rating (Ministry for Primary Industries, 2018). Another study, Hamlin et al. (2016) has tested the effect of the Health Star Rating System (HSR) on consumer choice. The presence of a HSR on a product consistently reduced customer preference for the product, independent of the product's star rating given (0.5 to 5 stars), which the authors conclude shows functional failure in the system, and adds to concern about the voluntary nature of this labelling system.

Earlier research on front of pack labelling reported that New Zealander's prefer simplified, graphic labels that could be interpreted quickly (Maubach and Hoek 2010). Reported use of nutritional information panels (NIP) ranged from 68% for Māori to 87% for European/Pakeha and Other (Gorton et al. 2009). Only 68% of Māori and Asian could correctly determine if a food was healthy from the NIP and 88% of European/Pakeha and Other, with lesser differences by income than ethnicity. Traffic light labelling was the most preferred nutrition information label Gorton, et al. 2009). Qualitative research with Māori, Pacific and low-income New Zealanders also found these groups rarely used NIPs (Signal et al. 2008).

The presence of health claims on packaged food and beverage labels has been investigated in two NZ studies (Alexander 2018, Al-Ani et al. 2016). Alexander (2018) found 56% of 600 packaged and 80 fresh randomly selected products had a nutrition claim on the label (e.g. high in Vitamin C) and 86% of these claims met the new standards in 2016. General-level health claims, which refer to a food property and its effect on normal health and wellbeing were found on fewer than 5% of foods in each food group, except special purpose foods (21%). 51% of General-level claims met the Standard. No high-level health claims (which explain what role a food property has in the risk of developing a serious illness, or risk of altering a recognised risk factor for a serious illness) were found on products. While the majority of claims used on food labels are meeting the requirements of the Food Standards Code, these claims are not being used as often as they could by food manufacturers and retailers (Alexander 2018). An earlier 2014 survey of 7526 products (Al-Ani et al. 2016) found cereals displayed the greatest proportion of nutrition and health claims (1503 claims on 564 products). One-third of claims were displayed on 'less-healthy' cereals, which the authors note could be misleading consumers' perceptions of nutritional quality of foods.

10. Menu labelling in restaurants

International evidence

Nine systematic reviews considered whether menu labelling with calories or other information would change purchasing behaviours (Crockett et al. 2018, Bleich et al. 2017 Sisnowski et al. 2017, Littlewood et al. 2015, Long et al. 2015, Sinclair et al. 2014, Swatz et al. 2011, Campos et al. 2011, Hillier-Brown et al. 2017). Campos et al. (2011) noted that at that time most jurisdictions limited nutrition labelling regulations to pre-packaged food products and did not apply these to foods served in restaurants or fast-food outlets, which account for a significant proportion of dietary intake in many high-income countries. Campos et al. (2011) state that mandatory display of nutrition information on menus and menu boards of food outlets may be a promising means of increasing the impact of nutrition labelling regulations and harmonizing nutrient information across information channels. From May 2018, USA restaurants and similar food establishments with 20 or more outlets have had to display the number of calories in standard items on menus and menu boards.

However, the majority of reviews to date do not suggest that calorie labelling or 'signposting' (indicating healthy products) on menus has the intended effect of decreasing calorie purchasing or consumption (Swatz et al. 2011, Bleich et al. 2017, Sinclair et al. 2014, Long et al. 2015, Sisnowski 2017, Hillier-Brown 2017). Only one review (Littlewood et al. 2015) concluded that menu labelling can effectively reduce energy ordered and consumed in the away-from-home food environment, and another, most recent review (Crockett 2018) concluded that "a small body of low-quality evidence suggest that nutritional labelling comprising energy information on menus may reduce energy purchased in restaurants. We tentatively suggest that nutritional labelling on menus in restaurants could be used as part of a wider set of measures to tackle obesity."

Similar to pre-package food labelling, Sinclair et al. (2014) and Sisnowski et al. (2017) noted that there is some evidence that mandating menu labelling results in modest reformulation of menus. Crockett et al. (2018) concluded that future research needs to takes account of possible wider impacts of nutritional labelling, such as the impact upon those producing and selling food, who may decide to reformulate or adjust the choice of items available, as well as the impact of labelling on consumer behaviour when applied in combination with other interventions.

New Zealand research

A study of 24 fast food stores (two from each of the 12 major chains in New Zealand) found that nutrition information was available at 92% of the chains, but less than 1% of this information was available at the point of purchase on the menu board (Chand et al. 2012). 64% of nutrition information was on the website, 17% on food packaging, 8% on food liners and 8% on in-store pamphlets (Chand et al. 2012). A more recent assessment of fast food restaurants found most had nutrition information available online (Vandevijvere et al. 2018b).

11. Reformulation

International evidence

Two systematic reviews considered population-level policies for food reformulation (Barberio et al. 2017, Hyseni et al. 2017), both focusing on sodium reduction. Hyseni et al. (2017) pointed out that the majority of dietary salt intake in high-income countries comes in processed food (75%) and so reformulation is very effective in reducing salt consumption. Though mandatory reformulation is more powerful, most countries currently use voluntary reformulation. Success is then dependent on the degree of political pressure applied to the food industry and on regular, independent monitoring, as recently achieved in the UK.

Both reviews concluded that multi-component strategies (including mandatory, or to a lesser extent voluntary, salt-reduction reformulation plus front-of-pack food labelling and/or media campaigns) achieved greater population-level reductions in salt consumption than individually focused interventions (e.g. dietary counselling in clinics or workplaces).

Barberio et al. (2017) found that the impact of national sodium reduction initiatives in terms of salt intake may be stronger among men than women. They suggest that this could be because globally, men consume more salt than women. Barberio et al. (2017) noted that most studies did not look at the differential effects of sodium reduction policies by socioeconomic status, but those that did showed that inequities did not necessarily increase (worsen) in the context of a national sodium reduction initiative. Hyseni et al. (2017) stated that more deprived groups in society are more likely to consume foods high in salt, (and sugar and fat) which are associated with poor health, so downstream interventions focused on individuals would typically widen inequalities whereas upstream structural interventions like reformulation may reduce inequalities.

New Zealand research

Research in New Zealand has focused on reformulation of products to reduce sodium. Eyles et al. (2016) estimated that the World Health Organization's target of 5 g/day would require a 36% reduction in the sodium content of packaged foods, as well as a 40% reduction in discretionary salt use and sodium content of foods consumed away from home. Key products requiring sodium content reduction were white bread, hard cheese, sausages, and breakfast cereals (Eyles et al. 2016).

A macro-simulation modelling study compared eight sodium reduction interventions and found the most feasible ones with the largest health gains were: a 25% reduction in sodium level of all processed foods; a package including voluntary food reformulation, food labelling and a media campaign; and mandatory 25% reduction in sodium levels in bread, processed meats and sauces (Nghiem et al. 2015). Interventions that produced lesser health gains included media campaigns, voluntary food labelling as currently used in New Zealand, and dietary counselling. All interventions produced net cost savings aside from counselling. Health gain per person was greater for Māori men and women compared to non-Māori (Nghiem et al. 2015). The authors, in a subsequent paper, conclude that maximum health gain could be seen by targeting reformulation toward "all packaged foods" and then "fast foods and restaurant meals" (Wilson et al. 2016). They conclude that reformulation interventions may also be pro-equity by achieving larger benefits for men and Māori (Wilson et al. 2016).

There is evidence of some progress on sodium reduction in New Zealand. Monro et al. (2015) found some categories where modest reductions had occurred over the 10 years 2003-

2013, specifically breakfast cereals, canned spaghetti and bread. However, there was no significant difference overall in the mean sodium content of matched products between 2003 and 2013, so the authors conclude that there needs to be a focus on reducing sodium across the food supply if we are to meet national commitments to reduce population sodium intake (Monro et al. 2015). Eyles et al. (2018) investigated the change in serve size, energy, and sodium contents of fast foods sold at chain restaurants in NZ between 2012-2016 and found evidence of reformulation of products and introduction of new products to reduce sodium levels. However, increased serve size over the time period offset the reformulation effect on actual intake of sodium (Eyles et al. 2018).

Setting targets for food manufacturers to achieve reductions in nutrients of concern (sodium, saturated fat, sugar) was one of the priority recommendations made by a panel of New Zealand public health experts in 2014 and again in 2017 (Vandevijvere et al. 2018a).

12. Portion size, plate and cutlery size

International evidence

Two systematic reviews considered whether it is possible to influence consumers' behavioural preferences towards healthier options by redesigning the environment in which consumers make their food choices (Hollands et al. 2015, Skov et al. 2013). This is often called "nudging" or "choice architecture" and usually involves changing the portion size (plate or container) or cutlery size in out-of-home food establishments.

Hollands et al. (2015) found that people consistently consume more food and drink when offered larger-sized portions, packages or tableware than when offered smaller-sized versions. This suggests that policies and practices that successfully reduce the size, availability and appeal of larger-sized portions, packages, individual units and tableware can contribute to meaningful reductions in the quantities of food (including non-alcoholic beverages) people select and consume in the immediate and short term. Skov et al. (2013) concluded that there was insufficient evidence. Neither of the reviews considered differences in the impact by sociodemographic factors, and both called for more research in this area.

New Zealand research

New Zealand research on the serve size and energy per 100g and per serve of fast foods sold at chain restaurants in NZ between 2012-2016, found serve size and energy density had increased significantly over the time period (Eyles et al. 2018). Particular food groups with larger serve sizes were beverages, chicken, desserts and pizza. More energy per 100g was found in desserts, pizza and sandwiches, and increased energy per serve were found in desserts, pizza, salads and sandwiches (Eyles et al. 2018). The authors conclude with a recommendation for systematic monitoring and implementation of Government-led targets for serve-size, energy and nutrient content of fast food products to improve population diet (Eyles et al. 2018). Research will be released soon on the health benefits and cost-savings of a cap on the size of single serve sugar-sweetened beverages (Cleghorn, personal communication).

13. Neighbourhood or community food environment

International evidence

Six systematic reviews have considered the effect of the community food environment on food-related behaviours or obesity outcomes (Chennakesavalu and Gangemi 2018, Pitt et al. 2017, Malambo et al. 2016, Mayne et al. 2015, Fraser et al. 2010, Fleischhacker et al. 2010), one of which considered qualitative studies (Pitt et al. 2017). The community environment involves the 'number, type, location, and accessibility of food outlets' in a location, frequently measured using proximity or density measures of food outlets.

The most recent review, Chennakesavalu and Gangemi (2018), found inconsistent associations between the fast food environment and rates of obesity/overweight, both in US and non-US studies. These findings echo earlier reviews (Fleischhacker et al. 2010, Fraser et al. 2010). However, one review (Malambo et al. 2016) found that a high density of fast food restaurants was associated with major CVD outcomes, body mass index, blood pressure and metabolic syndrome.

All reviews found lower socioeconomic status was consistently associated with fast food environments; with higher concentrations of fast food restaurants, higher consumption of junk food, and higher obesity rates in more deprived neighbourhoods (Chennakesavalu and Gangemi 2018, Pitt et al. 2017, Fraser et al. 2010, Fleischhacker et al. 2010). Additionally, Fraser et al. (2010) found evidence that greater exposure to fast food restaurants is associated with a lower fruit and vegetable intake. Fraser et al. (2010) postulate that this relationship with SES may be due to the companies targeting more deprived areas as the land is cheaper or it may be that the demand from consumers in these areas is greater. Either way this is an important issue to highlight to policy decision makers as land use restrictions on new fast food outlets could help to stop the 'deprivation amplification' effect.

Mayne et al. (2015) reviewed two studies that evaluated the effect of a new supermarket in a previously underserved area, both finding no effect on body mass index.

Pitt et al. (2017) found that availability, accessibility and affordability were consistently identified as key determinants of store choice and purchasing behaviours. Articles mentioned the proliferation of takeaway foods within communities and decreased or declining availability of produce, which was seen as one of the biggest influences on diet. Concern was raised regarding the availability of convenience or junk foods within stores, the proximity to fast food, and thus the subsequent increased consumption of these foods and decreased consumption of fresh produce. Accessibility was identified as a key determinant of food purchasing behaviours in terms of where food stores were located as well as transport options that facilitate access and was discussed in eighteen articles from the USA, the UK and Australia, being particularly evident for lower socio-economic groups.

New Zealand research

A GIS study of 20,000 registered food outlets in 66 council areas of NZ found a significant positive association between neighbourhood deprivation and density of all retailers (not just fast-food). The authors found 722 out of 2020 census areas in the country were 'food swamps' characterised by a high density of unhealthy food outlets (Sushil et al. 2017). The authors recommend that legislation be introduced to allow councils to consider health and wellbeing (not just safety) when assessing zoning and planning permissions, for them to give favourable zoning treatment for fruit and vegetable store outlets, and to restrict future

introduction of fast food outlets in high risk communities, allowing for community engagement in the zoning process (Sushil et al. 2017). The same findings of increased food outlets in areas of high deprivation were also found in an earlier GIS study (Pearce et al. 2007).

Two studies have investigated the association between neighbourhood access to fast food outlets in New Zealand and the diet or weight of local residents (Jani et al. 2018; Pearce et al. 2009). Jani et al. (2018) found no association between number of fast-food outlets and obesity prevalence, after adjustment for income and location. Pearce et al. (2009) found people with the furthest access to a multinational fast food outlet were more likely to eat the recommended intake of vegetables, but also more likely to be overweight. There was no association with fruit consumption. Access to locally operated fast-food outlets was not associated with the consumption of the recommended fruit and vegetables or being overweight. The study authors concluded that better neighbourhood access to fast-food retailing is unlikely to be a key contextual driver for socioeconomic inequalities in diet-related health outcomes in New Zealand (Pearce et al. 2009).

14. Availability and quality of healthy foods in-store

International evidence

Only one systematic review of qualitative studies considered the availability, access and quality of foods in-store (Pitt et al. 2017). Pitt et al. (2017) found that these aspects of the consumer nutrition environments greatly influenced in-store purchases. In-store availability of fruit, vegetables and meat was reported as a key driver of food store choice, and was discussed in fifteen articles from the Netherlands, USA and UK. Contrary to this, however, the availability of fresh produce was often referred to as unreliable and sporadic, especially in lower socio-economic areas. Corner stores and mini-markets were described as having less variety and fewer (if any) healthy items or alternatives than supermarkets. Local food stores tended to be stocked with unhealthy snack foods, cold drinks, cigarettes and beer. Consequently this limited the variety of healthy food people had access to, particularly if they were reliant on corner stores for their food purchasing. Nine articles, predominantly based in the USA, reported on customer concern regarding poor quality and safety of foods they could select from. Eight articles (seven from the USA and one from the UK) identified specific features or characteristics of food stores that play a role in influencing a person's decision to frequent a particular store and make food purchases, including in-store promotions and product placement, as well as cleanliness and customer service. Such factors were mostly examined in minority or lower socioeconomic communities.

New Zealand research

New Zealand researchers have examined aspects of the availability of healthy food in supermarkets. Vandevijvere et al. (2017a) measured the 'shelf length' (space) dedicated to healthy versus unhealthy foods in 15 supermarkets in 2015/16, finding a consistently low ratio of healthy to unhealthy products and considerable variation between the chains. Chand et al. (2012) investigated the availability and accessibility of healthier options at all NZ fast food chains with more than 20 restaurants (with exception of a sushi chain). Of all the items available, 21% were promoted as healthier options. These were generally cheaper and lower in energy, total fat, saturated fat, sugar and sodium per serve than the regular option.

One New Zealand study (Jani et al. 2018) investigated the availability and price of healthier foods versus regular counterparts (e.g. trim milk compared with full fat milk) and their associations with obesity. They found higher in-store availability of healthier food choices in rural versus urban locations, and low-income versus high-income areas, but no associations between the pricing of healthier foods and obesity.

15. Food advertising and promotions

International evidence

Two systematic reviews have considered trials of food retail store marketing strategies and their effect on diet and chronic disease risk (Gittelsohn et al. 2012, Glanz et al 2012). Glanz et al. (2012) classified 125 articles on in-store food marketing into categories of product, price, placement and promotion, finding that all four of these 'P's typically worked in combination to effect consumer choices. Amount of shelf-space and prominence of location, such as end-of-aisle, merchandising displays and checkouts, were influential. Point-of-purchase nutrition information was not successful. Most of the small-store trials that showed positive impacts in Gittelsohn et al.'s (2012) review used multipronged strategies designed to improve both access to healthy foods (supply) and consumption of health foods (demand). Several studies showed price reductions and limiting unhealthy foods (or at minimum moving them to the back of the store) appeared successful.

Outdoor advertising was also identified in Pitt et al.'s (2017) review of qualitative studies as an important influence on diet. Four articles (two from the USA and one each from Canada and the UK) discussed the role of outdoor advertising of fast food as influences on people's food choices. One article attributed the choice of out-of-home eating establishment to advertising and marketing techniques.

New Zealand research

In New Zealand, most of the research on food marketing and promotions has concentrated on those aimed at children or adolescents, e.g. promotions on social media or around schools. Research is currently underway co-designing and testing healthier supermarket interventions with a major retailer, which may include promotions and improved availability and access to healthy products in-store (Ni Mhurchu, personal communication).

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16. Workplaces

International evidence

Three systematic reviews considered the effect of workplace environment interventions to improve nutrition and/or physical activity and/or weight of employees (Ni Mhurchu et al., 2010, Verweij et al., 2011, Anderson et al., 2009). Most of the studies combined informational and behavioural strategies to influence diet and physical activity; fewer studies modified the work environment (e.g., nutrition labelling, canteen food supply/availability, menu reformulation, vending machines, exercise facilities, policies and business commitments) to promote healthy choices.

