Current and future trends in chronic disease prevention research

Thematic analysis of grey and scientific literature

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Executive summary

This report identifies and summarises the current and future trends in chronic disease prevention research in Australia and globally. A literature review was conducted to capture a broad view of the current research landscape in prevention, including both grey literature (policy and government documents and reports) and peer-reviewed literature (scientific publications). An iterative process of thematic analysis was used to identify and map the main topics and themes in the literature. The review questions were:

1. What are the current trends, major themes and topics of chronic disease prevention research in Australia and globally?
2. What are the thematic synergies across the scientific and grey literature?
3. What are the future trends anticipated for chronic disease prevention research?

Grey and peer-reviewed literature published between 2014 and 2019 was reviewed. Search terms included:

- Noncommunicable and chronic diseases and their risk factors and determinants
- Prevention, including primary prevention, policy, and public health
- Discussion of trends, predictions, priorities and challenges.

There were 147 publications included for analysis, 102 scientific publications and 45 grey literature publications. Across these publications we identified 26 topics as representing current trends in prevention research. Of these 26 topics, 18 were grouped into five major themes (with the remaining eight topics listed separately):

- Food production and consumption (n = 4)
- Place and spaces (n = 4)
- Environment and health (n = 3)
- Expanded determinants of health (n = 4)
- Personalised prevention (n = 3)
- Other (n = 8).

These themes and topics indicate important trends and opportunities for the future of prevention research. The review suggests a broadening of the scope and scale of prevention, seen through an increasing emphasis on multi-disciplinary and multi-sectoral collaboration for more effective and policy-relevant prevention research that moves beyond ‘silos’ in academia, government and sectors.

These trends reflect the growing use of systems thinking at local, national and global levels, including the application of systems methods and tools in prevention research. Moving from the ‘what’ to the ‘how’ for effective prevention is another core area for the future of prevention research. This includes developments in implementation and evaluation, and how to best utilise new technological opportunities such as linked data, digital health platforms and advances in precision medicine.

There are challenges for prevention research going forward, including new methodological questions for evidence generation in prevention, operationalising systems transformation, developing partnerships with non-health sectors, persistent structural and systemic inequities in health, and the politically contested nature of prevention. These trends, opportunities and challenges have implications for prevention research in terms of priorities, methods, translation and funding. This demonstrates the need for prevention researchers and policy makers to engage within these parameters and help build the evidence, knowledge, skills and actions required for effective prevention of chronic disease in the 2020s and beyond.
Introduction

Report aims and structure

This report was prepared by The Australian Prevention Partnership Centre to support the development of the next phase of the Prevention Centre’s program of research.

This report was envisaged as a discussion paper and conversation starter to inform internal and external dialogue about the future research agenda for the Prevention Centre and, more broadly, for prevention research in Australia. It is structured in a way similar to a scientific paper, with an introduction, methods section, results, discussion and conclusion.

This report identifies and summarises the current and future trends in chronic disease prevention research in Australia and globally, including both grey literature (policy and government documents and reports) and peer-reviewed literature (scientific publications).

This report is guided by three questions:

1. What are the current trends, major themes and topics of chronic disease prevention research in Australia and globally?
2. What are the thematic synergies across the scientific and grey literature?
3. What are the future trends anticipated for chronic disease prevention research?

This report is influenced by the current Australian context for prevention policy and research. However, it draws on scientific and grey literature from both an Australian and an international perspective.

About The Australian Prevention Partnership Centre

The Australian Prevention Partnership Centre (the Prevention Centre) was established in 2013 by Australia’s National Health and Medical Research Council (NHMRC) as a national collaboration between leading academics, policy makers and practitioners in the area of lifestyle-related chronic disease prevention.

The Prevention Centre has built an effective, efficient and equitable system to prevent lifestyle-related chronic disease, using a partnership model of research underpinned by a systems approach to prevention. The Prevention Centre uses a variety of methods and strategies in prevention research, including knowledge mobilisation, co-production, dynamic simulation modelling, implementation science, rapid evaluation, health impact assessment, complex systems mapping, and network analysis.

The Prevention Centre takes a systems approach to prevention of lifestyle-related chronic disease. This approach recognises that chronic diseases and their risk factors are complex, dynamic and have a web of interconnected elements.

Our program of research focuses on the key risk factors and determinants that cause or contribute to chronic disease including but is not limited to physical inactivity, diet and food systems, tobacco use, screening uptake, alcohol consumption, and overweight and obesity. Behavioural and biomedical risk factors as well as broader social, economic and environmental determinants of health are considered in our current program of research. The Prevention Centre also includes in its current program, research in the areas of mental health, dementia, and chronic pain.

The burden of chronic disease

Chronic, noncommunicable diseases (NCDs) include heart disease (cardiovascular disease), stroke, cancer, diabetes, and chronic respiratory conditions and diseases. Chronic disease is a significant contributor to poor health, accounting for 73.4% of deaths globally.
Chronic disease is causally linked with four key behavioural risk factors: tobacco use; harmful use of alcohol; unhealthy diet; and physical inactivity. These behavioural risk factors lead to metabolic and biological risk factors for chronic disease: high blood pressure; high blood plasma glucose; and high body mass index (BMI). Another key risk factor for chronic disease includes environmental risk factors such as air pollution.