The three reviews all suggest that changing workplace environments is moderately successful for health promotion. Structured programmes (i.e., scheduled individual or group sessions) for behavioural skills development or physical activity conferred greater benefit than unstructured (i.e., self-directed) approaches (Anderson et al. 2009). Verweij et al. (2011) found strong evidence of a modest reduction in weight as a result of worksite health promotion programmes (about -1.2kg) and when environmental changes were included in the programme, an additional -0.29 kg reduction was observed. The environmental component in studies differed: walking maps and team competitions, family involvement and prompts, point-of-choice messages, walking routes, business goals and management commitments, but all had a positive effect. Ni Mhurchu et al. (2010) noted that effect sizes for dietary interventions were typically modest: relative decreases of up to 9% in total dietary fat and increases up 16% in daily fruit and vegetable intakes. Offering multiple programme components typically resulted in greater weight loss, but the results were not always consistent.

Anderson et al. (2009) also reviewed the cost-effectiveness of workplace programmes, finding that "they may not only enhance employee self-confidence and improve the relationship between management and labour but also have the potential to boost the profits of companies by increasing employee productivity and reducing medical care and disability costs."

New Zealand research

One study in New Zealand has investigated the effect of a healthier vending machines policy gradually phased in over a two-month period in two hospitals (Gorton 2010). Researchers found a substantial reduction in the amount of energy, total fat, saturated fat, and total sugars per 100g of product sold. Sales volumes and percentage of staff using vending machines were not affected, and the proportion of staff satisfied with vending machine products increased. The results show such guidelines are feasible and acceptable for both consumers and vending contractors, and wider implementation of these guidelines is recommended by the authors (Gorton 2010). Research is currently underway at the University of Auckland to investigate the food environment (food availability, cost and promotion) in tertiary education settings (Roy, personal communication).

Population-level policies

Table 1 overviews the countries (out of NZ, Australia, the UK, US and Canada) that have implemented policies aimed at improving the food or physical activity environment, as noted in the monitoring systems which are detailed in the methods section of this document. The United States have implemented the most policies to change population diet and physical activity, but some of the US initiatives are only in specific states or cities. The UK has also implemented more policies in this area compared to NZ, Australia and Canada.

Table 1: Food and physical activity environment policies implemented in New Zealand, Australia, the United Kingdom, the United States and Canada

Key: * only some states or jurisdictions

Policy recommendation		Implemented in… NZ	Aust	UK	US	Can
Community-wide multi-strategic interventions		✓	✓ *		✓ *	
Mandatory nutrient lists on packaged food		✓	✓	✓	✓	✓
'Interpretive labels' on front of packaged food	*Voluntary*	✓	✓	✓		
	Mandatory					
Calorie and nutrient labelling on menus and displays in out-of-home venues	*Voluntary*					
	Mandatory		✓ *		✓	✓ *
Warning labels on menus and displays in out-of-home venues					✓ *	
Rules on nutrient claims (i.e. nutrient content and nutrient comparative claims)		✓	✓	✓	✓	
Rules on health claims (i.e. nutrient function and disease risk reduction claims)		✓	✓	✓	✓	
Standards in social support programmes					✓	
Standards in other specific locations (e.g. health facilities, workplace)	*Health Facilities (and Public Sector workplaces)*	✓	✓	✓ *	✓	
	Workplaces	✓				
	City Agencies (e.g. prisons)				✓	
	Vending Machines				✓	

Policy recommendation		Implemented in… NZ	Aust	UK	US	Can
Health-related food taxes	*Sugary Drinks*			✓	✓ *	
	Low nutritional value food items				✓ *	
Voluntary food taxes e.g. Jamie Oliver restaurants	*Sugar Tax*			✓		
Targeted subsidies for healthy food	*No GST on fruit and vegetables*		✓			
	Isolated/rural Communities					✓ *
	Pregnant women and/or families with children		✓	✓	✓	
	Low-income				✓	
Voluntary reformulation of food products	*Salt Reduction*			✓	*	✓
	Saturated Fat Reduction (not including trans-fat reduction as NA in New Zealand)					
Initiatives to increase the availability of healthier food in stores and food service outlets				✓	✓ *	
Incentives and rules to offer healthy food options as a default in food service outlets					✓	
Planning restrictions on food outlets				✓		
Public procurement through "short" chains (e.g. local farmers)					✓	
Plan to promote physical activity	*National*			✓	✓	✓
	High Performance	✓				
	Community Sport	✓				
Active transport	*Promote Active Transport*			✓		✓
	Cycling infrastructure			✓		✓
	Bike subsidies (e.g. bike share, workplace bikes)			✓		

Policy recommendation		Implemented in… NZ	Aust	UK	US	Can
National Health and Fitness Day						✓
Physical activity included in the national health monitoring system (e.g. surveys)		✓	✓	✓		

Summary

What research has been done internationally and in New Zealand on food and physical activity environments?

This stocktake of research published from 2007 to 2018 on population-level interventions for the food and/or physical activity environments identified 50 systematic reviews and 62 New Zealand research papers. Sixteen topics emerged from the stocktake. The most common topics in the systematic reviews were: infrastructure for cycling and walking, food pricing strategies, nutrition labelling on food and beverage products, food outlet density, and walkability (the built environment).

Research to date in New Zealand on healthy food and activity environments has largely involved data modelling and cross-sectional surveys, with some GIS analysis, experimental trials and qualitative studies. Authors with five or more publications in the stocktake are: Stefanie Vandevijvere, Boyd Swinburn, Cliona Ni Mhurchu, Helen Eyles, Sally Mackay, Tony Blakely, Karen Witten, and Jamie Pearce. Additionally, three NZ authors have led international systematic reviews that featured in the stocktake (Melody Smith, Helen Eyles, and Cliona Ni Mhurchu). The core research departments appear to be the University of Auckland's School of Population Health (Department of Epidemiology and Biostatistics, and the National Institute for Health and Innovation (NIHI) previously called the Clinical Trials Research Unit), the University of Otago's Department of Public Health, SHORE and Whāriki Research Centre at Massey University, and the GeoHealth Laboratory in the Department of Geography at the University of Canterbury.

How does the food and physical activity environment affect diet and exercise levels that contribute to the risk of developing NCDs?

Several aspects of the food environment were consistently identified in the systematic reviews as having moderate to strong evidence that they improve diets, and would likely reduce the overall burden of cancer, cardiovascular disease, diabetes and obesity. These were: subsidizing healthy food, taxation of unhealthy foods and beverages, labelling on pre-packaged foods and beverages, mandatory and voluntary reformulation of foods high in salt, and the density of fast food restaurants in lower socioeconomic areas.

Additionally, the following aspects of the built environment were shown to be strongly or moderately associated with physical activity and reduced risk of obesity and/or CVD: residential density (the number of destinations, walkability), multiple streetscape components, public transport options, improving or adding parks and playgrounds, and installing recreational facilities.

Other aspects have weaker evidence mostly due to methodological weaknesses in the research to date: infrastructure for cycling and walking, environmental interventions in workplaces, perceptions of safety and aesthetics, food marketing and availability/placement in store, and reducing portion sizes (serve sizes, plates and/or cutlery).

Aspects of the environment with weak evidence that they were related to diet/exercise and/or body size were: community wide multi-strategic interventions to increase physical activity, menu labelling in restaurants, and the density of fast food restaurants or supermarkets.

Which countries are implementing changes to food and/or physical activity environments that would impact on diet and physical activity, and thereby reduce the prevalence of obesity, diabetes, cancer, or cardiovascular disease?

Overall, it appears that the United States and the United Kingdom have implemented more regulations and policies designed to change population diet than NZ, Australia and Canada. The UK appears to lead the policy space around physical activity environments.

Which food or physical activity environment interventions show the most promise for reducing inequity in NCD health outcomes?

Very limited evidence has been collected internationally on the equity impact of policies related to the food and physical activity environment. However, from what is known currently, it appears that the following policies show particular promise to improve equity of health outcomes or at least not widen inequities: subsidizing healthy food, reducing the density of fast food outlets in areas of high deprivation, sugar-sweetened beverage tax, mandatory labelling of pre-packaged foods and beverages, and food reformulation.

Concerns were raised in the reviews that the following policies may widen inequities, but further research on this is needed: infrastructure for cycling and walking, and improving the streetscape, parks and recreation facilities.

Appendix 1: Keywords used in searches

All searches limited dates from 2007 to present, and English only.

Scopus keywords for Physical Activity Environment search:

Activ* OR exercis* OR health* OR sedent*
AND built environment* OR design* OR plan* OR neighbo* OR street* OR park* OR urban*
AND NOT child* OR prescool* OR adolescen* OR school OR infant*
AND NOT old* OR elder*
select 'Reviews', then repeated search with Zealand as keyword

Scopus keywords for Food Environment:

nutrition AND environment* OR food AND environment* OR diet*
AND intervention* OR polic*
AND NOT child* OR preschool OR adolescen* OR school OR infan*
AND NOT sustainab*
AND NOT old* OR elder*
select 'Reviews', then repeated search with Zealand as keyword

Cochrane keywords for Physical Activity Environment search:

Activ* OR physical OR sedent*
AND environment* OR design* OR OR neighbo* OR street* OR park* OR urban*
AND NOT child* (OR prescool* OR adolescen* OR school OR infant*)
AND NOT elder*

Cochrane keywords for Food Environment search:

nutrition AND environment* OR food AND environment* OR diet*
AND intervention* OR polic*
AND NOT child*
AND NOT elder*
Excl developing countries

Index New Zealand & NZ Research keywords for NZ food environment search:

Nutrition food environment

Index New Zealand & NZ Research keywords for NZ Physical Activity Environment search:

Physical activity environment

Appendix 2: PRISMA diagrams

Figure 4 outlines the literature search process followed to review the evidence about physical activity environments, using the Preferred Reporting Items for Systemic reviews and Meta-analyses – the PRISMA statement (Moher et al., 2009). This process resulted in 16 reviews included in this stocktake. The reviews are summarized in Appendix 3.

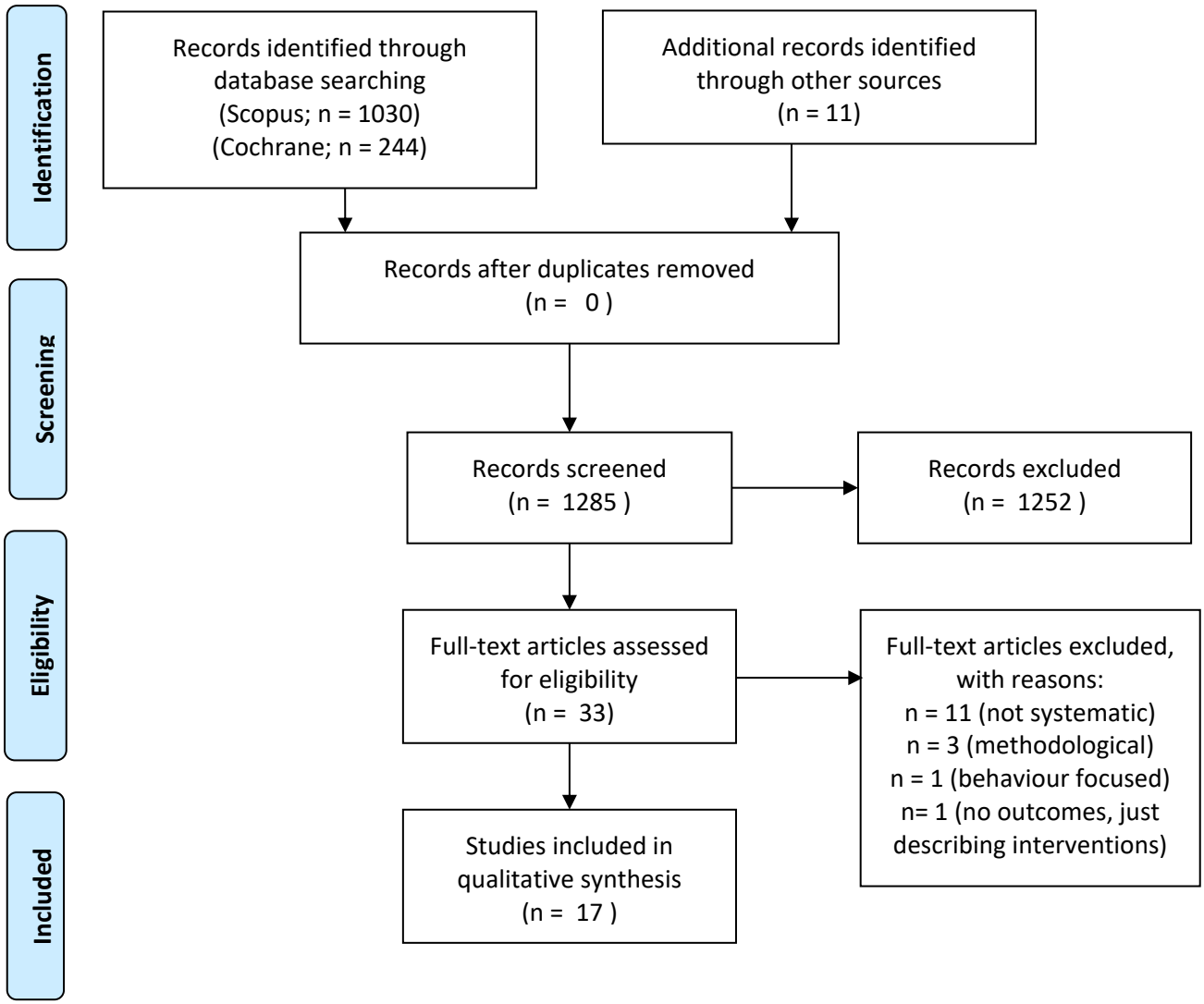

Figure 4: Phases of the review of systematic reviews on physical activity environments

Figure 5 outlines the literature search process followed to review the evidence about food environments, using the Preferred Reporting Items for Systemic reviews and Meta-analyses – the PRISMA statement (Moher et al., 2009). This process resulted in 30 reviews included in this stocktake. The reviews are summarized in Appendix 4.

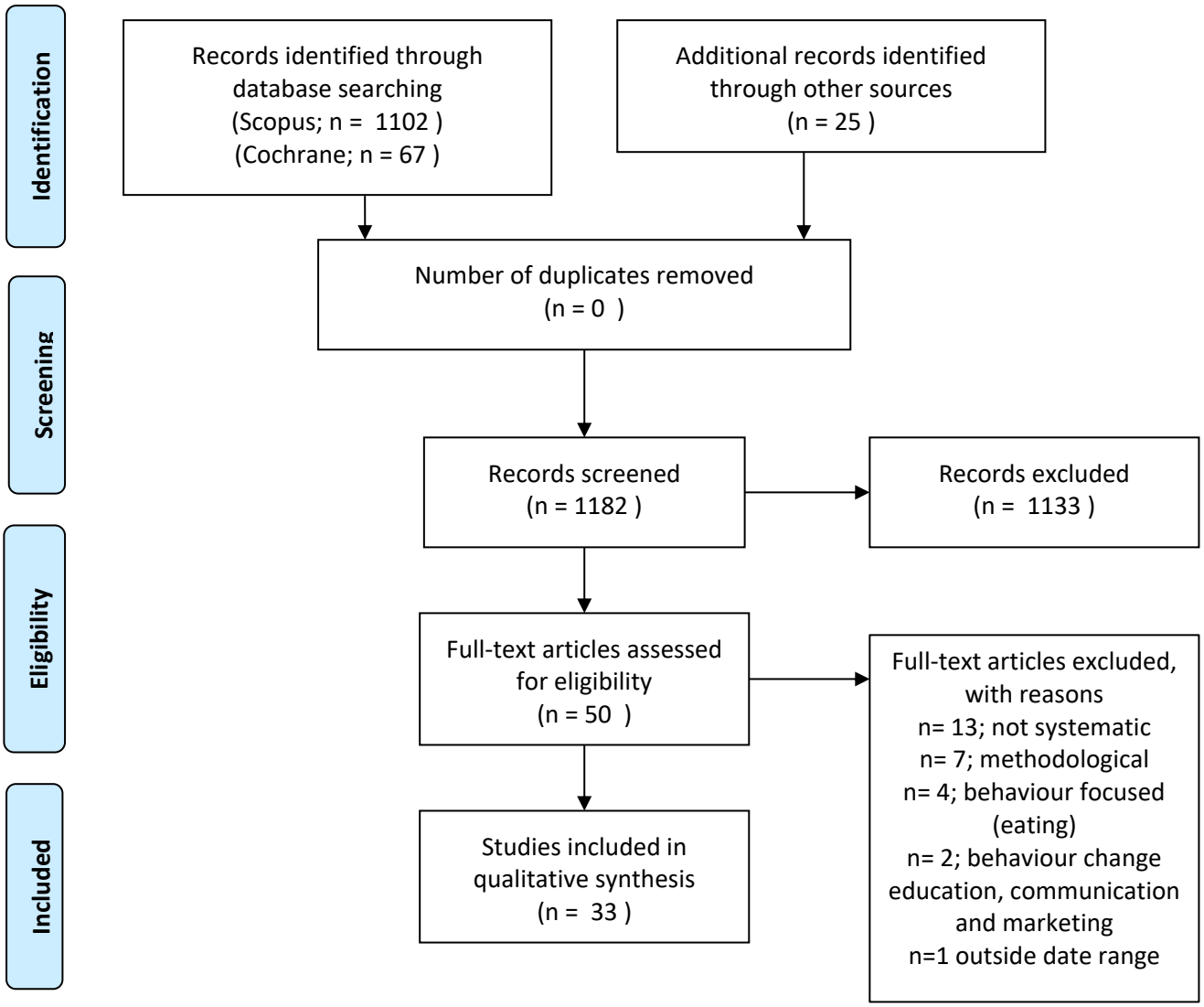

Figure 5: Phases of the review of systematic reviews on healthy food environments

Figures 6 and 7 outline the literature search process followed to find New Zealand studies on healthy food and physical activity environments, using the Preferred Reporting Items for Systemic reviews and Meta-analyses – the PRISMA statement (Moher et al., 2009). This process resulted in 49 studies which are summarized in Appendix 5 and 6, respectively.