While the risk of premature death due to chronic disease has reduced in recent years in Australia, chronic disease and conditions are responsible for 87% of all deaths and cause most of the burden of disease, accounting for a significant reduction in quality of life for Australians. The top five risk factors contributing most to the burden of chronic disease in Australia are tobacco use, overweight and obesity, poor diet, high blood pressure, and high blood plasma glucose.

Chronic diseases also have differential impacts for some population groups, including low socioeconomic status groups, Aboriginal and Torres Strait Islander people, and rural and remote Australians; these groups tend to have higher levels of chronic disease which contributes to major inequities in health.

Chronic diseases are costly and highly prevalent in Australia and worldwide, making prevention a public health priority. A third of the chronic disease burden in Australia is preventable. Prevention can also improve the health of people with existing chronic conditions, supporting them to have improved quality of life.

In addition to the population level impact and health inequities, chronic diseases have a high cost burden for individuals, governments and society, with the economic cost of poor health negatively impacting on individuals, the healthcare sector, business, and the productivity of other public and private sectors.

The Australian health system faces numerous challenges in striking a balance between investment in prevention and the escalating demand for health services, particularly for more complex care needs in an ageing population and the persistence of health inequities. Many of these challenges are not unique to Australia, however they help contextualise our prevention landscape amidst the wider health system.

**Definitions**

In this report, we focus primarily on the grey and scientific literature of primordial and primary prevention of lifestyle-related chronic diseases. This report is guided by the World Health Organization’s first Global Action Plan for the Prevention and Control of NCDs 2013–2020 which focuses on the four major chronic disease conditions – cardiovascular diseases, cancer, diabetes and chronic respiratory diseases – and their associated risk factors.

We use the terms ‘chronic disease’ and ‘noncommunicable disease’ (NCD) to mean the same thing; the former is used more frequently in Australia while NCD is a term more used internationally, such as by multilateral organisations like the World Health Organization.

We have defined ‘prevention’ as any action taken to protect, promote and sustain the health of the population. Prevention aims to decrease the risk, chance or likelihood of an individual experiencing a disease or condition. Prevention is often categorised into three levels: primary, secondary and tertiary. While a fourth level of prevention – primordial prevention – is sometimes included, this is more often incorporated into primary prevention (Table 1).

<table>
<thead>
<tr>
<th>Level of prevention</th>
<th>Definition</th>
<th>Examples in chronic disease prevention</th>
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| Primordial          | Supporting social and environmental conditions that promote good health and minimise hazards and risks to health | • Plain packaging and taxation of tobacco products  
• Air pollution laws  
• Cycling and walking paths to encourage active travel  
• Healthy canteen programs and guidelines in schools  
• Occupational (workplace) health and safety measures |
<table>
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<tr>
<th>Level of prevention</th>
<th>Definition</th>
<th>Examples in chronic disease prevention</th>
</tr>
</thead>
</table>
| **Primary**         | Taking action and intervening before health effects and disease have occurred. This includes reducing risk in the whole population as well as addressing risk in higher risk groups and individuals. | • HPV vaccination (immunisation)  
• Healthy eating and physical activity guidelines  
• Social marketing and mass media campaigns for obesity prevention  
• Breastfeeding promotion |
| **Secondary**       | Identifying and responding to disease through early detection and intervention, including in individuals with no symptoms but who may already have the disease or who are at very high risk. | • Bowel, breast and cervical cancer screening  
• Heart disease risk assessment and medication in high-risk groups  
• Cessation (quit) programs and support for smokers |
| **Tertiary**        | Managing existing disease to prevent further disease progression and to minimise complications and impact on health. | • Diabetes control programs  
• Chronic disease management plans in primary care |

We also note there are important areas of research that are part of the prevention landscape, including mental health and suicide prevention, dementia, chronic pain, drug use (outside of tobacco and alcohol) and injury prevention. We do note ongoing discussions about the need for inclusion of mental health within chronic disease prevention and its relevance to other risk factors and determinants. However, the identified areas have their own extensive body of literature and were outside the scope of this report.
Review methods

Literature search

A literature review, as defined by Grant et al.\textsuperscript{13}, was conducted between August and December 2019 to identify grey and peer-reviewed literature published between 2014 and 2019 that was relevant to the research questions. The agreed area of interest for this project was a focus on the current trends and future directions of lifestyle-related chronic disease prevention.

The search aimed to find grey and peer-reviewed literature that discussed and reported on:

- Lifestyle-related chronic diseases or conditions, or their major risk factors
- Prevention, including but not limited to primordial, primary, secondary or tertiary prevention
- Policy, health promotion, economics, social determinants of health
- Future, health priorities, forecasting, or trends.

Due to the nature of the research questions, several search terms were identified by the research team before commencement.

Databases searched were Ovid Medline, Scopus, Google and Google Scholar. Manual searching and snowballing was also employed by members of the research term. Examples of more detailed search terms can be found in Appendix A.

Two members of the research team searched, identified, extracted and analysed the grey and scientific literature from the identified databases. Titles and abstracts were first screened for relevance, followed by full text screening.

Inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Inclusion</th>
<th>Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period</td>
<td>Published between January 2014–December 2019</td>
<td>Pre-2014</td>
</tr>
<tr>
<td>Language</td>
<td>Published in English</td>
<td>Published in a language other than English</td>
</tr>
<tr>
<td>Type of publication</td>
<td>Published in peer-reviewed journals (including original research, reviews, commentary) or grey literature publication (including reports and summary statements) from a reputable source, including national and international government bodies or multilateral organisations.</td>
<td>Blog posts or commentary pieces published by media outlets; books</td>
</tr>
<tr>
<td>Criterion</td>
<td>Inclusion</td>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Primary focus</td>
<td>Primary focus of publication was prevention of lifestyle-related chronic diseases or conditions, and/or their risk factors, including: Diet / food / nutrition / food systems, Physical (in)activity / sedentary behaviour / built environment, Obesity / overweight / high BMI, Tobacco / smoking, Alcohol, High blood pressure, High cholesterol, Air pollution.</td>
<td>Communicable or infectious diseases and their risk factors (unless clearly linked to prevention of chronic disease), Mental ill health, suicide prevention, dementia, chronic pain, injury prevention, drug use.</td>
</tr>
<tr>
<td>Additional focus</td>
<td>An additional focus of the publication could relate to any other aspect of prevention, such as preventive health or medicine; health promotion; community health; public health; health policy; other areas of health including: Ecological, environmental or planetary, Commercial or corporate, Digital, e-health or m-health, Legal, Social or cultural, Economic, Urban, Global. Publication may also include discussion of trends, projections, forecasts, future, drivers, emerging priorities, challenges, and predictions.</td>
<td>Treatment and management, including healthcare and healthcare services, unless clearly linked to secondary or tertiary prevention of chronic disease.</td>
</tr>
<tr>
<td>Additional criteria</td>
<td>Publications were included if they discussed prevention in a global sense or discussed case studies in prevention research or policy (or their application) in a specific country.</td>
<td>Publications limited to discussing specific countries.</td>
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**Data analysis**

A search of the literature was conducted by two members of the research team, followed by an iterative, inductive process of qualitative thematic analysis to identify recurring topics and broad themes in the grey and scientific literature. Two members of the research team discussed which literature met the established criteria and which items should be included and excluded in the review. The authors discussed and prioritised topics that were consistent with the research aims across both the grey and scientific literature. Finally, the topics were categorised into five major themes, which formed the core structure for the reported findings.
Results

A total of 147 publications, (grey literature publications, n=45; scientific publications n=102) was identified and included for thematic analysis.

Types of publications

Grey literature comprises reports, research reports, strategic plans, frameworks, guidelines and green papers published by government agencies or departments, intergovernmental partnerships and multilateral agencies (such as the World Health Organization and the United Nations), non-governmental organisations, research groups and institutions, policy think tanks, and private sector and business consultancies. Most of the grey literature comes from Australia, the United Kingdom (UK) and the European Union or has an international focus.

In the scientific literature, types of publications include commentary pieces and editorials, original research articles, reviews, lectures, and essays. The introductions to five Lancet commissions and five series (four from the Lancet and one from the BMJ) are also included. The majority of the scientific literature reflects an international or global focus, though 11 focus on the USA or Canada and four on the UK.

Major themes and topics

Twenty-six topics were identified across the grey and scientific literature (Appendix B). During analysis, 18 of these topics were arranged into five major themes (Figure 1) which represent the main thematic synergies identified across the grey and scientific literature. The remaining eight topics are discussed separately to these major themes.

Figure 1: Major themes of prevention research
Frequency of topics occurring was also calculated based on this thematic analysis. **Figure 2** shows the frequency of topics in both the grey and scientific literature.

![Proportional frequency of topics in the grey and scientific literature](image)

**Figure 2**: Proportional frequency of topics in the grey and scientific literature
Food production and consumption

A major theme identified for chronic disease prevention was food production and consumption. Poor diet is a significant contribution to the burden of chronic disease, with one in five adult deaths globally due to suboptimal diets.14 The topics identified as part of this theme are interrelated with food production and consumption, though each topic takes a different focus or perspective and the relationship to chronic disease prevention.

Food systems

The prevention literature indicates that the present nature of global food systems poses one of the greatest risks to human health.15,16 The current food system is seen as failing to promote health given the problems caused by chronic disease and the growing challenge of ‘malnutrition in all its forms’ (both overnutrition and undernutrition). The food sector is also highlighted as a major contributor of greenhouse gas emissions; these emissions are projected to increase by 40% by 2050 without substantial changes in food production, consumption and waste.17

Researchers and policy makers alike recognise that current food, agriculture and trade policies, devised to ensure quantity, accessibility and acceptability of food, have led to serious health problems including chronic disease.14,18,19 Current food systems support food that is inefficiently and unsustainably produced, unequally distributed and with high levels of wastage.15,20 Both the grey and scientific literature reflect the need for fundamental change across the whole food system. For example, linking food security and nutrition with environmental sustainability to improve the quality of diets, reduce the burden of malnutrition and diet-related chronic conditions and meet the Sustainable Development Goals (SDGs) by 2030.16,18,21,22

A systems approach to food looks at how different components of the system are functioning collectively to support or hinder health.19 This approach draws attention to the fragmented sectors of agriculture, food production and retail, trade, economics, public health and environment.23 Food systems that do not promote health have often been linked with climate change.15,19,24 This is exemplified by the recent EAT-Lancet commission report which takes a systems approach to food, diet, health and the environment.16,25 Common recommendations from a systems approach to food include aligning these sectors with a shared goal of transitioning towards healthier, sustainable diets. It calls for a more integrated policy approach, including cross-government and multi-sectoral collaboration, and reshaping the food system, with benefits for chronic disease prevention.