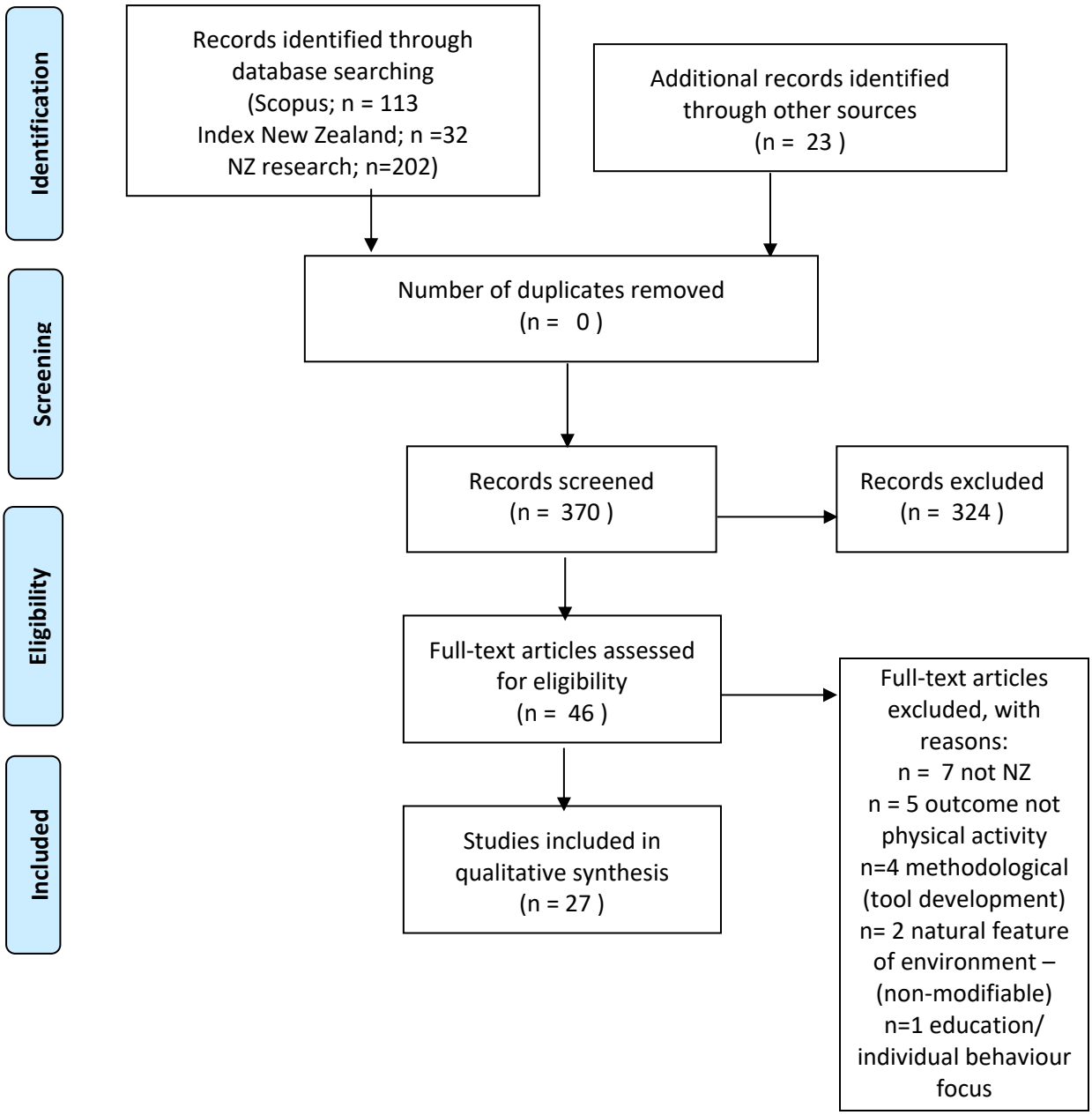

Figure 6: Phases of the review for NZ literature on physical activity environments

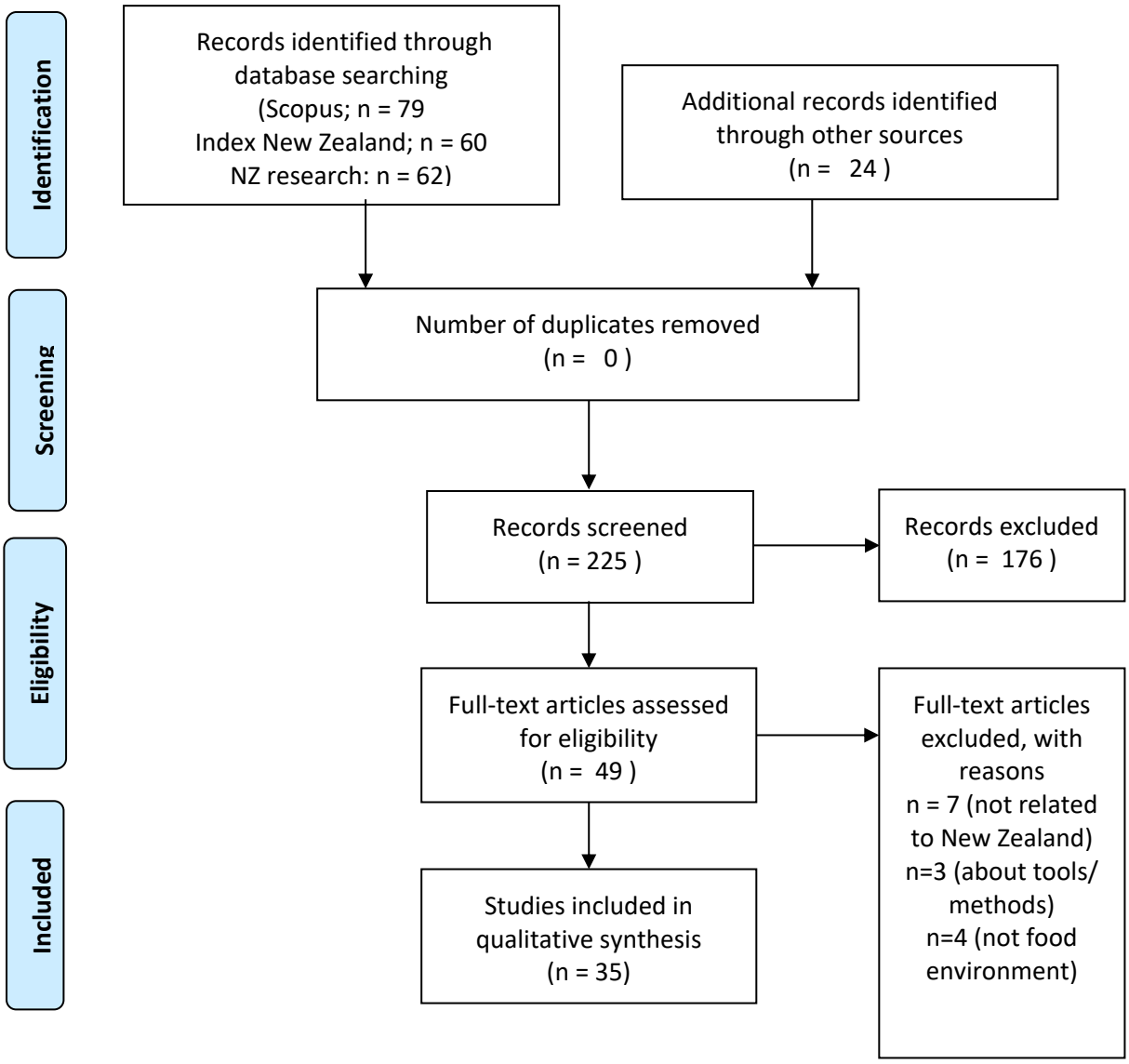

Figure 7: Phases of the review for NZ literature on healthy food environment

Appendix 3: Physical Activity Environment Systematic Reviews

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
Anderson et al. 2009	Worksite nutrition and PA interventions for reducing obesity	Worksite cafeteria, exercise facilities	Employees	1989-2005	54 studies, including 31 RCT, 12 nonrando mised studies, 3 cohort, 1 time-series (rest excluded as limited quality)	Half in US, remainder in Europe, Australia, NZ, Japan, Canada, India and Iceland.	Six quality categories based on Communit y Guide (Zaza et al. 2000)	There is evidence of modest reduction in weight as a result of workplace health promotion programmes aims at improving nutrition or PA or both. Difficult to summarise the contribution of the environmental and policy component (distinct from instructional or behavioural approaches) due to differences in comparison conditions and outcomes reported.	Not able to be examined as usually only gender included in studies as a variable of interest (not age or ethnicity data).	Need to be able to contrast programme components (behavioural, information, environment change, policy).
Baker et al. 2015	Multi-strategic community wide interventions for PA	At least two PA interventions which target whole communities, including environment change strategies such as walking trails, policy and planning. Usually included improved communication between agencies, partnership building between NGOs and local government	Whole communities (with populations between 500 and 1.9 million)	to Jan 2014	33 studies	25 high-income countries (11 in North America, 3 in Australia 1 in Japan, 10 in Europe) remaining in lower middle income countries.	Cochrane GRADE	There is an absence of effectiveness for community-wide interventions for PA.	Several studies analysed by gender, 1 by age, 2 by socioeconomic position/education and one by race. Effects remain unknown in absence of adequate reporting.	
Ferdinand et al. 2012	Built environment and PA or obesity	Parks, trails, sidewalks	Total population, 35% of studies were of children, 10% of the elderly.	2001-2010	169 studies, all observational	All in US - sorted into Northern and Southern states.	Own coding sheet	A high proportion of studies identify a beneficial relationship between the built environment and PA or obesity, but given the observational nature of the studies it is difficult to know if this is causal.	Not able to be examined. Noted that very little research has been done with minority or rural populations	Research is needed which employs more scientifically rigorous tools when studying health outcomes due to the built environment. look for opportunities for quasi-experimental designs given that experimental studies

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
										may not be feasible in many situations; a shift to natural experiments and longitudinal studies is warranted.
Hunter et al. 2015	PA in urban green spaces	Pedestrian infrastructure connectivity, parks, recreational areas, pocket parks	Non specific	Before July 2014	12, 11 natural experiments and 1 RCT	9 USA, 3 Australia	Cochrane Risk of Bias tool	Interventions that involve the use of PA programmes combined with a physical change to the built environment are likely to have a positive effect on PA.	Nil but many studies took place in low SES areas and with ethnic minority groups	Longer term follow up post-intervention, adequate control groups, sufficiently powered studies and consideration of the social environment.
Kärmeniemi et al. 2018	Built environment contribution to physical inactivity	New infrastructure for walking, cycling and public transportation; accessibility; park and playground improvements; street network characteristics; density; aggregate walkability measures; other such as crime	Participants representing general population	Before December 2015	51, 21 prospective cohort studies and 30 natural experiments	Not available	QualSyst tool	Overall, supports designed activity-friendly and health-enhancing cities and living environments.The findings provide implications for zoning policy and support the creation of compact and diverse residential areas where housing is mixed with commercial, public and recreational destinations and the circumstances for daily living are located within walking and cycling distance.	Nil	Further studies with more rigorous study designs assessing changes in the built environment and their effect on PA is needed.

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
Macmillan et al. 2018	Natural experiments of effect on physical activity and diet through changing the built environment	Redeveloping or introducing cycle and/or walking trails, rail stops/lines, supermarkets and farmers' markets, and parks and green spaces	1 study focused on children, 3 targeted socially deprived/ low income areas.	2002-2016	15 natural experiment	U.S, U.K, South America and New Zealand	Cochrane Risk of bias ratings	Interventions were largely ineffective so no definitive recommendations can be made.	Impact of built environment differs across SES so must be considered.	Future research should consider a consistent approach to measure the same outcomes (e.g., using measurement methods that collect comparable physical activity and diet outcome data), to allow for pooled analyses. Additionally, including comparison groups wherever possible and ensuring high quality reporting is essential.
Malambo et al. 2016	Built environment attributes related to cardiovascular disease risk	Neighbourhood attributes such as street connectivity, supermarkets, fast food restraurants, traffic density, green and open spaces etc.	Over 18 year olds	2005-2015	18, quantitative and largely cross sectional	Not available	STROBE	Policy focused on the neighbourhood environmental, transportation, health and education at grass roots level	Not examined	Further explore associations of CVD risk and CVD outcomes with a broad set of neighbourhood attributes using a longitudinal approach to better understand the direction of effects.
Mayne et al. 2015	Impact of policy and built environment on obesity-outcomes	Greenspace and outdoor play/exercise equipment (changes in park playgrounds and other outdoor exercise equipment, paths/trails)	Almost half of studies focused on adults (16 studies, 43%), eight focused on children (22%), and 10 included a combination of age groups (27%).	2005-2013	37 natural experiment or quasi-experiments, 17 on physical activity and 2 on effect of built environment on body mass index (Rest on nutrition) Usually repeated cross-sectional with a comparison group.	78% of studies were in US, the rest were in Australia, the United Kingdom, Canada, Chile and New Zealand.	Own rubric created which prioritized pre-post measurements and a comparison group	Over half found changes in PA - smaller studies and short follow-up tended not to find a change. New amenities may promote residents to substitute one type of activity for another, but not impact overall total physical activity levels. Active transport largely positive, but only two studies assessed increase in total PA with only one of these finding an increase. Stronger impacts when the intervention improved infrastructure for active transportation or had a long follow-up period.	Not examined	Long-term follow up – are interventions maintaining healthy weight and/or reducing overweight (often studies just measured change in behaviour rather than outcome of overweight). More natural experiments are needed and also explore whether timing of exposure and/or longer/repeat exposures enhances or reduces impacts on obesity-related outcomes.

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
McCormack & Shiell, 2011	Built environment and physical activity	Street and pedestrian connectivity, land uses, transit proximity and access, population and employment density, aesthetics and design, pedestrian and cyclist , neighbourhood parks and open space, traffic-related characteristics, walkability sprawl and neighbourhood type.	Mean ages 30-50 years, all income groups represented, one study with focus on before and after high school	1996-2010	33, 20 cross sectional 12 quasi-experimental studies	29 USA, 1 from each of Canada, Australia, UK and Holland	Nil	The association between the built environment and physical activity likely exists independent of residential location choices. Modifying one or a few environmental attributes independent of other factors has the potential to encourage more pa. Creating or modifying neighbourhoods to make them walkable may not always immediately lead to more PA	Not examined	More quasi-experimental studies are needed to contribute to recommendations for improving walkable neighbourhoods for physical activity
Rissel et al. 2012	Public transport effect on PA (additional walking during commute)	Walking to public transport	Adult commuters, one study over 70 year olds, one of university students	2002-2012	27 studies, 9 used pedometers or accelerometers	6 USA, 2 UK and 1 Australia (others not detailed)	None	Walking to public transport adds somewhere from 8 to 33 minutes of additional physical activity a day for commuters (several papers reported 12–15 minutes). For some people transport related walking is sufficient to achieve the recommended levels of physical activity.	Not examined	None
Saelens & Handy, 2008	Built environment and walking	Accessibility of proximity, mixed land use, density, aesthetics, sidewalks, street connectivity, safety and neighbourhood types	All ages (11 studies were about children)	2005-May 2006	13 reviews and 29 original studies	Australia, Belgium and USA	Nil	Land use policies and practices are effective in increasing walking and cycling through mixed land use, sidewalk quality and connectivity. Also suggested are transportation system reform in terms of traffic calming programmes.	Not able to be examined. Further investigation to understand perceived and real barriers for different populations, especially groups with low SES and limited auto access, is needed	Need to enhance specificity of recommendations

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
Salvo et al. 2018	Neighbourhood built environment influences on physical activity in adults	Functionality, safety, aesthetics and destinations	Non specific	1998 - 2015	36 qualitative studies, not literature reviews or methodological studies or commentaries	USA, Canada, UK, Australia, NZ, Ireland, Brazil, Sweden, Belgium and Iceland	Nil	Local individuals (citizens) and groups with different sociodemographic backgrounds need to have input into neighbourhood environment planning process. Combining built environment changes with other health promotion and behaviour change strategies can be successful in increasing PA in adults	Age and other socio-demographic characteristics contribute to perception of built environments enablers and barriers of PA, and can even have a detrimental effect on PA of individuals. For instance, built env. characteristics related to police surveillance made some people feel safe and others feel racially profiled and impacted the PA levels of different populations in different ways.	Mixed method sudy designs within natural experiments will provide a fuller understanding regarding the plausibility of the causal relations between Built environment and PA.
Smith et al. 2017	Built environment effects on physical activity and active transport	Infrastructural interventions such as bicycle boulevards, installation of cycle lanes, improving sidewalks. Parks and playgrounds also.	Three studies focused on children, the remainder on either all age groups or only adults.	1979 - 2015	28, mostly cross sectional studies and longitudinal studies.	Usa, Australia, Belgium, England, Scotland, New Zealand	Evaluation of Public Health Practice Projects Quality Assessment Tool (EPHPP)	Improving neighbourhood walkability, quality of parks and playgrounds, and providing adequate active transport infrastructure is likely to generate positive impacts on activity in children and adults.	Infrastructure use for walking and cycling was lower for those of lower educational level and income, but not ethnicity. Infrastructure improvements may predominantly benefit socioeconomically advantaged groups warrants further exploration in future evaluations.	The possibility that the benefits of infrastructure improvements may be inequitably distributed requires further investigation.

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Stappers et al. 2018	Effect of built environment infrastructural changes on PA, active transportation and sedentary behaviour in adults	On and off road bicycle and/or walking trails	Both children and adults, very few children studies.	Up to February 2018	19, quasi- or natural experiments	USA, Australia, Brazil, UK,	Adapted version of Cochrane Risk of Bias Assessment Tool : for non randomized studies of intervnetions (ACROBAT-NRSI)	Built environment infrastructural changes can lead to changes in overall PA and active transport, with the most promising results for bicycling. However, the current state of evidence is inconclusive.	Not examined	Need for high quality (obejctive) experiments in the future, using objective and context specific PA measurements. Need to be able to to detect changes in PA, active transport and sedentary patterns other than changes in overall PA, active transport and sedentary level; and also determine individual-level proximity and actual exposure to the intervention (or intervention area).
Valson & Kutty, 2018	Influence of gender in the relationship between built environment and NCD's	recreational facilities, neighbourhood perceptions of safety and walkability	Separated into men and women, ONLY include the 3 studies >18 years, 33-55 years and 15-74	Up to 2016	3, only included ones within Umbrella review age range	Jamaica, USA & UK	nil	Smart cities and green cities could incorporate gender-based preferences such as access to recreational resources, safety from crime and safety from traffic to engage in walking and take part in physical activity.	Women preferred safety from harm/crime to engage in outdoor activities, and aesthetics and greenery in neighbourhood as well as density, proximity of recreational facilities and safety from traffic. Men prioritised access to destinations, proximity to workspace and high street connectivity to engage in transport related walking. Income-levels and ethnic backgrounds also influential in the gendered relationship.	Qualitative and quantitative approaches to explore lived experiences of men and women and the modifying role gender plays in PA.

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Verweij et al. 2011	Workplace PA and Dietary behaviour interventions on weight outcomes	Workplace environment, various components including: walking maps and routes, team competitions, family involvement, prompts, point-of-choice messages, business goals and management commitment	Employees 18-67 years, 7 studies men only, 4 studies women only, 16 white-collar, 9 blue-collar (rest unknown).	1983-2009	43 RCTs, 22 of which were included in meta-analysis	Mostly USA, also England, Australia, Denmark, Japan, Canada, Sweden, Netherlands, Belgium,	Cochrane GRADE	Interventions focusing on improving PA AND dietary behaviour are moderately effective in reducing body weight of employees by -1.19kg, but adding an environmental component reduces body weight by an additional -0.29 kg.	Analyses could not be performed for gender, age or blue vs. white collar workers, because this could not be determined in the majority of the studies.	Future research should focus on environmental opportunities in addition to behavioural strategies. Report multiple outcome measures (not just BMI).

Appendix 4: Food Environment Systematic Reviews

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
Afshin et al. 2017	Prospective impact of food pricing on improving dietary consumption	Food pricing changes	Generally healthy individuals	From 1990	23 interventional studies and 7 prospective cohort studies	N/A	Evidence frameworks from the American Heart Assoc., the U.S Preventive Services Task Force and CDC Prevention Community Guide.	Subsidies can increase consumption of healthful foods and taxation to reduce intake of unhealthful beverages and foods. Subsidies combined with multicomponent interventions appear most effective.	Not examined	Most studies were from high-income Western countries, informing the need for additional research in lower-income nations in which fiscal measures might be even more effective.
Andreyeva et al. 2010	Price changes affecting demand for food and substitutions	Food prices/elasticity	Non specific	1983-Sept 2007	160, time series data and household survey data	USA	Nil	SSB tax have a high price elasticity meaning a tax of 10% could lead to an 8-10% decrease in purchases. The public is willing to pay increased taxes if the funds generated are used to address childhood obesity. Changes in prices alone would probably not increase consumption of fruits and vegetables to the levels recommended. However, price changes combined with public education campaigns and other regulations affecting the food environment in institutional and home settings may have a multiplicative effect that could significantly improve diets, particularly among at-risk populations.	Few studies were included about food price elasticity in low income areas	Given the relative consensus in the economic community about the magnitude of food price elasticities and the observed gaps in research related to substitutions between healthy and unhealthy foods, future research should focus on predicting the impact of specific public health policies aimed at improving diets and reducing the burden of chronic disease.

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Backholer et al. 2016	Sugar sweetened beverage (SSB) tax and socioeconomic position	SSB tax	Adult, adolescent, children consumption	Not stated recent	11 articles, 3 SSB tax effect on body size; 1 on price elasticity and 7 modelling hypothetical SSB tax with population specific intake, body weight	USA, UK, Ireland, Australia, New Zealand	Own checklist	SSB tax is likely to be effective policy to reduce SSB consumption.	Likely to have same or greater impact on low-income households compared to high income households.	Real-world SSB tax experimental studies are required to strengthen evidence base
Barberio et al. 2017	Population-level interventions in government jurisdictions for dietary sodium reduction	Structural interventions (large scale food product reformulation), public information campaigns	Non specific	Prior to 5 Jan 2015	53, empirical but variant	Austria, Canada, China, Denmark, Finland, France, Ireland, Japan, Netherlands NZ, Switzerland Thailand, Turkey, UK, USA.	GRADE and Cochrane risk of bias tool	While national population-level dietary sodium reduction initiatives in general have the potential to achieve population-wide reductions in salt intake, those that are multicomponent and incorporate intervention activities of a structural nature are likely to be the most impactful.	Differential impacts measured by sex.	Future reviews should consider health outcomes related to sodium consumption.
Black et al. 2012	Food subsidy programs and the impact on health and nutritional status of disadvantaged families	Food subsidies	Socioeconomically disadvantaged adults, children or families living independently in communities.	1983-2010	Sixteen articles discussing fourteen studies, all randomised controlled trials (4), controlled before and after studies (7), or interrupted time series analyses of routine data (3).	USA (11), UK (2), NZ (1)	Cochrane guidelines for RCTs, Effective practice of Care guidelines and the Newcastle-Ottawa Scale.	Food subsidy programmes for pregnant women and children should aim to improve nutritional status in the longer term. The improved intake of targeted foods such as fruit and vegetables could potentially reduce the rate of non-communicable diseases in adults, if the changes in diet are sustained.	Focused only on socioeconomically disadvantaged individuals and families.	Further prospective data is needed to confirm that food subsidies produce sustainable improvements in dietary intake and document any adverse effects.

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Bleich et al. 2017	Calorie labelling and modified calorie labelling interventions and their impact on consumer and restaurant behaviour	Menu labelling	Non specific	Up to Oct 2016	48, randomized control trial, quasi-real world randomized controlled trial, natural experiments, cross sectional designs, pre/post design without comparison	N/A	Nil	It is unclear as to the degree menu labelling encourages lower calorie purchases and whether that translates to a healthier population. Some evidence suggests a lowering of calories purchased at certain types of restaurants and in cafeteria settings.	Making calorie information easier to understand is an equitable approach, focused towards those with lower numeracy capabilities.	More powered studies that can properly pick up meaningful reductions in calories purchased at restaurants.
Campos et al. 2011	Nutrition labels on pre-packaged foods	Nutrition labelling	Wide range of age groups, socioeconomic strata and geographical regions	Not specified	120 articles, 96 cross sectional surveys, 17 experimental designs, 7 natural experiments and 2 longitudinal population based surveys.	USA (88), Europe (12), Canada (9), Australia and New Zealand (4), Norway (2), Thailand (1) and Trinidad (1).	Nil	Nutrition labels on pre-packaged foods are a cost effective population level interventions with considerable reach. Governments need to explore new formats and different types of information content to ensure that nutrition information is accessible and understandable. For e.g. expansion to restaurants and fast food outlets.	Not examined	Evidence is needed to inform regulatory development. Should consider expanding the scope of mandatory nutrition labelling to foods served in restaurants of fast food outlets.
Cecchini and Warin, 2016	Impact of labelling systems on food choices and eating behaviours	Food labelling methods	Non specific	Jan 2008 - April 2015	9, randomised studies with a control population	England & France	Publication bias evaluated using a funnel plot.	Nutrition labelling schemes may be an effective approach to empowering consumers in choosing healthier products. Interpretive labels such as traffic light labels may be more effective.	Not examined	Studying the effects of single labelling schemes on calorie intake/choice
Chennakesavalu et al. 2018	Relationship between Fast Food Environments and Obesity Rates	Concentration of fast food restaurants	37% of studies were children only (8 of them were specifically around schools), 39%	2008-2015	46 studies, 89% cross-sectional in design, 5 were longitudinal.	Mostly USA (76%). Two studies examined multiple countries: One study	None	Findings were largely similar between US and non-US studies; in both groups, there were inconsistent associations between the fast food environment and rates of obesity/overweight. However, in terms of SES, findings were	62% of studies examined the relationship with SES. Lower SES associated with a higher density of fast food restaurants and	More longitudinal research must be performed with consistent methodology in order to better understand the role of the fast food

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
			were adults only, remainder did not mention.			examined 26 countries, and another study examined three countries (US, Scotland and Canada).		consistent across both US and non-US studies; lower SES was consistently associated with unfavourable fast food environments, with higher concentrations of fast food restaurants, higher consumption of junk food, and higher obesity rates.	convenience stores, an unfavourable retail environment, poorer food environments, higher consumption of junk foods, and higher obesity rates. Higher SES was associated with a "healthier" food environment and lower obesity rates. When a significant positive association was found between the fast food environment and rates of obesity /overweight, the association was often strongest in areas with low SES (persistent poverty, higher levels of deprivation, etc.).	environment in the development of obesity.
Crockett et al. 2018	Nutrition labelling for healthier food or non-alcoholic drink purchasing and consumption	Food labelling methods	Largely within University settings including students and staff.	Up to 26 April 2017	28 studies, 17 randomized controlled trials, 5 quasi-randomised controlled trials and 6 interrupted time series studies	Mostly USA (21)	Cochrane Risk of Bias tool and GRADE	Tentatively suggests that nutrition labelling on menus in restaurants could be used as part of a wider set of measures to tackle obesity.	Not examined, but noted that further research should include differential socioeconomic status impacts of such interventions.	High quality evidence is needed to address the dearth of evidence from grocery stores and vending machines and to assess potential moderators of the intervention effect, including socioeconomic status.
Eyles et al. 2012	Food pricing strategies as mechanisms to encourage healthy eating habits and curb increases in non	Food pricing strategies (taxes, subsidies)	Countries within the OECD	Jan 1990 - Oct 2011	32 studies of cross-sectional or panel data.	OECD countries	Nil	Pricing strategies have the potential to produce changes in population food consumption. Majority of studies evaluating lower socioeconomic groups depicted that food pricing strategies would be associated	Pricing policies appeared to result in improved food and nutrient consumption and health benefits for lower	Higher quality evidence in regard to the unintended effects of compensatory purchasing and the potential impacts on health equity, long term

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
	communicable diseases.							with pro health outcomes and have the potential to reduce disparities.	socioeconomic groups. Taxes would likely be regressive.	health and NCD mortality. Cost effectiveness and pragmatic issues associated with implementation should be addressed.
Fleischhacker et al. 2011	Fast food access and association with health outcomes	Concentration of fast food restaurants	2 studies were of adults only, 2 of children and 3 more school based, 2 were hospital based.	1998-2008	40 articles, 1 longitudinal and 39 cross-sectional.	USA=25, Australia=5 Canada=5, UK=4, New Zealand=2	None	Fast food restaurants are more prevalent in low-income areas. 16 out of 21 studies indicated fast food restaurants were more prevalent in low-income areas compared with middle- to higher-income areas.. BMI findings were too uncertain to draw solid conclusions on the relationship between fast food access and BMI. Among studies of adults, six studies found an association, while four did not find an association. Most adult studies (n = 7, 70%) relied on self-reported height and weight.	16/21 studies indicated fast food restaurants were more prevalent in low-income areas compared with middle- to higher-income areas. Only three non-US studies did not find significant associations when exploring the association of fast food access with SES. Ten of 12 studies reported fast food restaurants were more prevalent in areas with higher concentrations of ethnic minority groups in comparison with Caucasians.	Further work is needed to understand (i) If and how fast food access impacts dietary intakes and health outcomes and (ii) If fast food access has disparate socioeconomic, race/ethnicity and age associations.
Fraser et al. 2010	Summarise research on location of fast food outlets and therefore the availability of such foods to the population	Concentration of fast food restaurants	3 based on children, 4 around schools, rest whole communities or adults	1990-2009	33 articles, 16 used a population level approach (i.e., data pertained to entire cities or communities within cities) and the other 17 used	Most US, also 5=Australia 3=UK, 2=New Zealand, 2=Canada.	None	A large number of studies which have shown a significant relationship between lower area level socioeconomic status and higher availability of FF outlets. The cross sectional studies have shown mixed results for the association between FF availability and weight status but there is some evidence that greater exposure	14 of 16 studies which looked at an entire population showed a significant association between increasing area level deprivation variables and the availability fast food outlets:	There is a need for research which combines good methodology with data on as many possible potential confounding factors. The geographical analysis should combine the exposure to FF outlets with consumption data as well as physical

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					individual level data			to FF is associated with a lower fruit and vegetable intake	decreased income, increased FF exposure, increased deprivation, increased FF exposure.	activity and transport data.
Gittelsohn et al. 2012	Small store environment changes to improve diet and reduce disease risk	Promoted foods, health promotion and communications, community engagemnet, store owner training, structural modifications, pricing.	Small food stores with fewer than 10 employees and less than 1,000 square feet of floor space	1990-2010	16 intervention trials met inclusion criteria. Of these, 8 trials provided peer-reviewed published materials and the other 8 were grey literature	12 trials in the United States, 2 in Scotland, 1 in the Republic of the Marshall Islands, and 1 in Australia	None	Most of the trials that showed positive impacts used multipronged strategies designed to improve both access to healthy foods (supply) and consumption of health foods (demand). Several studies showed price reductions were successful, limiting unhealthy foods (or moving to back of store) appeared successful.	Not examined but did mention that most interventions were in low income areas	Findings are more descriptive than definitive. Need more higher-quality trials in this area. Sales data needs to be examined.
Glanz et al. 2012	Retail grocery store marketing strategies and obesity	Product, price, place and promotion of products in grocery stores	All retail grocery stores	1995-2010	125 primary research articles, plus additional documents	No detail	None	There is limited evidence at this stage. Strategies for in-store marketing to promote healthful eating include increasing availability, affordability, prominence and promotion of healthful foods, and restricting or not marketing unhealthy foods.	Not examined	More evaluation on health-promoting marketing strategies is needed to build evidence base for how to sell more-nutritious foods and fewer unhealthy foods. There is potential for the use of industry methods (e.g. loyalty cards) to determine consumer behaviour and shopping patterns in public health research.
Hillier-Brown et al. 2016	Interventions to promote healthier ready to eat meals sold by food outlets	Promotion of healthier options through formulation laws, price changes, information provision and telemarketing promotion.	Adults (22), parents and their children (3) children (1) and food outlets that provide ready to eat meals at a cost (4).	Jan 1993 to Oct 2015	30 studies describing 34 interventions. Cross sectional, cohort and controlled trials.	USA (27), Australia (2), UK (1)	Global quality rating (strong, moderate or weak).	More 'intrusive' interventions that restricted or guided choice generally showed a positive impact on food-outlet-level and customer-level outcomes. However, interventions that simply provided information or enabled choice had a negligible impact. Interventions to promote healthier ready-to-eat meals sold by food outlets	Not examined	Most interventions were of interventions low down the "Nuffield ladder" Further work is required to develop, and evaluate, a wider range of interventions, particularly those higher up the ladder that may be more effective and achieve more equitable

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								should restrict choice or guide choice through incentives/disincentives. Public health policies and practice that simply involve providing information are unlikely to be effective.		effects. Researchers should consider where differential effects may be most likely to occur (by sociodemographic characteristics) and design evaluations in such a way that they are able to draw firm conclusions on whether or not such effects occurred.
Hollands et al. 2015	Portion, package or tableware size for changing selection and consumption of food, alcohol and tobacco	Product sizes and shapes, including packaging of products.	Adults and children	Up to July 2013	72, 69 focused on food products (excl tobacco).	USA mostly	Cochrane Risk of bias tool	Policies and practices that successfully reduce the size, availability and appeal of larger sized portions, packages, individual units and tableware can contribute to meaningful reductions in the quantities of food (including non alcoholic beverages) people select and consume in the immediate and short term.	Nil	Further research into the effect of these methods on alcohol consumption as this could not be included in this review.
Hyseni et al. 2017	Dietary salt reduction policies	Media campaigns, nutrition labelling, voluntary and mandatory reformulation	All age groups from all populations, from high, middle and low income countries.	1975-October 30, 2015	70, 49 empirical studies and 21 modelling studies	Not available	Nil	Mandatory and voluntary reformulation appeared far more cost-effective than labelling or dietary advice targeting individuals. Multi component strategies involving upstream population wide policies such as regulation, mandatory reformulation and food labelling are the most effective.	Downstream interventions focused on individuals typically widen inequalities, whereas upstream "structural" interventions may reduce inequalities.	Feasibility of implementing policy changes, such as political feasibility and stakeholder influence
Kaur et al. 2017	Impact of health related claims on dietary choices	Health related claims on food packaging	Adults / consumers	From 2003	31 controlled experimental studies	Most in Europe (n=17) and USA (n=7)	Cochrane Risk of bias tool	Health-related claims have a substantial effect on dietary choices. Results of choice experiments (without actual purchasing of foods) suggest that products carrying a health-related claim are 75% more likely to be chosen than an identical product without a	Not examined	Findings are based on research mostly conducted in artificial settings. Findings from natural experiments have yielded smaller effects. Is a need for more research into the effect of health related

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								health-related claim. Results from the meta-analyses suggest that health and nutrition claims have a similar effect on dietary choices (consumers don't distinguish between them)		claims on real-life dietary choices.
Kliemann et al. 2018	Serving size and nutrition labelling and the implications for nutrition information and nutrition claims on packaged foods	Nutrition information, labelling and serving size suggestions	Not specified	Not specified	5 countries and their legislations	Mercosul countries, Australia and NZ, Canada, USA, European countries	Nil	Reporting the number of servings per package may also help in the understanding of the nutrition information and may reduce portion distortion. However, the use of fractions for household measures should not be allowed when the product is consumed as a whole, following the example of the Canadian legislation. The inclusion of symbols and pictures has also been suggested as an alternative to improve the understanding of nutrition information	Not examined	Studies exploring the impacts of different nutrition labelling formats regarding serving size presentation on consumers' understanding and the use of nutrition information are urgently needed. Although food labelling is one of several policies aimed at reducing obesity rates, gathering more evidence on the effect of serving size information on healthy food choices will allow the adoption of more cost effective obesity prevention actions.
Littlewood et al. 2015	Menu labelling to reduce energy ordered and consumed	Menu labelling	17,859 participants	2012-2014	15 peer reviewed articles	USA, Canada and Australia	Quality assessed by study setting, sample size, extent of displaying ML, ML noticing rate, randomization or case control match, degree of blinding.	The review supports that menu labelling can effectively reduce energy ordered and consumed in the away-from-home food environment.	ML can be effective across social grades (SES), but no more than other demographics. It is an equitable intervention	More reliable research is needed to determine the impact of ML on reducing energy ordered and consumed in real-world settings.