Agriculture

Agriculture is a major area outside of the health sector that is important to engage with in terms of research and policy for chronic disease prevention. Multidisciplinary research has brought together environmental scientists and nutritionists to research the development of more sustainable food and agricultural practices and measure impact on diet, such as how to grow sufficient healthy food within planetary boundaries.26 Refocusing agriculture and food systems towards more healthy foods is also seen as a priority ‘double-duty’ action that addresses two health issues at once, undernutrition and overnutrition.27

The Lancet’s Global Syndemic report indicates current agricultural production is unsustainable and is depleting the environment beyond repair, with significant consequences for health.21 A separate study found that the agriculture and livestock sector accounts for approximately a quarter (24%) of global greenhouse gas emissions.23,28 Around 40% of the world’s agricultural land is degraded and the diversity of crops is decreasing, with implications for the diversity of our diets.15 Meanwhile, one-third of all food produced is wasted, accounting for 8% of greenhouse gas emissions, and yet the world is producing 22% less of the fruit and vegetables needed to meet nutritional recommendations.15 This suggests current agricultural practices are unsustainable both economically and environmentally, with a major impact on health.

Current findings suggest some of the greatest gains for chronic disease prevention and improved diet may be obtained through interventions in the agriculture sector. For example, reducing production of meat and dairy and reducing food waste16,23, and introducing more sustainable agricultural production measures.21,29 Reducing livestock production and halving consumption of animal-source foods could result in a 15% reduction in disease burden due to reduced consumption of saturated fats and associated heart disease, in addition to a 25% reduction in greenhouse gas emissions.21,10 The benefits would reduce and prevent chronic disease as well as lower emissions.21,28
Diet and nutrition

The topic of diet and nutrition was regularly identified through the process of thematic analysis, particularly in the scientific literature. It reflects a great deal of interest in dietary interventions for chronic disease prevention. Unhealthy diets are now the leading preventable risk factor for chronic disease and the greatest contributor to morbidity and mortality in Australia and globally.19 The literature cites a number of contributors to poor diet, including changing consumption patterns, urbanisation and globalisation, and changing dietary preferences.14,15,19

A criticism of current approaches to nutritional research is the focus on single micronutrients, macronutrients or specific foods, which has led to food and nutrition policies and interventions that have too narrow a focus.20 Current trends in nutritional research instead focuses on eating patterns for the promotion of health and prevention of chronic disease.31-33 For example, the National Committee for Nutrition20 emphasises the need for a more holistic approach to diet. This is also echoed by the EAT-Lancet commission that argues for planetary and ecological boundaries to be considered in the development of healthy eating guides.16

Other major developments in diet and nutrition have focused on economic, legal and commercial determinants of diet, and strategies that take a multicomponent view of food policies and environments. For example, the influence of trade regulations and laws which promote or hinder actions to achieve healthier diets.18,34-37 This may reflect a changing global context in terms of interventions to promote healthier diets given the introduction of sugar-sweetened beverage taxes in more than thirty countries within the last five years.37 Some scientific publications also include the development of evidence-based frameworks to promote healthier diets.16,38

Malnutrition in all its forms

The challenge of malnutrition in all forms – undernutrition and overnutrition – is a significant topic in prevention literature, which is linked with drivers such as food insecurity.

For many countries, including Australia, obesity is a major focus for government agencies, non-government organisations and research institutions alike. Obesity and overweight are complex issues caused by multiple factors. Obesity now affects all countries worldwide and no country has successfully reversed its trends in obesity.38 However, some have noted that dietary and epidemiological transitions are contributing to a ‘double burden’ of both undernutrition and overnutrition, particularly in low and middle-income countries. This was a focus of a recent Lancet series led by the WHO which promoted a number of ‘double-duty actions’27 and ‘multi-stakeholder actions’14 to simultaneously address undernutrition, overnutrition and food insecurity.

Addressing malnutrition in all its forms is discussed in the grey literature as a top policy priority to accelerate progress towards chronic disease prevention. A focus on early childhood for obesity prevention is also a priority in the grey and scientific literature. This is likely due to the WHO setting global targets to halt the rise in obesity39,40 and national governments setting further targets to halve childhood obesity rates by 2030.41 Prevention strategies for childhood obesity include improving population nutrition and promoting physical activity through school-based interventions and regulatory, fiscal and marketing policies.41,42 Yet effective and sustained prevention efforts are slow, and there remains the challenge of translating evidence into policy.21 The grey literature also discusses food insecurity and its impact on malnutrition in all its forms, particularly in disadvantaged and Aboriginal and Torres Strait Islander communities in Australia.20 This is important given moderate food insecurity is associated with higher obesity prevalence.21
**Place and spaces**

Prevention research has focused on how the physical environment – the place and spaces of individuals and communities – affects chronic diseases and associated risk factors and determinants.\(^{21,23,24,43,44}\) It suggests complex associations between urban design, planning and infrastructure; access to green space; and transport infrastructure and policy.\(^{5,45,46}\) The literature also suggests possible co-benefits for other public policy priorities, such as carbon emissions and traffic congestion. Such ‘double duty’ and ‘triple duty’ actions are seen to represent important opportunities for chronic disease prevention.