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Long et al. 2015	Calorie menu labelling in restaurants and non-restaurant settings - impact on calories ordered.	Menu labelling	Adults		19 studies, 9 in restaurants (1 RCT, 8 natural experiments), 10 in non-restaurant settings (all RCTs)			Current evidence does not support a significant impact on calories ordered. Meta-analysis of the experiments with controls in restaurant settings shows no significant effect on calories purchased.	Not examined	Additional research on alternative menu labelling formats is important to inform potential regulation in other countries that have yet to pass legislation. Surveillance of restaurant product reformulation, pricing, and promotions should continue as federal menu calorie labelling regulations are implemented.
Ni Mhurchu et al. 2010	Worksite health promotion interventions on employee diets	Changes to worksite nutrition policies and practices such as nutrition labelling, vending policies, canteen food supply/availability and menu reformulation	Non specific	1995-April 2009	16	North America, Europe	Checklist that included randomisation methods, use of a control group, and study attrition rates.	Worksite interventions have a positive but small effect on dietary behaviour. Findings of these eight studies about environmental interventions were generally positive for dietary outcomes but effect sizes were small; typically individual-level interventions appeared to deliver slightly greater effects than environmental interventions. Future programmes should aim to intervene at multiple levels of the worksite environment, particularly with respect to economic levels to influence food choice.	Not examined	Well matched comparison groups, objective measures of environmental and individual dietary change and sufficiently long periods of follow up to determine long term effects of programmes on employee health, absenteeism and productivity. Need to integrate qualitative methods with traditional study designs in order to provide more insight into reasons for programme success or failure.
Niebylski et al. 2015	Food subsidies and taxes	Food prices as per legislation i.e. Subsidy and taxes	Nil	2003-2013	78, studies, reviews and predictive models	Western Europe, Canada, US, Australia, NZ	Nil	This review supports implementation of subsidies and taxes on a population-wide basis. Prior or simultaneous implementation of ancillary education and marketing about healthy eating and supportive pricing policies are likely to be critical success factors.	Current research shows negative impacts on financial and nutrient intake but improved diets, for those of low income.	Though robust, many of the studies were based on predictive modelling and price elasticity rather than real world interventions. Experimental studies had relatively weak evidence suggesting some larger population-

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
										wide trials are justified. Need more on the impact on SES inequity.
Olstad et al. 2016	impact of universal policies on socioeconomic inequities in obesity, dietary and physical activity behaviours among adults and children	Policies such as free national bus passes for older adults, menu labelling, taxes	Anyone classified as socioeconomically disadvantaged	2005-2015	36, including RCT, longitudinal, repeat cross sectional and one time cross sectional.	USA (16), UK (6), Canada (2), Denmark (2), Norway (2), Korea (2), Netherlands (2), France (1), Finland (1), Hungary (1) and Australia (1).	Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies	Policy has an important role in addressing high rates of obesity in an equitable manner. A broad complement of policies spanning the agency structure continuum.	Evidence of positive impact on inequities: Taxes on unhealthy food and soda. Evidence of neutral impact on inequities: US state level soda tax, national nutrition and public health programme, menu labelling.	Investigate strategies to ensure policy reduce, rather than simply maintains current obesity related inequities.
Pitt et al. 2017	The influence of local food environments on food purchasing behaviours	Availability of healthy and unhealthy options in communities, accessibility of options, affordability, food store charactertics/ features, neighbourhood characteristics and safety concerns	Include both adults and children but only from the perspective of adults reporting. Both rural and urban areas included and schools/work places/within home environments excluded.	2000-2015	30 qualitative studies, with focus groups (14), interviews (12) and a combination of the two (4).	USA, UK, Mexico, Canada, Australia, Netherlands.	Quality assessment used but not specified as a particular method.	Availability, accessibility and affordability were consistently identified as key determinants of store choice and purchasing behaviours that often resulted in less healthy food choices within community nutrition environments. Food availability and quality within stores, and food store characteristics within consumer nutrition environments, also greatly influenced in-store purchases. Media and advertising as well as other environmental characteristics each influenced food purchasing behaviours.	The evidence tends to suggest the presence of cost and access disparities for low-income and minority communities in the USA, this is not necessarily consistent in other countries such as the UK. All studies discussed the importance of socio-economic status and its contribution to disparities in food access, availability and cost. There are challenges in seeking to explore environmental factors in isolation from other social-	Food and purchasing decisions are influenced by more than just the environment and thus the importance of intra- and interpersonal, social and cultural factors that influence behaviour must not be underestimated. Future research should focus on integrating findings from qualitative and quantitative food environment syntheses in order to generate both new and refined hypotheses for ongoing research into the associations between aspects of the food environment and health/diet-related behaviours. Given the significant focus of included articles on

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									ecological determinants of behaviour.	socio-economic determinants, future research could explore how different people use the same food environment; that is, what characteristics result in individuals using food environments in different ways.
Redondo et al. 2018	Impact on sugar sweetened beverage consumption, purchase and sales, of a tax	Taxes and subsidies on food and beverages	Non specific	2011-2017	17 naturalistic experiments, or virtual/experimental conditions.	USA, Mexico	CONSORT and TREND	Taxation significantly influences planned purchases and increases likelihood of purchasing healthy beverages. SSB taxes may reduce calorie and sugar intake. Inclusion of warning labels together with a tax shows significant effect on behavioural intent.	Reductions in purchases after tax implementation where higher in low socioeconomic settings.	Further research is needed to evaluate effects on overall diet quality.
Shangguan et al. 2018	Influence of food and beverage labelling on consumers and industry responses	Food and beverage labelling	Non specific	1990 onwards	60 studies: 16 RCTs, 23 interventions with external controls, 21 interventions with pre/post comparisons	US, Canada, Europe, Australia, Asia	5 criteria: Study design, assessment of exposure, assessment of outcome, control for confounding and evidence of selection bias.	Food labelling effectively reduces consumer intakes of total energy and total fat, while increasing intake of vegetables. Food labelling did not significantly alter consumer intakes of other dietary targets, including sodium, total carbohydrate, protein, saturated fat, fruits, or whole grains. This metaanalysis also found that food labelling altered industry formulations for sodium and trans fat, but did not significantly affect product formulations for total energy, saturated fat, dietary fiber, or other healthy/unhealthy dietary components. This study did not identify consistent differential	No consistent gradient in responses by SES, age or sex. Although this meta-analysis represents the most comprehensive assessment of these questions to date, only 35 studies (58%) reported socioeconomic information, which is defined based on various factors (e.g., education, income).	More studies are needed to assess the effects of labelling on other dietary targets, disease risk factors, and clinical endpoints.

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
								effects according to label type, placement, intervention duration, or mandatory versus voluntary labelling.		
Sinclair et al. 2014	Influence of menu labelling on calories bought or consumed	Menu labelling	Adolescents or adults	1990-2013	17, 7 quasi-experimental and 10 experimental	Canada, the United States, or any other country with a similar nutrition labelling environment, such as the United Kingdom, Australia, or New Zealand	The Scottish Intercollegiate Guidelines Network methodology checklists for cohort studies and for controlled trials	Results of the meta-analysis of the experimental studies suggest that labelling of menus with calories alone had no effect on calories selected or consumed. Data from the quasi-experimental studies confirm that calorie labels have little influence on calories purchased in settings where mandatory menu labelling had been implemented. Interpretive but not informative (calorie) menu labels are effective.	Women used menu labels to select and consume fewer calories, whereas men did not.	The best approach for menu-based nutrition information, particularly for those consumers who may be limited in their food and health literacy skills, merits further exploration.
Sisnowski et al. 2017	Realist approach to real world policies targeting aspects of the food environment	Menu labelling (restaurants), changes to food infrastructure, subsidies, taxation, government food standards and nutrition labelling.	Non specific	2004 - Oct 2015	36 policies	Mostly the USA (80%)	Quality Assessment of Before-After (Pre-Post) Studies with No Control Group & Quality Assessment of Observational Cohort and Cross-Sectional Studies	The policy examples discussed demonstrate feasibility in terms of surviving policy making processes and reaching immediate program goals. More stringent and comprehensive nutrition policy and obesity prevention regimes should be informed by these interventions	Not examined	Nil
Skov et al. 2013	Choice architecture as a means to change eating behaviours in self-service settings	Choice architecture of self-service settings	Healthy individuals	June 2011 - March 2012	12, field studies in real life settings and studies carried out in food laboratories.	N/A	Ratings from weak to very strong.	Choice architecture cannot be recommended as a strategy for changing food consumption behaviour. Strategies with a stronger evidence base should be chosen instead, with supplementation of choice architecture interventions.	Not examined	Emphasize a real-life setting and compare their results with the effect of other more well-established interventions on food behaviour in self-service eating settings.

Lead author surname, Year	Topic of review	Environment factors examined	Participant details	Date range	No. and type of studies	Country of origin of studies	Quality appraisal	Population-level findings and policy recommendations	Equity outcomes	Future research direction indicated
Swatz et al. 2011	Calorie menu labelling on quick service restaurant menus	Menu labelling	Non specific	2006-2008	7, quasi-experimental design or experimental design.	USA	Investigator developed quality grading instrument	Calorie menu labelling has no effect or only a modest effect on calorie ordering and consumption. No strong support of calorie menu labelling reducing rates of overweight and obesity.	Not examined	Longer term scientifically rigorous studies to determine whether prolonged exposure to calorie labels has an effect on rates of overweight and obesity.
Thow et al. 2014	Food taxes and subsidies to improve diets	Taxes and subsidies on food and beverages	Non specific	Jan 2009 - March 2012	38, RCT (2) and 30 using household expenditure surveys, dietary survey data, longitudinal data, state level obesity prevalence data and /or sales data.	New Zealand, USA, France, Brazil, Norway, Finland, Sweden, UK, Australia, The Netherlands	Based on the Cochrane Hierarchy of Evidence	Fiscal measures can be effective in promoting desired dietary changes. Soft drink taxes and healthier food subsidies appear highly effective and are likely to be the least burdensome administratively.	A greater tax burden for low income earners is an expected effect of taxes on goods, especially foods. In practice, while such taxes are arguably inequitable from the point of view of fiscal financing, they can also be considered as equitable as public health measures, since a regressive tax represents a stronger deterrent in lower income groups.	Further research into the response of industry to health related taxes and subsidies would provide increased understanding about the effects of these measures on food prices and purchases.

Appendix 5: NZ research on physical activity environments

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Badland et al. 2012 Hannah M. Badland (1), Melody Oliver (2), Robin A. Kearns (3) Suzanne Mavoa (1) Karen Witten (4) Mitch J. Duncan (5) G. David Batty (6)	1 University of Melbourne 2 Auckland University of Technology, 3 University of Auckland, 4 Massey University, 5 Central Queensland University, 6 University College London.	Association of neighbourhood residence and preferences with the built environment, work-related travel behaviours, and health implications for employed adults: Findings from the URBAN study	This study aimed to identify associations between neighbourhood selection, neighbourhood preference, work-related travel behaviours, and transport infrastructure. Findings demonstrated that more people preferred to live in urban (more walk- able), rather than suburban (less walkable) settings. Those living in more suburban neighbourhoods had significantly longer work commute distances and lower density of public transport stops available within the neighbourhood when compared with those who lived in more urban neighbourhoods. Those preferring a suburban style neighbourhood commuted approximately 1.5 km further to work when compared with participants preferring urban settings. Respondents who preferred a suburban style neighbourhood were less likely to take public or active transport to/from work when compared with those who preferred an urban style setting, regardless of the neighbourhood type in which they resided. Although it is unlikely that constructing more walkable environments will result in work-related travel behaviour change for all, providing additional highly walkable environments will help satisfy the demand for these settings, reinforce positive health behaviours, and support those amenable to change to engage in higher levels of work-related public and active transport.	Cross-sectional survey
Badland et al. 2010 Hannah Badland (1), Rosanna Keamv(2), Karen Witten (3), and Robin Kearns (2)	1 Auckland Univeristy of Technology 2 School of Geography, University of Auckland 3 SHORE and Whāriki Research Centre, Massey University	Examining Public Open Spaces by Neighbourhood-Level Walkability and Deprivation	Public Open Spaces (POS) located in less deprived communities have better quality environments, but fewer activities and safety features present when compared with more deprived neighbourhoods. A positive relationship existed between presence of POS attributes and neighbourhood walkability, but the relationship between POS and neighbourhood-level deprivation was less clear. Variation in neighbourhood POS quality alone is unlikely to explain poorer health outcomes for residents in more deprived areas.	Cross-sectional survey
Field et al. 2018 Adrian Field (1, 2), Kirsty Wild (2), Alistair Woodward (2), Alexandra Macmillan (3), Hamish Mackie (4)	1 Dovetail Consulting 2 University of Auckland 3 University of Otago 4 Mackie Research and Consulting Ltd	Encountering bikelash: Experiences and lessons from New Zealand communities	3 community case studies; 12 interviews. The research supports earlier findings of the role of retailer concerns and conservative dissent in 'Bikelash' (organised opposition to bike lanes), and also highlights the importance of design and engagement in the process. More fundamentally however, bike lanes have a community-wide impact, and challenge existing modal hierarchies and patterns of movement. Countering bikelash requires an understanding of the roles of actors and coalitions at macro (national policy and regulation), meso (city and industry) and micro (community) scales in fostering bike lane development and countering opposition. For city planners, the challenge of bikelash requires committed leadership, design, planning, capacity-building and engagement that moves beyond business as usual processes, builds local coalitions, and aligns with community needs and aspirations for placemaking.	Case studies, interviews

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
HEHA Strategy Consortium, 2010	A team of researchers from AUT University, Native Consultancy Ltd, and Whakauae Research Services Victoria University of Wellington, and the University of Otago, led by the University of Otago	Healthy Eating – Healthy Action: Oranga Kai - Oranga Pumau Strategy Evaluation Final Report: Stocktake of HEHA Initiatives II	Database included 1249 intitiatives identified in 2008/09, 20% of which focused on nurtition, 25% PA and 44% both, most implemented at a regional level. All three types of initiatives were targeted primarily at Māori, Pacific, low socieconomic and family/whānau. By 2009/10, only 801 initiatives were running (a 36% decrease), with a major reduction in the number of initiatives targeting children, especially younger (0-5) and primary school children (6-12). Overall focus was on creating supportive environments, strengthening community actions, developing personal skills and building healthy public policy.	Evaluation
Hinkson et al. 2017 Erica Hinckson (1), Ester Cerin (2,3), Surzanne Mavoa (4,5), Melody Smith (6), Hannah Badland (7), Karen Witten (5), Robin Kearns (8), Grant Schofield (1)	1 Auckland University of Technology. 2 Australia Catholic University. 3 School of Public Health, University of Hong Kong 4 University of Melbourne 5 SHORE & Whariki Research Centre, Massey University. 6 School of Nursing, University of Auckland. 7 Centre for Urban Research, RMIT University. 8 School of Environment, University of Auckland.	What are the associations between neighbourhood walkability and sedentary time in New Zealand adults? The URBAN cross-sectional study.	No significant main effects of GIS-based neighbourhood walkability measures were found with accelerometer-derived sedentary time (ST). Retail footprint area ratio was negatively associated with sedentary time in women, significant only for 500 m residential buffers. An increase of 1 decile in street connectivity was significantly associated with a decrease of over 5 min of ST per day in Christchurch residents for both residential buffers. Neighbourhoods with proximal retail and higher street connectivity seem to be associated with less ST. These effects were sex and city specific.	Cross-sectional GIS and accelorometre data
Ivory et al. 2015a Vivienne C. Ivory (1), Marie Russell (1), Karen Witten (2), Carolyn M. Hooper (1), Jamie Pearce (3), Tony Blakely (1)	1 Health Inequalities Research Programme, Dept. of Public Health, University of Otago 2 SHORE and Whāriki Research Centre, School of Public Health, Massey University, 3 Centre of Research on Environment, Society and Health, School of GeoSciences, University of Edinburgh	What shape is your neighbourhood? Investigating the micro geographies of physical activity	Residents' social practices around physical activity demonstrated their agency in shaping neighbourhoods that enabled healthy lifestyles. People were not restricted to resources within their immediate area and made distant places 'near'. Transport facilitated access to non-local places that met residents' need for physical activity or gave them more choice. Employment was also important in taking people out of their residential settings and lead to different ways of engaging with local and non-local places. Not all residential settings equally provide motivation for residents to undertake physically active lifestyles. Quality and safety of streets were important factors in whether residents used their streets for physical activity. Neighbourhood characteristics appeared to affect how residents engaged with places e.g. streets that promoted walking were talked about as being more than routes.	Qualitative focus groups
Ivory et al. 2015b Vivienne C. Ivory (1) Tony Blakely (1), Jamie Pearce (2), Karen Witten (3) Nasser Bagheri (4), Hannah Badland (4, 5) Grant Schofield (5)	1 Department of Public Health, University of Otago, Wellington, 2 University of Edinburgh 3 Center for Social and Health Outcomes Research and Evaluation (SHORE) and Whariki Research Centre, Massey University, 4 University of Melbourne, 5 Auckland University of Technology	Could strength of exposure to the residential neighbourhood modify associations between walkability and physical activity?	This study investigated whether greater neighbourhood 'exposure' through reliance on or engagement with the residential setting magnifies neighbourhood-health associations. Three built environment characteristics (destination density, streetscape (attractiveness of built environment) and street connectivity) and two physical activity components (weekday and weekend accelerometer counts) were measured for 2033 residents living in 48 neighbourhoods within four New Zealand cities in 2009-2010. Interactions were in line with the hypothesis, with a stronger association seen for proxy exposure indicators (for example, restricted car access). Added to the wider evidence base, our study strengthens causal evidence of an effect of the built environment on physical activity, and highlights that health gains from improvements of the residential neighbourhood may be greater for some people.	Cross sectional survey and GIS