**Physical activity**

Physical activity is a major topic relevant to place and spaces, though it is noted that physical activity research is not limited only to this area. Lack of physical activity is a major risk factor for chronic disease and is an ongoing focus of prevention research. The emphasis of this research is on population-based strategies, particularly strategies targeting the physical environment such as the built environment, urban planning and active transport.

Of particular interest to researchers is the notion of ‘double duty’ actions to increase physical activity levels for health while also achieving other benefits, such as carbon emissions reduction and other societal or community benefits.\(^{47}\) This includes ‘active-friendly environments’ that have a range of co-benefits for health and the environment.\(^{48}\)

However, despite robust evidence on how to address physical inactivity, there is an evidence-policy gap, with few grey literature publications looking specifically at physical activity as a risk factor, and few frameworks or guidelines. One exception was the release of the WHO **Global action plan on physical activity 2018–2030: More active people for a healthier world** which takes a systems approach, focusing particularly on built environment and cities.\(^{49}\)

Some possible unintended consequences of promoting physical activity and active transport in urbanised settings were also raised in the literature, such as the impact of air pollution, though the long-term benefits of physical activity may outweigh the risks associated with short-term exposure to air pollution.\(^{50}\)

**Built environment**

The health impact of the built environment reflects a shift towards population-level strategies and approaches for physical activity and chronic disease prevention. Many of the peer-reviewed publications that looked at physical activity also discussed the built environment as important for chronic disease prevention.\(^{51,52}\)

The built environment, including access to green space, tree canopy, active-friendly buildings and active transport routes, has a major impact on how easy it is for people to participate in physical activity. Some discussed the built environment as a primary cause of ‘missing NCDs’ like air pollution and physical inactivity, which were often overlooked in chronic disease prevention.\(^{53}\)

A challenge for prevention research is quantifying the impact of the built environment on physical activity levels and other health behaviours. Multi-sectoral research that works with sectors outside of health and engages communities in the design of local programs or policies is needed. This is an important opportunity for prevention research going forward.\(^{29}\)

**Urban health and cities**

Linked with the built environment was the topic of urban health and cities, an important area given the vast increases in urban populations both worldwide and in Australia.\(^{44,45,44}\) Urban health and behaviours are therefore likely to be areas of interest for researchers and policy makers going forward.\(^{54}\)

The challenges of chronic disease prevention and increasing urbanisation were discussed in several ways. Urban sprawl was noted for increasing the risk for chronic disease through reduced physical activity while also exacerbating heat island effects, thus increasing heat-related illness and mortality.\(^{55}\) Likewise, noise stress in cities contributes to chronic diseases including hypertension, cardiovascular disease, and has negative effects on mental health through anxiety and sleep disturbance.\(^{24}\) As a consequence, healthy urban planning and liveability represent an important area for future prevention policy and research to alleviate the direct and indirect effects of urban
environments on health. This is particularly the case in low and middle-income countries and ‘mega-countries’ (countries with over 100 million people).

While there is some research on how specific features of urban environments contribute to chronic disease risk factors, more research is needed into the types of urban planning policies and physical designs of cities that could help reduce risk through increasing physical activity, reducing air pollution and minimising heat island effects. The challenges for prevention research include measuring the benefit and impact of healthy urban planning policies, and combining investments from different areas.

Urban policy goals for productive, sustainable, liveable and socially inclusive cities can also serve as important catalysts to improve health and advance climate change mitigation. Healthy urban planning has been identified as a priority area for action in both prevention and climate change. New models of engagement may therefore be needed between researchers, policy makers and other sectors in order to achieve feasible, acceptable and equitable solutions for healthier urban planning.

**Transport**

Current research shows transport systems have developed in unsustainable ways that impact on population health, as seen by the increase in motor traffic and injuries, and a reduction in active travel modes such as walking and cycling.

In Australian cities, driving remains the preferred means of transport and accounts for 80% of travel, while only one in eight people use public transport for daily commuting. The scientific literature has tended to link transport systems with climate change, highlighting how poorly designed cities contribute to global environmental changes and further exacerbate chronic disease risk. It suggests that increasing active transport and reducing car use are important actions that can address both chronic disease and climate change. Commitments to the SDGs are also frequently discussed in government and policy reports as a means to simultaneously drive forward the prevention and climate action agendas through increasing access to public and active transport.

Transport interventions are an area of chronic disease prevention that involves multisectoral and cross-sectoral engagement and collaborations. In the scientific literature, there are examples of such collaborations in Canada. However, it has also been identified that transport policies and interventions will need to strike a delicate balance of promoting and facilitating physical activity while accounting for potential harms from exposure to urban air pollution and rising temperatures.

There are gaps in knowledge about the potential incentives and policy levers that support more public and active transport infrastructure while also creating demand for such infrastructure. More research is needed to consider the different mixes of transport investment and the resulting benefits to physical activity and air pollution.
Environment and health

An emerging theme for chronic disease prevention is linking the environment (the ecological system or natural world) with human health. Some literature suggests that the increasing prevalence of chronic disease is associated with global environmental shifts such as climate change, with clear opportunities to bring prevention together with environmental health. There was also interest in the environmental impact of chronic disease and the health system.

Air pollution

Global exposure to air pollution causes an estimated 7 million deaths a year. Increasing levels of air pollution and poorer air quality will result in higher rates of chronic diseases including chronic obstructive pulmonary disease, lung cancer, ischaemic heart disease and stroke as well as other chronic conditions including asthma. Urban populations are particularly susceptible to poor air quality – 90% of people living in urban areas were breathing air that did not meet the WHO air quality guidelines for particulate matter.

Air pollution is identified in the grey literature as a priority area for prevention, particularly for cardiovascular disease and respiratory diseases. The importance of air pollution to public health and prevention is also indicated by the growing number of government bodies that now report on the disease burden attributable to air pollution, including the Australian Institute of Health and Welfare. Public Health England has also included similar evidence, showing that reducing air pollution in the UK over the next two decades could prevent a significant proportion of the burden of chronic disease.

Research highlights the complexities of air pollution as both a cause of climate change and caused by climate change, which requires a systems approach. A systems approach to air pollution identifies the underlying causes as the energy sources running our transportation, food production, industry and electricity generation systems. Air pollution and other environmental risk factors for chronic disease require multisectoral leadership and intervention in sectors outside of health.

However, there has been criticism of bodies like WHO for the limited attention on chronic respiratory diseases and air pollution. Many researchers and advocates have termed respiratory diseases and conditions as the ‘missing’ chronic diseases due to their lack of attention in major policy documents and frameworks such as the Global Action Plan for the Prevention and Control of NCDs 2013–2020. Environmental epidemiologists and researchers point to pollution being a major environmental health hazard that contributes to chronic disease which is worsening over time, yet public health evidence is not being translated into policy action. There are significant gaps of high quality epidemiological evidence that demonstrate the full dose-response curve for air pollution and impact on human health.

Planetary health

Planetary health is an inter and multi-disciplinary emergency area in public health. It is defined as ‘the health of human civilisation and the state of the natural systems on which it depends’; this is a concept put forth in 2015 by the Rockefeller Foundation-Lancet Commission on planetary health.

This newer area of research has been highlighted as providing important opportunities for chronic disease prevention. It suggests a broadening of the scope of prevention research that supports a whole-of-system approach, with particular focus on healthy food systems within ‘planetary’ or ecological boundaries of the Earth’s natural environment.

Planetary health is also seen as providing a public health perspective on climate change, defined as ‘preventive medicine for the planet and its peoples’. It is about identifying the true health and environmental costs of particular actions or policies; new health threats mean a new science and a shift in thinking are needed, with a particular focus on determining the co-benefits of these actions.

While a report from The Academy of Medical Sciences discusses planetary health, most policy documents and government reports have yet to take up this terminology, perhaps suggesting it is currently more of an academic term. However, some have noted that the SDGs represent an opportunity to integrate planetary and human health.
to simultaneously address the core drivers of poor human and environmental health.43,79 This suggests that planetary health as a concept is being used in the grey literature but perhaps less explicitly than in the scientific literature.

Climate change

Linked with the concept of planetary health for prevention is the issue of climate change. In the past few years, researchers have demonstrated interest in the health impacts of climate change and the common causal pathways through which global environmental changes are also driving chronic disease.80

Climate change poses severe risks to global health and is widely regarded as the defining health issue for the 21st century by the WHO, government agencies, intergovernmental panels and research institutions alike.23,43,45 A growing international body of evidence explores the direct and indirect effects of climate change, which increases risk factors for chronic disease.

Direct effects include increased temperatures leading to heat stress and higher incidence of cardiovascular and respiratory disease, air pollution, water shortage, biodiversity loss and increased ultraviolet radiation.24,28,58,65 Changing weather patterns and water scarcity will cause crop failures and disrupted food production, leading to increases in food insecurity, particularly among vulnerable population groups.19,24,28,65 There is also concern about the mental health impacts of climate change due to increasing levels of stress, depression and anxiety associated with extreme weather events, heat and reduced physical activity levels.45,56,81

Research indicates there is overlap for both chronic disease and climate change, with a range of interventions that capture the health co-benefits of climate action.24,82 Three main areas in the scientific literature reflect an alignment between climate change and the prevention agenda: a transition to lower carbon renewable energy systems23,24, improved urban planning to create greener and more walkable cities44,46-48,83; and transitioning toward healthier, sustainable and lower-carbon diets.21,28,84

These interventions for chronic disease prevention could have health, economic and environmental benefits.56 Health benefits (such as reduced air pollution) from climate mitigation policies have been estimated to offset the cost of implementation of climate policies by up to 10 times.85 However, greater understanding of the effectiveness of interventions aimed at addressing health and climate change is needed.58 The literature in this area also points to the need for research including cost-benefit and cost-effectiveness analyses of climate change mitigation measures and policies to help demonstrate the full range of direct and indirect consequences for health.56
Expanded determinants of health

Twelve years on from the WHO Commission on the Social Determinants of Health, addressing health equity remains a priority area for chronic disease prevention. However, this report identified new ways of understanding and defining the determinants of health, with a number of expanded categories in addition to the social determinants of health. These expanded determinants consider broader socioeconomic and political structures and systems that drive risk factors and behaviours, such as commercial and corporate arrangements, economic and fiscal structures, and laws and regulations.

Social determinants

A large proportion of the peer-reviewed literature refers to the ongoing challenges for chronic disease prevention due to the social determinants of health and health inequities. Chronic diseases are a substantial human and economic cost nationally and globally, with social determinants of health exacerbating chronic disease and inequality. Poverty is seen as a major barrier to progress in prevention, with lower socioeconomic groups consistently showing a higher incidence of chronic disease.