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Keall et al. 2015 Michael Keall (1), Ralph Chapman (2), Philippa Howden-Chapman (1), Karen Witten (3), Wokje Abrahamse (2), Alistair Woodward (4)	1 Dept of Public Health, University of Otago (all authors also at the NZ Centre for Sustainable Cities) 2 Victoria University of Wellington, 3 SHORE and Whariki Research Centre, Massey University, 4 School of Population Health, University of Auckland	Increasing active travel: results of a quasi-experimental study of an intervention to encourage walking and cycling	Substantial changes in walking and cycling were found following improvements in infrastructure and associated programmes in two NZ cities (New Plymouth and Hastings). Relative to the control cities, the odds of trips being by active modes (walking or cycling) increased by 37% (95% CI 8% to 73%) in the intervention cities between baseline and postintervention. The net proportion of trips made by active modes increased by about 30%. In terms of physical activity levels, there was little evidence of an overall change.	Quasi-experimental pre-post study design
Mackenbach et al. 2016 Joreintje Dingena Mackenbach (1), Edward Randal (2), Pengjun Zhao (3) Philippa Howden-Chapman (2)	1 Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research , Amsterdam, 2 NZ Centre for Sustainable Cities, University of Otago, 3 Department of Urban and Regional Planning, College of Urban and Environmental Sciences, Peking University	The influence of urban land-use and public transport facilities on active commuting in Wellington, New Zealand: Active transport forecasting using the WILUTE model.	In Wellington, high income individuals were more likely to commute actively than individuals on low income. Several land-use and transportation factors were associated with active commuting. Results from modelling showed a potential increase in active commuting following an increase in bus frequency and parking fees. Regional level policies stimulating environmental factors that directly or indirectly affect active commuting may be a promising strategy to increase population level physical activity. Access to, and frequency of, public transport in neighbourhood can act as a facilitator for a more active lifestyle among its residents without negatively affecting disadvantaged groups.	Modelling survey and GIS data
Macmillan et al. 2014 Alexandra Macmillan (1), Jennie Connor (1), Karen Witten (2), Robin Kearns (3), David Rees (4), and Alistair Woodward (5)	1. School of Population Health, University of Auckland 2 Department of Preventive and Social Medicine, University of Otago 3 SHORE and Whāriki Research Centre, Massey University 4 School of Environment, University of Auckland 5 Synergia Ltd	The societal costs and benefits of commuter bicycling: simulating the effects of specific policies using system dynamics modelling	This study developed a system dynamics model of commuter bicycling through interviews and workshops with policy, community, and academic stakeholders. Five policy scenarios over the next 40 years in Auckland were simulated, demonstrating which policies would be needed to change a historical pattern of decline in cycling into a pattern of growth that would meet policy goals. Model projections suggest that transforming urban roads over the next 40 years, using best practice physical separation on main roads and bicycle-friendly speed reduction on local streets, would yield benefits 10-25 times greater than costs.	System dynamics modelling
Matheson et al. 2017 Anna Matheson, Mat Walton, Rebecca Gray, Kristin Lindberg, Mathu Shanthakumar, Nikki Chilcott, Nan Wehipeihana, Barry Borman	1 School of Health Sciences, Massey University	Healthy Families interim evaluation report	Key features of the initiative, as directed by the building blocks of the prevention system (workforce, leadership, relationship, resources, knowledge and data), have mostly been put in place. Guiding principles have helped focus on activities that are more likely to achieve systems change. There are strong indications that local adaptations of the initiative to local cultural and environmental circumstances is occurring. Most locations have begun to consolidate their stakeholder relationships, as well as their own purpose, and are collaborating on substantial activities within their communities.	Evaluation report
Matheson et al. 2018 Anna Matheson, Mat Walton, Rebecca Gray, Kirstin Lindberg, Mathangi Shanthankumar, Nan Wehipeihana	1 School of Health Sciences, Massey University	Summative Evaluation Report: Healthy Families NZ.	Healthy Families NZ has been implemented with integrity to its intention and purpose across the 10 locations (implementing a systems approach to preventing chronic disease). There are examples of a paradigm shift away from silo thinking and practices to focusing on relationships between settings, and the wider determinants of health. There has also been a continued prioritisation and emphasis on Māori ownership and participation, as well as on equity. Leadership and 'joined up' community leadership for prevention has been a key focus. It is too soon to see HFNZ making a change to chronic disease risk factors. Healthy Families NZ locations combined showed more worsening than improving trends in the chronic disease risk factors groups, when compared to the Rest of New Zealand. While there has been worsening in adult obesity and overweight in all Healthy Families NZ	Evaluation

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
			locations compared to the total population, inequalities for Māori in adult obesity and overweight have improved after comparing to the Rest of New Zealand. Improvements in local data are needed. Local action has been constrained by regulatory inaction. 18 recommendations were given to strengthen the programme.	
Mavoa et al. 2011 Suzanne Mavoa (1), Karen Witten (1), Tim McCreanor (1) David O'Sullivan (2)	1 SHORE and Whāriki Research Centre, Massey University 2 School of the Environment, University of Auckland	GIS based destination accessibility via public transit and walking in Auckland, New Zealand	The paper describes two measures of public transit access. The first is a combined public transit and walking accessibility index, which measures potential access to destinations via public transit and walking modes. The second is a transit frequency measure, which is a measure of transit service level in an area. These two measures extend current public transit accessibility measures by including all components of the public transit journey, calculating accessibility at the parcel level and providing a measure of public transit service. Results for the Auckland region show that although 94.4% of the urban population live in areas with medium–high public transit and walking access, only 26.5% of the urban population also have an average transit frequency of two or more trips per hour per stop. Moreover, only 5% of the urban population live in areas with an average transit frequency of more than four services per hour per stop.	GIS analysis
McLean et al. 2009 Rachael M McLean (1) Janet A Hoek (1) Sue Buckley (2) Bronwyn Croxson (2) Jacqueline Cumming (2) Terry H Ehau (3) Ausaga Fa'asalele Tanuvasa (2) Margaret Johnston (1) Jim I Mann (1) and Grant Schofield (4), 2009	1 Department of Medical and Surgical Sciences, University of Otago 2 Health Services Research Centre, School of Government, Victoria University of Wellington 3 Native Consultancy Ltd, Maketu, Te Puke 4 School of Sport & Recreation, Centre for Physical Activity and Nutrition, Auckland University of Technology, New Zealand	"Healthy Eating - Healthy Action": Evaluating New Zealand's obesity prevention strategy	[Only discussion of how the evaluation will be conducted, no results]	Evaluation
Oliver et al. 2015 Melody Oliver (1), Karen Witten (2), Tony Blakely (3), Karl Parker (4) Hannah Badland (5), Grant Schofield (1), Vivienne Ivory (3), Jamie Pearce (6), Suzanne Mavoa (4), Erica Hinckson (1), Paul Sweetsur (4) and Robin Kearns (7)	1 Human Potential Centre, Auckland University of Technology, 2 SHORE and Whāriki Research Centre, Massey University, 3 Dept of Public Health, University of Otago, Wellington, 4 University of Melbourne, 5 School of GeoSciences, University of Edinburgh, 6 School of Environment, The University of Auckland.	Neighbourhood built environment associations with body size in adults: mediating effects of activity and sedentariness in a cross-sectional study of New Zealand adults	This research found that an increase in street connectivity, neighbourhood destination accessibility, dwelling density, and streetscape predicted a decrease in body size variables. Physical activity was also found to have a mediating effect on the relationship between body size and street connectivity and neighbourhood destination accessibility. This research did not find a significant mediating effect of sedentary behaviour.	Cross-sectional survey and GIS data

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Pearce et al. 2007 Jamie Pearce (1), Tony Blakely (2), Karen Witten (3), Phil Bartie (1), 2007	1 GeoHealth Laboratory, Department of Geography, University of Canterbury, Christchurch, 2 Wellington School of Medicine and Health Sciences, University of Otago, Wellington 3 Centre for Social and Health Outcomes Research and Evaluation, Massey University, Auckland, New Zealand	Neighbourhood deprivation and access to fast-food retailing: a national study	This study found a strong association between neighbourhoods deprivation and geographic access to fast food outlets (multinational and locally operated) in New Zealand. The travel distances to both types of fast food outlets were at least twice as far in the least socially deprived neighbourhoods compared to the most deprived neighbourhoods. A similar pattern was found for the outlets selling healthy food such as supermarkets and small food outlets. These findings highlight the importance of considering all aspects of the food environment (healthy and unhealthy) when developing environmental strategies to address the obesity epidemic.	Cross-sectional GIS coded data
Perry et al. 2018 Meredith Perry, Hemakumar Devan, Harry Fitzgerald, Karen Han, Li-Ting Liu, Jack Rouse	School of Physiotherapy, University of Otago,	Accessibility and usability of parks and playgrounds.	21 public parks and playgrounds in three metropolitan cities of New Zealand were evaluated for their accessibility and usability, identifying potential design, environmental and safety barriers to participation for persons with disabilities across the lifespan. A larger, more comprehensive evaluation of parks and playgrounds is required.	Observational cross-sectional
Raerino et al. 2013 K. Raerino (Ngāti Awa, Te Arawa) (1) Alex K. Macmillan (2) Rhys G. Jones (Ngāti Kahungunu) (1), 2013	1 Te Kupenga Hauora Māori, The University of Auckland 2 School of Population Health, University of Auckland	Indigenous Māori perspectives on urban transport patterns linked to health and wellbeing	This research found that there are different drivers for transport patterns for Māori than non-Māori. Four main themes were identified as important factors for family wellbeing: the lived experience of being Māori (identity, culture, and access to the Māori world), the relationship between transport behaviour and the built and natural environment, the link between transport and healthy daily lives, and the ability to participate fully in society economically and in the wider family. However, the process of colonisation has led to the design of transport systems that privilege the dominant group and marginalise the needs of indigenous populations. Current discourses of transport disadvantage fail to identify the specific effects of transport policies and systems on indigenous wellbeing. The authors give three recommendations for transport. Firstly, there should be greater representation of indigenous peoples in the development and implementation of transport strategy to provide an understanding of the relationship between indigenous wellbeing and transport systems. Secondly, policy makers should empower the development of small community-owned and operated public transport systems that reflect the specific needs of indigenous communities, including systems such as marae-based transport. This would mitigate the adverse effects of reliance on private cars. Finally, transport strategies and policies should be introduced to support access to education and employment for indigenous youth.	Qualitative interviewing (Kaupapa Māori methodology)
Shaw et al. 2016 Caroline Shaw, Marie Russell, Kim van Sparrentak, Annabel Merrett, Harry Clegg (1), 2016	1 New Zealand Centre for Sustainable Cities, University of Otago, Wellington	Benchmarking cycling and walking in six New Zealand cities: Pilot study 2015	Walking was most common form of active transport in New Zealand, with cycling only comprising 1% of trips. Cycling to work was most common in Christchurch and least common in Auckland, while walking to work was most common in Wellington and least common in Tauranga. Cycling and walking were more common in younger age groups in most, but not all, cities. Cycling to work remained stable across age groups and across deprivation quintiles, however walking to work was much more common in people who lived in poorer areas.	Household survey

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
			Cities with higher levels of car-ownership had lower levels of cycling and walking. In cities with higher levels of people cycling and walking for transport, more people had adequate levels of physical activity for health.	
Shaw et al. 2017 Caroline Shaw (1), Michael Keall (1), Haley Guiney (2), 2017	1 Department of Public Health, University of Otago, Wellington, 2 Department of Psychology, University of Otago	What modes of transport are associated with higher levels of physical activity? Cross-sectional study of New Zealand adults	People who walk or cycle to their main activity are 76% more likely to meet physical activity guidelines compared to motor vehicle users.. People who take public transport are no more likely to meet the physical activity guidelines than motor vehicle users. Association for walking or cycling and meeting guidelines is seen for both those in-work and those not-in-work. Encouraging walking and cycling to main activity may be a way of increasing population physical activity in NZ; however the association with public transport needs further investigation. A concerted effort needs to be made to develop policies, infrastructure and programmes that democratise walking and cycling.	Cross-sectional
Shaw et al. 2018 Caroline Shaw (1), Edward Randal (1), Michael Keall (1), Alistair Woodward (2)	1 Department of Public Health University of Otago, 2 School of Population Health, University of Auckland	Health consequences of transport patterns in New Zealand's largest cities	If Auckland, Tauranga, Hamilton, Christchurch and Dunedin had the same cycling, walking and public transport mode-share as Wellington there would be considerable health and carbon gains. The health gains are predominately through increased physical activity, and, to a lesser extent, as a result of reduced air pollution and injury deaths. The economic land-use planning and transport policies that have been put in place in many cities around New Zealand over the preceding decades have disadvantaged the health of their populations (and the planet). Decisions with regards to the planning of transport and land use need to be recognized by local councils and central Government as not just 'bricks and mortar' or a means of improving efficiency, but as policy that can either improve or harm the health of their constituents.	Modelling
Sushil et al. 2017 Zaynel Sushil, Stefanie Vandevijvere, Daniel J. Exeter and Boyd Swinburn	School of Population Health, University of Auckland	Food swamp by area socieconomic deprivation in New Zealand: a national study	A significantly positive association was observed between area deprivation and density of all retailers. A significantly negative association was observed between area deprivation and proximity to all retailers. Nationwide, 722 Census areas were identified as food swamps. Access to food retailers is significantly higher in more deprived areas than in less deprived areas. Restricting unhealthy outlets in areas with a high relative density of those outlets is recommended.	GIS spatial analysis
Wild et al. 2017 Kirsty Wild (1), Alistair Woodward (1), Adrian Field (2), Alex Macmillan (3)	1 University of Auckland 2 Dovetail Consulting 3 University of Otago	Beyond 'bikelash': engaging with community opposition to cycle lanes	The emerging literature on bikelash points to four key sources of organised opposition to bike lanes: retailers; conservative voters; residents opposed to gentrification; and disaffected cyclists. There are some ideas which could be used to support cycle lanes development.	Literature review
Witten et al. 2008 Karen Witten (1), Rosemary Hiscock (2), Jamie Pearce (2), Tony Blakely (3)	1 SHORE and Whāriki Research Centre, Massey University 2 GeoHealth Laboratory, University of Canterbury, 3 University of Otago	Neighbourhood access to open spaces and the physical activity of residents: A national study	Neighbourhood access to parks was not associated with BMI, sedentary behaviour or physical activity, after controlling for individual-level socio-economic variables, and neighbourhood-level deprivation and urban/rural status. There was some evidence of a relationship between beach access and BMI and physical activity in the expected direction. This study found little evidence of an association between locational access to open spaces and physical activity.	Survey data matched with GIS

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Witten et al. 2010 Karen Witten (1), Jamie Pearce (2), Peter Day (3)	1 Massey University, 2 University of Edinburgh, 3 GeoHealth Lab, University of Canterbury	Neighbourhood destination accessibility index: A GIS tool for measuring infrastructure support for neighbourhood physical activity.	Development of a tool (Neighbourhood Destination Accessibility Index (NDAI) which measures destination opportunities, the proximate access to which could conceivably encourage higher rates of physical activity by residents for transport and recreation. Found considerable variation in destination accessibility between neighbourhoods within a city and between neighbourhoods in different cities of New Zealand. Also noted a positive relationship between increasing neighbourhood deprivation and access to neighbourhood destinations, a relationship that holds at varying population densities. Does not include other aspects of built environment (e.g. Perceptions of safety, and the quality and attractiveness of destination venues, as well as the walking routes taken to reach them), which have all been associated with walking behaviour. a definitive answer to the question of whether NDAI predicts physical activity levels awaits its application of NDAI in a study that is currently collecting objective physical activity data in neighbourhoods in the four cities	Observational GIS data
Witten et al. 2012 Karen Witten (1), Tony Blakely (2), Nasser Bagheri (2) Hannah Badland (3,4) Vivienne Ivory (2) Jamie Pearce (5) Suzanne Mavoa (1) Erica Hinckson (4) and Grant Schofield (4)	1 Center for Social and Health Outcomes Research and Evaluation (SHORE) and Whariki Research Centre, Massey University, 2 Department of Public Health, University of Otago, Wellington, 3 University of Melbourne, 4 Auckland University of Technology, 5 University of Edinburgh	Neighbourhood Built Environment and Transport and Leisure Physical Activity: Findings Using Objective Exposure and Outcome Measures in New Zealand	The URBAN Study of 2,033 adults living in 48 New Zealand neighbourhoods investigated associations of five objectively measured characteristics of the neighbourhood built environment—destination access, street connectivity, dwelling density, land-use mix and streetscape quality—with residents' self-reported PA (transport, leisure, and walking) and accelerometer-derived measures of PA. Associations of neighbourhood destination access, street connectivity, and dwelling density with self-reported and objectively measured PA were moderately strong, indicating the potential to increase PA through changes in neighbourhood characteristics.	Cross sectional survey
Witten et al. 2018 Karen Witten (1), Penelope Carroll (1), Octavia Calder-Dawe (1), Melody Smith (2), Adrian Field (3), Jamie Hoskings (2) and the Future Streets team, 2018	1 SHORE and Whāriki Research Centre, Massey University 2 University of Auckland 3 Dovetail consulting	Te Ara Mua –Future Streets: Knowledge exchange and the highs and lows of researcher-practitioner collaboration to design active travel infrastructure	Future Streets is a researcher-practitioner collaboration that has successfully used a participatory design process to retrofit suburban streets to support active transport. This paper details frictions that arose between project partners as delays in street design decision-making became apparent and timelines started slipping in the project's second year.	Interviews

Appendix 6: NZ research on food environments

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Al-Ani et al. 2016 Haya Al-Ani, Anadita Devi, Helen Eyles, Boyd Swinburn, and Stefanie Vandevijvere	Dept of Epidemiology and Biostatistics, University of Auckland	Nutrition and health claims on healthy and less-healthy packaged food products in New Zealand	An overview of the extent and nature of nutrition and health claims on the FoP of eight food categories of New Zealand packaged foods. Overall, more than half of all products across the eight categories featured claims on the FoP with a total of 7058 individual claims, indicating extensive use of nutrition and health claims on packaged foods in New Zealand. More than a quarter of 'less-healthy' products (26 %) featured nutrition claims and 7 % carried health claims. The proportion of cereals with claims (90 %) is markedly higher than for the other seven food categories.	Cross-sectional
Alexander, Donell, 2018	1 Ministry of Business and Employment	Claiming Health Benefits: what effect has the new nutrition and health claims Standard had on food labels?	Two surveys done in 2014/15 and 2016/17 (following a change in the Food Standards) A random sample of 600 products was selected from across 15 food product categories housed in the Nutritrack database (University of Auckland) found in New Zealand supermarkets plus 80 randomly selected products from two extra food product categories not housed in the Nutritrack database (fresh fruits/vegetables and alcoholic beverages). 56% of labels contained nutrition content claims (e.g. high in Vit C) and 86% of these met the standards in 2016. General-level health claims, which refer to a food property and its effect on normal health and wellbeing were found on fewer than 5% of foods in each food group, except special purpose foods (21%). 51% of General-level claims met the Standard. No high-level health claims (which explain what role a food property has in the risk of developing a serious illness, or risk of altering a recognised risk factor for a serious illness) were found on products. While the majority of claims used on food labels are meeting the requirements of the Food Standards Code, some common misunderstandings clearly still exist.	Nutritrack database survey
Blakely et al. 2011 Tony Blakely (1), Cliona Ni Mhurchu (2), Yannan Jiang (2), Leonie Matoe (3), Mafi Funaki-Tahifote (4), Helen C. Eyles (2), Rachel H. Foster (1), Sarah McKenzie (1) and Anthony Rodgers (5)	1 Department of Public Health, University of Otago, Wellington 2 Clinical Trials Research Unit, Auckland 3 Te Hotu Manawa Māori, Auckland 4 Pacific Heartbeat, The National Heart Foundation of New Zealand 5 George Institute of International Health, Sydney	Do effects of price discounts and nutrition education on food purchases vary by ethnicity, income and education? Results from a randomised controlled trial	In this study, 1104 New Zealand shoppers were randomised to receive a 12.5% discount on healthier foods and/or tailored nutrition education, or no intervention, for 6 months. The study found that there was no overall association of price discounts or nutrition education with percentage energy from saturated fat, or nutrition education with healthy food purchasing. There was an association of price discounts with healthy food purchasing increase that varied by ethnicity: European/other 1.02 kg/week, Pacific 1.20 kg/week, Māori –0.15 kg/week. This association of price discounts with healthy food purchasing did not vary by household income or education. The authors caution against a causal interpretation of variation by ethnicity due to likely biases. The null findings for tailored nutritional education across all social groups suggest that structural interventions (such as price) may be more effective.	Randomised controlled trial
Chand et al. 2012 Ashmita Chand, Helen Eyles, Cliona Ni Mhurchu (1)	1 Clinical Trials Research Unit, The University of Auckland,	Availability and accessibility of healthier options and nutrition information at New Zealand fast food restaurants	The aim of this study was to assess the availability of healthier options and nutrition information at major New Zealand fast food chains. Of available products, only 21% were healthier options. Healthier options were generally cheaper and lower in energy, total fat, saturated fat, sugar, and sodium per serve than their regular counterparts. Regular options were commonly high in sugar or sodium per serve. Nutrition information was available at 92% of restaurant chains (range = 0% at Tank Juice to 99% at Domino's Pizza). However, <1% of this information was available at the point-of-purchase. Therefore, there is huge potential for improving nutrition in the New Zealand fast food restaurant setting.	Cross-sectional survey

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
			Implications of these findings for policy and food industry include: consideration of mandatory menu labelling, increasing the percentage of healthier options available, and improving the nutrient content of regular options at New Zealand fast food restaurants.	
Eyles et al. 2016 Helen Eyles (1, 2), Emma Shields (1), Jacqui Webster (3), Cliona Ni Mhurchu (1)	1 National Institute for Health Innovation and 2 Dept of Epidemiology and Biostatistics, University of Auckland; and 3 George Institute for Global Health, University of Sydney, Sydney, Australia	Achieving the WHO sodium target: Estimation of reductions required in the sodium content of packaged foods and other sources of dietary sodium	This research aimed to develop a sodium reduction model to determine the reductions required in the sodium content of packaged foods and other dietary sources of sodium to reduce adult population salt intake to meet the WHO target of 5 g/d. The model found that this reduction could be achieved with a 36% reduction in the sodium content of packaged foods, as well as a 40% reduction in discretionary salt use and sodium content of foods consumed away from the home. Key products requiring sodium content reduction include white bread, hard cheese, sausages, and ready-to-eat breakfast cereals.	Linkage of household food-purchasing data with branded food composition data
Eyles et al. 2018 Helen Eyles (1), Yannan Jiang, (1) Tony Blakely (2), Bruce Neal (3), Jennifer Crowley (1), Christine Cleghorn 2 and Cliona Ni Mhurchu (1)	1 School of Population Health, University of Auckland 2 Department of Public Health, University of Otago, 3 The George Institute for Global Health, University of Sydney	Five year trends in the serving size, energy and sodium contents of New Zealand fast foods: 2012-2016	The serve size and energy density of NZ fast food products has increased significantly over the past 5 years. Lower sodium concentration in new and reformulated products has been offset by overall increases in serve size. Continued monitoring and development and implementation of Government-led targets for serve size and nutrient content of new and existing fast food products are required.	Cross-sectional surveys of serve size and nutrient data
Gorton et al. 2009 Delvina Gorton (1), Cliona Ni Mhurchu (1), Mei-hua Chen (1), Robyn Dixon (2)	1 Clinical Trials Research Unit, University of Auckland 2 Centre for Child and Family Policy Research, University of Auckland	Nutrition labels: A survey of use, understanding and preferences among ethnically diverse shoppers in New Zealand.	This study examined use, understanding and preferences regarding nutrition labels among ethnically diverse shoppers in New Zealand. Reported use of nutrition labels ranged from 66% for Māori to 87% for New Zealand European and Other. There was little difference in ability to obtain information from the Nutrition Information Panel according to ethnicity or income. However, there were marked ethnic differences in ability to use the Nutrition Information Panel to determine if a food was healthy (88% for New Zealand European and Other, 68% for Māori and Asian), with lesser differences by income. Of the four label formats tested, multiple traffic light and simple traffic light labels were best understood across all ethnic and income groups, and multiple traffic light labels were most frequently preferred.	Survey of supermarket shoppers
Gorton et al. 2010 Delvina Gorton (1), Julie Carter (2), Branko Cvjetan (2), Cliona Ni Mhurchu (1)	1 Clinical Trials Research Unit, University of Auckland 2 Healthy Lifestyles Team, Waitemata District Health Board	Healthier vending machines in workplaces: Both possible and effective.	This study aimed to assess the effect of healthier vending guidelines on nutrient content and sales of snack products sold through hospital vending machines, and on staff satisfaction. The study found that guidelines resulted in a substantial reduction in the amount of energy, total fat, saturated fat, and total sugars per 100g product sold. Sales volumes and percentage of staff using vending machines were not affected, and the proportion of staff satisfied with vending machine products increased. The results show such guidelines are feasible and acceptable for both consumers and vending contractors. The authors recommend wider implementation of these guidelines.	Quasi-experimental design of surveys pre and post workplace intervention
Hamlin and McNeill, 2016 Robert Hamlin and Lisa McNeill (1)	1 Department of Marketing, University of Otago	Does the Australasian "Health Star Rating" front of pack nutritional label system work?	This research aimed to test the impact of the HSR label on consumer choice. Presence of HSR label consistently reduced consumer preference. The concumser choice effect of the HSR label was not differentiated by nutritional status (i.e. whether the HSR was 0.5 or 5). These results suggest a significant functional failure of the HSR label system.	Consumer survey

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Jani et al. 2018 Rati Jani (1); Elaine Rush (2); Nic Crook (3); David Simmons (4)	1 School of Clinical Sciences, University of Canberra, Australia; 2 Centre for Physical Activity and Nutrition, Auckland University of Technology, New Zealand ; 3 Lakes District Health Board, New Zealand ; 4 School of Medicine, Western Sydney University, Australia	Availability and price of healthier food choices and association with obesity prevalence in New Zealand Māori	This survey of N=1149 food outlets (n=392 supermarkets, n=757 fast-food outlets) within n=2 urban locations (defined as areas within Hamilton) and 96 rural locations (defined as areas out of Hamilton) found in-store availability of healthier food choices in fast-food outlets is higher in rural vs urban locations and lower income vs higher income areas, consistent with previous research in New Zealand (Pearce 2007). Bottled water vs sugar-sweetened-beverages prices were inversely associated with obesity. The authors conclude that this supports the argument to regulate the availability and price of sugar-sweetened-beverages in NZ. The positive association of the availability of trim milk with the prevalence of obesity warrants investigation into individual's dietary and food-purchase behaviour. No association between number of fast-food outlets with cluster and obesity prevalence after adjusting for income and location.	Cross-sectional survey
Kemper and Ballantine 2017 Joya Kemper, Paul Ballantine, (1)	1 Department of Management, Marketing and Entrepreneurship, UC Business School, University of Canterbury	Socio-technical transitions and institutional change: addressing obesity through macro-social marketing.	Macro-social marketing has been suggested as an approach to addressing wicked problems (e.g. obesity) through systemic change. This paper offers a new framework to macro-social marketing, whereby "multi-level perspective on socio-technical transitions" (MLP) is introduced to macromarketing, and then the authors outline a research agenda based upon this framework. Macromarketing can offer unique insight into the socio-cultural environment which is lacking in public health and nutritional research, such as the rituals, identities, and social practices, wrapped up in eating.	Secondary review and theory
Mackay et al. 2017 Sally Mackay (1), Stefanie Vandevijvere (1), Pei Xie (1), Amanda Lee (2), Boyd Swinburn (1)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland 2 The Australian Prevention Partnership Centre, The Sax Institute, Sydney	Paying for convenience: comparing the cost of takeaway meals with their healthier home-cooked counterparts in New Zealand.	Healthier options of home-prepared meals were generally cheaper than their takeaway counterparts, for the cost of the complete meal and the cost standardised for weight. Adding the cost of preparation and waiting time made the home-assembled meals the cheapest and either the home-made or takeaway meal the most expensive option. Home-made meals can be healthy and cheap but do require time. Home-assembled meals are quicker to prepare and can be cheaper and healthier than takeaways, so is a recommended option if time is limited.	Observational
Mackay et al. 2018 Sally Mackay (1), Tina Buch (2), Stefanie Vandevijvere (1), Rawinia Goodwin (1), Erina Korohina (3), Mafi Funaki-Tahifote (2), Amanda Lee (4) and Boyd Swinburn (1)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland, 2 Heart Foundation, 3 Toi Tangata, 4 The Australian Prevention Partnership Centre, The Sax Institute, Sydney	Cost and affordability of diets modelled on current eating patterns and on dietary guidelines, for New Zealand total population, Māori and Pacific Households	A lower-energy healthy diet is not necessarily more expensive than the current diet, but discretionary foods make up 36–41% of food costs in the current diet. Strategies to switch current spending on discretionary food and takeaways to healthy food need not cost more. However, overall food security is of concern as a considerable portion of income is required to purchase either a healthy or the current diet in NZ, especially for households receiving minimum wage or income support. In order to consume a healthy diet, policies are required to lower the cost of healthy food or ensure that households have sufficient income after fixed expenses to purchase nutritious, acceptable and safe food.	Modelling (and expert panel)
Maubach and Hoek 2010 Ninya Maubach (1), Janet Hoek (2)	1. Department of Communication, Journalism and Marketing, Massey University, Palmerston North 2 Department of Marketing, University of Otago, Dunedin	A qualitative study of New Zealand parents' views on front-of-pack nutrition labels	This study explored parents' reactions to industry-led labels and formats proposed by health advocates. Key themes included the volume of information, the ease of interpreting this and the ability and time required to assimilate it into decision. Participants preferred information they could process easily and quickly. Simplified, graphic information formats appear more likely to inform consumers' food choices than labels dominated by numeric information. This suggests that policy-makers should explore several front-of-pack labels, particularly those that use visual heuristics such as Traffic Light labels.	Qualitative interviews

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
Monro et al. 2015 David Monro (1), Cliona Ni Mhurchu (2), Yannan Jiang (2), Delvina Gorton (1) Helen Eyles (2,3)	1 Heart Foundation of New Zealand. 2 National Institute for Health Innovation, University of Auckland. 3. Epidemiology and Biostatistics, University of Auckland.	Changes in the sodium content of New Zealand processed foods: 2003-2013	This research found that there was no significant difference in the mean sodium content of matched products between 2003 and 2013. The largest percentage reductions of sodium included breakfast cereals, canned spaghetti and bread. Reduction in sodium was greater for matched private versus branded foods There has been modest progress with sodium reduction in some New Zealand food categories over the past 10 years, but a renewed focus across the whole food supply is needed if New Zealand is to meet its global commitment to reducing population sodium intake.	Quantitative secondary data analysis
Nghiem et al. 2015 Nhung Nghiem(1), Tony Blakely (1), Linda J. Cobiac (1, 2), Amber Lee Pearson (1), Nick Wilson (1)	1 Department of Public Health, University of Otago, Wellington 2 School of Population Health, University of Queensland, Brisbane, Australia	Health and economic impacts of eight different dietary salt reduction interventions	This research used epidemiological modelling and cost-utility analysis to compare the impact and feasibility of eight sodium reduction interventions. The most significant health gains and cost savings could be achieved with a 'sinking lid' on the amount of food salt released to the national market, and a salt tax. However the study authors deemed these interventions to be more theoretical than feasible. Of the most feasible interventions, the largest health gains could be achieved with a mandatory 25% reduction in sodium levels in all processed foods, a package including voluntary food reformulation, food labelling and a media campaign, and mandatory 25% reduction in sodium levels in bread, processed meats and sauces. Interventions that produced lesser health gains included media campaigns, voluntary food labelling as currently used in New Zealand, and dietary counselling. All interventions produced net cost savings aside from counselling. Health gain per person was greater for Māori men and women compared to non-Māori.	Modelling and cost-utility analysis (macro simulation)
Ni Mhurchu et al. 2010 Cliona Ni Mhurchu (1,2), Tony Blakely (3), Yannan Jiang (1), Helen C. Eyles (1), Anthony Rodgers (4)	1 Clinical Trials Research Unit, School of Population Health, University of Auckland 2 MRC Human Nutrition Research, Elsi Widdowson Laboratory, Cambridge 3 Department of Public Health, University of Otago, Wellington 4 George Institute of International Health, Sydney	Effects of price discounts and tailored nutrition education on supermarket purchases: A randomized controlled trial	This study aimed to evaluate the effect of price discounts (12.5%) and tailored nutrition education on supermarket food and nutrient purchases. The study found that neither price discounts nor tailored nutrition education had a significant effect on saturated fat purchase. However, subjects who were randomly assigned to receive price discounts bought significantly more predefined healthier foods at 6 months, which indicates that pricing strategies hold promise as a means to improve population diets.	Randomized controlled trial
Ni Mhurchu et al. 2013 Cliona Ni Mhurchu (1), Helen Eyles (1), Chris Schilling (2), Qing Yang (2), William Kaye-Blake (2), Murat Genc (3), Tony Blakely (4)	1 National Institute for Health Innovation, The University of Auckland. 2 New Zealand Institute for Economic Research, Wellington 3 Department of Economics, University of Otago, Dunedin 4 Department of Public Health,	Food prices and consumer demand: Differences across income levels and ethnic groups.	Targeted food pricing policies may improve population diets. To assess their effects on inequalities, it is important to determine responsiveness to price changes across income levels and ethnic groups. This research aimed to estimate price elasticity (PE) values for major commonly consumed food groups in New Zealand, by income and ethnicity. PE values represent percentage change in demand associated with 1% change in price of that good (own-PE) or another good (cross-PE). This study used food expenditure data from national household economic surveys in 2007/08 and 2009/10 and Food Price Index data from 2007 and 2010. Adopting an Almost Ideal Demand System approach, own-PE and cross-PE estimates were derived for 24 food categories, household income quintiles, and	Modelling/secondary data analysis