Some prevention researchers have demonstrated the most effective interventions for promoting population health and reducing chronic disease are those which seek to reduce social disparities and inequalities. Implicit in current prevention research, particularly at a global level, is a critique of the ‘medicalisation’ of chronic disease. Researchers and advocates argue these diseases need a whole of society approach beyond access to medicines and treatment, such as focusing on addressing the ‘causes of the causes’ of chronic disease. A comprehensive, evidence-based strategy to address chronic disease therefore requires moving beyond singular, individualised risk factors that are behavioural in nature; instead the focus is the complex structures driving poor health. This includes allocating resources to those most at risk.

Addressing health inequities was a consistent theme in the grey literature. While it was often conceptualised as a key priority for current health policy and prevention efforts, a major challenge was identified in striking a balance between maintaining and improving population-level health gains while also targeting disadvantaged and high-risk groups experiencing significant health inequities.

In Australia, these inequities disproportionately affect certain groups, including those living in rural and remote areas and Aboriginal and Torres Strait Islander people, who have poorer access to health care and preventive services and face an inequitable burden of chronic disease risk factors and outcomes. Inequities are exacerbated by co-morbidities in chronic disease, including poor mental health.

Commercial and corporate determinants

One of the expanded determinants of health appearing in the prevention literature is the commercial or corporate determinants of health. This area of research looks specifically at the strategies and actions of the private sector in manufacturing, selling and promoting products with negative health consequences that increase the risk of chronic disease.

Researchers argue the commercial drivers of ill health must be addressed as chronic disease are a ‘profit-driven epidemic’. The commercial determinants literature focuses primarily on products such as tobacco, alcohol and...
junk food. Researchers have also highlighted evidence that trade rules are being used to undermine public health regulations for harmful products.36,96

A growing area of prevention research focuses specifically on private industry influencing and obstructing health-promoting policy mechanisms.21 Some have argued that private industry influence in chronic disease prevention requires more effective policies and guidance for managing conflicts of interest.35 While products such as tobacco have international frameworks such as the WHO Framework Convention on Tobacco Control driving rules of engagement with industry, there is no equivalent framework for companies manufacturing and selling products like alcohol or ultra-processed food and drink. The vested interests of commercial, globalised entities and lack of appropriate regulations are thus seen as major barriers for effective chronic disease prevention.74,97

While much of the prevention literature discusses the negative implications of the commercial determinants of health, some argue for a degree of careful private sector engagement in order to generate effective solutions for chronic disease prevention.97-99 Examples given include the creation of health-promoting business models and markets that simultaneously advance public health aims and economic growth.45,87,94

Some have identified this as a ‘healthy growth strategy’, particularly for food systems and obesity prevention.100 Encouraging the development of health-enhancing products (for example, foods lower in added sugars, salt and saturated fats) is seen as an important area for prevention policy going forward. In this way, the commercial sector could play a major role in shaping health outcomes in positive ways by aligning their strategies with health and societal goals.101

However, given the often competing interests of the commercial sector and preventive health, guidance and research on effective mechanisms for collaboration and synergistic action is urgently needed, including clear guidelines and stronger monitoring of commercial industry practices.45,99

Economic determinants

An aspect of the prevention literature focuses on what we have defined as the economic or ‘fiscal’ determinants of health. This includes the structures and systems driving consumption and health behaviours such as pricing and taxation of products. Prevention researchers and policy makers have focused on economic and fiscal measures to influence health behaviours and support reinvestment in chronic disease prevention.37,102,103

Examples of interventions for chronic disease prevention that address these economic or fiscal determinants of health include taxes on harmful products to reduce unhealthy consumption of tobacco, alcohol, and sugar-sweetened beverages.104 For example, raising taxes on tobacco could do more to reduce premature mortality than any other single health policy.105 The WHO ‘Best Buys’106 policy framework was released in 2017, offering a menu of the most cost-effective policy options targeting the four key chronic disease risk factors (tobacco use, harmful use of alcohol, unhealthy diet and physical inactivity). However, there is concern most countries may not be taxing these products at high enough thresholds to significantly discourage consumption.105

Other economic and fiscal determinants identified in the literature include agriculture and food production subsidies. Priority fiscal actions to address obesity and chronic disease include redirecting subsidies toward the production of healthier foods, and toward renewable energy in place of fossil fuels.21

The interest in exploring and responding to the economic determinants of health has also resulted in a growing evidence base, helped by the recent implementation of sugar-sweetened beverage taxes around the globe. These natural experiments allow for real-world monitoring and evaluation of fiscal interventions for chronic disease prevention.37

There is also interest in ‘behavioural economics’ or ‘nudge’ approaches to chronic disease prevention. While not always directly addressing economic or fiscal behaviours of individuals, these may use economic incentives and discounting to influence people’s decision-making. However, the quality of evidence of their use in chronic disease prevention is poor and there are major evidence gaps for different chronic disease risk factors.107
Legal determinants

Another expanded determinant identified in the literature are the ‘legal’ determinants of health, as exemplified by The Lancet commission in 2019 titled ‘The legal determinants of health: harnessing the power of the law for global health and sustainable development’.34