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
	University of Otago, Wellington		two ethnic groups (Māori and non-Māori). This research found that although demand for food is relatively inelastic, the power of price changes to change consumer purchasing should not be underestimated, given that effects accumulate across an entire population. The greater sensitivity of low-income households and Māori to price changes suggests the beneficial effects of such policies on health would be greatest for these groups.	
Ni Mhurchu et al. 2014 Cliona Ni Mhurchu (1), Helen Eyles (1), Murat Genc (2), Tony Blakely (3)	1 National Institute for Health Innovation, University of Auckland, 2 Department of Economics, University of Otago, Dunedin 3 Department of Public Health, University of Otago, Wellington	Twenty percent tax on fizzy drinks could save lives and generate millions in revenue for health programmes in New Zealand.	20% tax on carbonated drinks would reduce daily energy intakes and avert or postpone 0.2% of all deaths in New Zealand per year. Impact would likely be larger amongst Māori and Pacific consumers due to their greater responsiveness to changes in food prices, and amongst children and young people due to their higher consumption of such drinks. There would also be parallel positive impacts on morbidity (i.e. diabetes, obesity). A 20% tax on carbonated drinks could generate up to $40 million revenue per year, even allowing for reductions in consumption due to tax. This revenue could be invested in programmes to improve population health e.g. food in schools. Practically, this tax is also more likely than other taxes to be a politically viable first step.	Macro simulation/Letter
Ni Mhurchu et al. 2015 Cliona Ni Mhurchu (1), Helen Eyles (1), Murat Genc (2), Peter Scarborough (3), Mike Rayner (3), Anja Mizdrak, Kelechi Nnoaham (3), Tony Blakely (4)	1 National Institute for Health Innovation, University of Auckland, 2 Department of Economics, University of Otago, Dunedin, 3 British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention, University of Oxford, 4 Department of Public Health, University of Otago, Wellington	Effects of health-related food taxes and subsidies on mortality from diet-related disease in New Zealand: An econometric-epidemiologic modelling study	Healthy-related food taxes and subsidies could improve diets and reduce mortality from diet-related disease. A 20% subsidy on fruit and vegetables would result in 560 deaths prevented or postponed (DPP) each year. A 20% tax on major dietary sources of saturated fat would result in 1500 DPP each year. A 20% tax on major dietary sources of sodium would result in 2000 DPP. Combining taxes on saturated fat and sodium with a fruit and vegetable subsidy would result in 2400 DPP. Population groups likely to benefit most from such policies are Māori and low-income New Zealanders because their diets are currently less healthy than those of non-Māori and high-income New Zealanders, they experience a greater burden of diet-related disease, and are more responsive to changes in food prices. Health-related food taxes and subsidies are likely to be highly cost-effective in comparison to other strategies to prevent diet-related disease such as individually-focused weight reduction programmes.	Modelling (macrosimulation)
Ni Mhurchu et al. 2017a Cliona Ni Mhurchu (1), Ekaterina Volkova (1), Yannan Jiang (1) Helen Eyles (1) Jo Michie (1), Bruce Neal (2,3) Tony Blakely (4) Boyd Swinburn (5) Mike Rayner (6)	1 NIHI, University of Auckland; 2 The George Institute for Global Health and Charles Perkins Center, University of Sydney; 3 Division of Epidemiology and Biostatistics, Imperial College London, London, United Kingdom; 4 Dept of Public Health, University of Otago Wellington, Wellington, New	Effects of interpretive nutrition labels on consumer food purchases: The Starlight randomized controlled trial	In this large RCT of interpretive nutrition labels that were delivered via a smartphone application, neither traffic light labels nor Health Star Ratings had a significant effect on the healthiness of consumer food purchases compared with the effect of the control (Nutrition information panel). However, participants who were randomly assigned to HSR and TLL groups were significantly more likely to report that they found the assigned labels useful and easy to understand, and their nutrition knowledge improved as a result of the use of the labels in the application. Findings, in conjunction with known effects of interpretive front of pack nutrition labels on healthier product reformulation, support the inclusion of interpretive FOP labels as a component of strategies to improve population diets. However, comprehensive policies that include other proven approaches, in addition to interpretive nutrition labels, will be essential to achieve meaningful improvements in population diets.	Parallel-group randomized controlled trial

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
	Zealand; 5 Dept of Epidemiology and Biostatistics University of Auckland; and 6 Nuffield Department of Population Health, University of Oxford, Oxford, UK			
Ni Mhurchu et al. 2017b Cliona Ni Mhurchu, Helen Eyles and Yeun-Hyang Choi (1)	1 National Institute for Health Innovation, University of Auckland	Effects of a voluntary front-of-pack nutrition labelling system on packaged food reformulation: The health star rating system in New Zealand	Two years after adoption of voluntary system 5.3% of packaged food and beverage products surveyed displayed HSR labels. Highest uptake was for cereals, convenience foods, packaged fruit and vegetables, sauces and spreads, and 'other' products (predominantly breakfast beverages). Products displaying HSR labels had higher energy density but lower mean saturated fat, total sugar and sodium, and higher fibre, contents than on-HSR products. Reformulation of HSR-labelled products was greater than that of non-HSR products, energy reduction in HSR products was greater than in non-HSR products, and sodium content decreased in HSR products while increasing in non-HSR products. Roll-out of the voluntary HSR labelling system is driving healthier reformulation of some products. Greater uptake across the full food supply should improve population diets. If voluntary implementation fails to achieve widespread uptake by industry, consideration should be given to making the programme mandatory.	Evaluation using supermarket surveys of packaged food and beverage labelling and composition
Ni Mhurchu et al. 2018 Cliona Ni Mhurchu (1), Helen Eyles (1), Yannan Jiang (1), Tony Blakely (2)	1 National Institute for Health Innovation, University of Auckland 2 Department of Public Health, University of Otago	Do nutrition labels influence healthier food choices? Analysis of label viewing behaviour and subsequent food purchases in a labelling intervention trial.	Labels were viewed for about one fifth of all food purchases made over a four-week period (n = 1255 study participants), but frequency of use decreased over time. Shoppers were most likely to view labels on packaged foods where nutrition composition is heterogeneous and ambiguous. There was a significant positive association between label use and healthiness of products purchased, which suggests that nutrition labels may influence healthier food purchases by those consumers who choose to use them.	Randomised control trial
Pearce et al. 2009 Jamie Pearce (1), Rosemary Hiscock (1), Tony Blakely (2), Karen Witten (3)	1 GeoHealth Laboratory, Department of Geography, University of Canterbury, Christchurch, 2 Wellington School of Medicine and Health Sciences, University of Otago, Wellington 3 Centre for Social and Health Outcomes Research and Evaluation, Massey University, Auckland	A national study of the association between neighbourhood access to fast-food outlets and the diet and weight of local residents.	This study examines whether neighbourhood access to fast food outlets is associated with individual diet-related health outcomes. The study found that residents in neighbourhoods with the furthest access to a multinational fast food outlet were more likely to eat the recommended intake of vegetables, but also more likely to be overweight. There was no association with fruit consumption. Access to locally operated fast-food outlets was not associated with the consumption of the recommended fruit and vegetables or being overweight. The study authors concluded that better neighbourhood access to fast-food retailing is unlikely to be a key contextual driver for socioeconomic inequalities in diet-related health outcomes in New Zealand.	Cross-sectional GIS coded data matched with survey data
Signal et al. 2008 Louise Signal (1), Tolotea Lanumata (2), Jo-Ani Robinson (1), Aliitasi Tavila (3), Jenny Wilton (1) and Cliona Ni Mhurchu (4)	1 Department of Public Health, Wellington School of Medicine and Health Sciences, University of Otago, Wellington 2 Roy McKenzie Centre for the Study of Families, Victoria University, Wellington, 3 Health Services Research Centre, Victoria University, Wellington, 4	Perceptions of New Zealand nutrition labels by Māori, Pacific and low-income shoppers	This study aimed to evaluate perceptions of New Zealand nutrition labels by Māori, Pacific and low-income peoples and to explore improvements or alternatives to current labelling systems. Findings showed that Māori, Pacific and low-income New Zealanders rarely use nutrition labels to assist them with their food purchases. This was due to lack of time to read labels, lack of understanding, shopping habits and relative absence of simple nutrition labels on the low-cost foods they purchase. The authors concluded that nutrition labels were not meeting the needs of those who need them most. Possible improvements included targeted social marketing and education campaigns, increasing the number of low-cost foods with voluntary nutrition labels, a reduction in the price of 'healthy' food, and consideration of an alternative mandatory nutrition labelling system that uses simple	Qualitative focus groups

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
	Clinical Trials Research Unit, University of Auckland		imagery like traffic lights.	
Signal et al. 2018 Louise Signal (1), Carolyn Watts (2), Celia Murphy (2), Helen Eyles (3), Cliona Ni Mhurchu (4)	1 Health Promotion and Policy Research Unit, University of Otago, 2 Quigley and Watts Ltd, 3 National Institute for Health Innovation and Department of Epidemiology and Biostatistics, University of Auckland, 4 National Institute for Health Innovation, University of Auckland	Appetite for health-related food taxes: New Zealand stakeholder views	According to key stakeholders interviewed (n=20) there appears to be little appetite for taxes on foods high in saturated fat or salt in NZ. Stakeholders largely agreed that a tax on sugar-sweetened beverages (SSBs) and a subsidy on fruit and vegetables were both feasible and likely acceptable. There was strong support for starting with a SSBs tax, possibly framed around protecting children and dental health. Addressing obesity and non-communicable diseases is a multidimensional challenge. A tax on SSBs and a subsidy on fruit and vegetables, possibly in tandem, could be part of the solution in NZ.	Stakeholder interviews
Swinburn et al. 2014 Boyd Swinburn, Clare Dominic, Stefanie Vandevijvere (1)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland	Benchmarking food environments: Experts' assessments of policy gaps and priorities for the New Zealand government	An expert panel of over 50 independent public health experts rated the extent of implementation of policies on food environments and infrastructure support systems by the NZ government against international best practice. New Zealand is at world standard in applying a nutrient profiling system to prevent unhealthy foods carrying health claims, in requiring nutrition information panels on packaged foods, having good monitoring systems for NCDs and their risk factors, and having high levels of transparency in policy development and access to government information. However, policies with very little implementation included reducing the marketing of unhealthy foods to children, using fiscal policies to support healthy food choices, supporting local communities to limit the density of unhealthy food outlets in their communities, and ensuring that trade and investment agreements do not negatively affect population nutrition and health. Another gap in New Zealand is the lack of a comprehensive national action plan to address unhealthy food environments and to reduce obesity and NCDs. This must be the highest priority for action. The expert panel recommended 34 actions, prioritising 7 for immediate action (see paper).	Expert panel
Tupai-Firestone et al. 2016 Ridvan Tupai-Firestone, Hana Tuisano, Moana Manukia, Keawe'aimoku Kaholokula, Sunia Foliaki, Te Kani Kingi, Rozanne Kruger, Bernhard Breier, Angelique O'Connell, Barry Borman, Lis Ellison-Loschmann (1)	1 Centre for Public Health Research, Massey University	Understanding Pasifika youth and the obesogenic environment, Auckland and Wellington, New Zealand.	This research investigated the factors of the obesogenic environment that were indigenous of the Pasifika youths' social-cultural context, their food purchasing behaviours, and associated anthropometric measures. This exploratory study included 30 Pasifika youth aged 16-24 years in Wellington and Auckland. It found that a large proportion of the participants were obese, suggesting that the future health and wellbeing trajectory of the studied Pasifika youth is poor.	Qualitative
Vandevijvere et al. 2017a Stefanie Vandevijvere (1), Tara Mackenzie (1) and Cliona Ni Mhurchu (2)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland 2 National	Indicators of the relative availability of healthy versus unhealthy foods in supermarkets: a validation study	Shelf length dedicated to unhealthy food is higher than the shelf length allocated to healthy foods in supermarkets. Using the 'gold standard' measurement, the ratios calculated in this study varied between 0.18 and 0.38, depending on supermarket chain. Check-outs and end-of-aisle endcaps had more space dedicated to unhealthy vs healthy food, compared with other parts of the supermarket.	Cross-sectional survey

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
	Institute for Health Innovation, University of Auckland;			
Vandevijvere et al. 2017b Stefanie Vandevijvere, Sally Mackay, Boyd Swinburn (1)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland	Benchmarking Food Environments: Progress by the New Zealand Government on implementing recommended food environment policies and priority recommendations	NZ is at world standard in requiring nutrition information panels on packaged foods, having good monitoring systems for NCDs, their inequalities and risk factors, and high levels of transparency and access to government information. Major concerns included having low implementation of food environment policies, particularly in schools, fiscal policies, supporting communities to reduce density of unhealthy food outlets in their communities, supporting food retail and service industry to reduce unhealthy food practices and ensuring that trade and investment agreements do not negatively affect population nutrition and health. Experts found that there was low implementation of restrictions to protect children from unhealthy food marketing. Experts also noted lack of government leadership to reduce obesity and improve public health nutrition. In particular, lack of substantive action to improve healthiness of children's food environments in government's plan to tackle childhood obesity, level of funding to improve nutrition in New Zealand was rated as 'low'. Another important gap was lack of targets to reduce childhood obesity rates and inequalities and achieve WHO recommendations for average population sugar, salt and saturated fat intakes. The expert panel urges the government to act on the top recommendations (9 prioritsed actions).	Expert panel
Vandevijvere et al. 2018a Stefanie Vandevijvere, Sally Mackay, Erica D'Souza, Boyd Swinburn	Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland	How healthy are New Zealand food environments?: a comprehensive assessment 2014-2017	In 2014 and 2017, public health experts (n=56 and 71 respectively) rated the extent of implementation of 23 policy and 24 infrastructure support good practice indicators for healthy food environments compared to international best practice. Overall implementation scores were moderate at 43% in 2014 and 48% in 2017. Priority recommendations related to adult food environments were: • Food composition: Set targets for nutrients of concern (sodium, saturated fat, sugar) • Food labelling: Strengthen the Health Star Rating System (HSR) and make it mandatory • Food prices: Implement a 20% tax on sugary drinks • Leadership: Translate Eating Guidelines in the social, environment and cultural contexts • Funding: Increase population nutrition promotion funding to at least 10% of health care and productivity costs of overweight and obesity.	Expert survey
Vandevijvere et al. 2018b Stefanie Vandevijvere (1), Nick Young (2), Sally Mackay (1), Boyd Swinburn (1) and Mark Gahegan (2)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland, 2 Centre for e-Research, Faculty of Science, The University of Auckland	Modelling the cost differential between healthy and current diets: The New Zealand case study	Healthy New Zealand diets were on average more expensive than current diets, but one-quarter of healthy diets were cheaper than the average cost of current diets. For Māori and Pacific population groups, however, in view of their high current energy intakes, current household diets were on average $40-60 more expensive than healthy diets. The impact of diet composition, types of prices and policies on the cost differential was substantial. Reducing taxes on fresh and frozen fruit and vegetables in New Zealand in conjunction with a sugary drinks tax could reduce the average cost of healthy diets towards the average of current diets and make it easier for people to consume healthy diets.	Modelling
Vandevijvere et al. 2018c Stefanie Vandevijvere, Kadture A, Sally Mackay, Boyd Swinburn (1)	1 Dept of Epidemiology and Biostatistics, School of Population Health, University of Auckland	Committing to health: food company policies for healthier food environments	Some NZ food companies are performing well and are meeting good practice benchmarks, including:	Survey

Author name (First Surname), Year	Author affiliation/institution	Title of publication	Key findings and policy recommendations	Type of study
			• All sectors: Incorporating population nutrition and/or obesity prevention into the overarching corporate strategy to some extent • Food and non-alcoholic beverage manufacturers and supermarkets: Reformulating products to reduce levels of sodium; Having some existing targets to reduce sugar in specific food categories; Committing to implement the Health Star Ratings on food products; Committing to comply with the Advertising Standards Authority Children and Young People's Advertising Code • Quick Service Restaurants: Providing nutrition information online.	
Wilson et al. 2016 Nick Wilson (1), Nhung Nghiem (1), Helen Eyles (2), Cliona Ni Mhurchu (3), Emma Shields (4), Linda J. Cobiac (5), Christine L. Cleghorn (1) and Tony Blakely (1)	1 Department of Public Health, Burden of Disease Epidemiology, Equity and Cost Effectiveness Programme, University of Otago. 2 National Institute for Health Innovation and Department of Epidemiology and Biostatistics, University of Auckland. 3 National Institute for Health Innovation, University of Auckland. 4 University of Auckland. 5 British Heart Foundation Centre on Population Approaches to NCD Prevention, Oxford University	Modelling health gains and cost savings for ten dietary salt reduction targets	Implementation of mandatory maximum levels of sodium in packaged foods and reducing sodium in fast foods/restaurant food could reduce overall dietary salt intake by 35%. All ten target interventions studied were cost-saving, with the greatest costs saved for the mandatory 'full target'. These interventions may also be pro-equity by achieving greater health gains per adult for men and for Māori.	Modelling
Wilson et al. 2018 Nick Wilson; Amanda C. Jones; Nhung Nghiem; Tony Blakely (1)	1 Department of Public Health, Otago University	Preventing cardiovascular disease in New Zealand: making better use of statins but also tobacco control, changing the food supply and other strategies	New Zealand probably needs to do more work to increase statin use among those at increased CVD risk. There seems to be a need to explore various options such as fixed-dose combination pills, polypills, behind-the-counter dispensing and six-month prescriptions. But there is also a strong case for the New Zealand Government to do more population-level CVD prevention via adopting policies to advance tobacco control, improve the nutrition environment (eg, particularly around sodium and saturated fat), improving alcohol control and making walking and cycling easier.	Secondary analysis / Viewpoint

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