Public health experts and researchers have argued that though the law is poorly applied and understood in terms of chronic disease, laws and regulations provide huge potential in terms of advancing population health and equity.34 For example, risk factors such as obesity require better regulatory actions by governments to change food environments and systems.36,100 This area also suggests that public health professionals need a range of skills to address chronic disease, including the ability to work with regulatory and legal mechanisms and structures.108

In the literature, two key areas were identified that represent important opportunities for prevention using the legal determinants of health: a human rights approach to prevention; and analysing and developing effective trade laws and regulations. Some policy documents take a human rights approach as a means to protect socially disadvantaged populations and drive forward the chronic disease prevention agenda.87

The human rights approach or ‘right to health’ framing is also reflected in the peer-reviewed literature on chronic disease prevention.109-111 More recently this has been used in terms of the ‘right to good food’.112 In comparison, while trade and investment agreements are viewed as important for implementing health-protective interventions, this is mostly in the peer-reviewed literature rather than in the grey literature. Interventions for chronic disease prevention require more research and analysis of the implications of trade policies and laws for population health.18,36
Personalised prevention

The grey and scientific literature both cover a range of technological and biomedical developments and innovation in health for prevention. This literature highlights some opportunities for prevention due to new developments in predictive, personalised medicine and technology.41,45,54,65,113 However, there is some scepticism about the benefit of these approaches for chronic disease prevention and population health, including the possibility these approaches could reinforce rather than address existing disparities in health.88,114,115

Digital health

The use of digital technologies and platforms to support health is a core feature of personalised prevention. New health platforms such as eHealth, mHealth and other digital technologies are viewed as having the potential to transform how people engage with healthcare and prevention.45,115 This is in part due to their widespread use amongst the population; 46% of people globally rely on smartphone use to support their health, which is expected to increase in the near future.116 Use of apps and wearable technologies to support health is also on the rise and projected to almost double in the next few years.116

Digital technologies have the potential to complement the role of health professionals and provide consumers with greater autonomy over management of their health and wellbeing.65 Use of technologies such as wearable sensors for monitoring health behaviours and exposures (for example, nutrition, exercise, air pollution) could enable enhanced health tracking, self-assessment and support.116-118 Nanotechnology and artificial intelligence (AI) are other new major technologies to support the future of public health, including internet-based disease surveillance.119 Collectively, these tools and data sources are expected to provide people with a more complete, integrated view of their health, to assist with chronic disease prevention.65

New digital technologies present some challenges in terms of the potential application and relative usefulness of data for health.120 Some have argued that digital transformation for health has been dominated by a focus on innovative technologies rather than establishing sufficient evidence of the benefits and harms for population wellbeing, with limited available evidence on effectiveness for a wide range of digital health interventions.115

Many practical questions exist in relation to feasibility, effectiveness, cost-effectiveness, acceptability, governance, equity and rights such as privacy.121 For example, while advances in health-related technologies may lead to improvements in individual health, they are unlikely to reduce health inequities and may instead widen them without concerted effort from governments.45,122,123

There is limited evidence for more evolving areas such as genetic-based nutritional counselling.124 Researchers also have concerns about the safety and reliability of prevention offerings, with unclear benefits and lack of clarity of data governance.123 However, other research indicates personal health trackers and apps are popular, and sharing of data is well accepted by the population, but ownership and sharing of data are priority issues to address for effective chronic disease prevention.125

Precision medicine

Advances in genetics and genomic sciences have resulted in the development of ‘precision medicine’, which uses individuals’ genetic makeup and epigenetic exposures to tailor treatment or intervention.88,126 Precision medicine in public health (‘precision public health’) would provide the right intervention to the right population at the right time, and is seen by some as providing remarkable promise to improve prevention and management of chronic disease.41,45,118,121

Precision public health would use diagnostic technology backed by AI and multiple data sources to better stratify populations into disease risk sub-groups (behavioural or genetic) and target personalised preventative interventions towards those most at risk, to delay or prevent onset of conditions.67,117 For example, personalised nutrition guidance based on real-time assessment of dietary intake from apps and wearable technologies may help improve glycaemic control and more effective prevention and management of type 2 diabetes.126,127

Harnessing such technology may support earlier, more accurate and precise risk factor identification.121 It may also enable better precision to predict vulnerability of certain groups and determine the populations with the greatest need for preventive interventions.118,121
However, critical questions are raised in the research literature as to whether stratifying high-risk patient subpopulations and predictive biomarkers will improve prevention strategies and health outcomes. Many researchers are concerned precision public health, in pursuit of the new, hyper-individualised approach, may divert attention from other existing measures.

There is also caution in the peer-reviewed literature about whether precision medicine tests are useful beyond rare inherited diseases, and the unintended consequences if many precision medicine and advanced screening tests are expanded to the population level. Others have argued that precision medicine needs to track both social and behavioural data, not just genetic data, and that the predictive value for more complex chronic disorders and conditions is somewhat limited, with the greatest opportunity in terms of tailoring preventive interventions based on disease susceptibility. Highly sensitive, personalised screening methods and technologies could increase risk of overscreening and overdiagnosis.

More research is needed that considers the unintended consequences of innovations in precision medicine and public health that will help policy makers and researchers evaluate the potential benefits and harms.

**Big data**

Increasing use of digital tools within and outside the health sector will generate large and more complex sources of data with potential uses for personalised prevention.

New sources and applications of big data such as universal health records, citizen-generated data, digitised demographic databases and data linkage may offer improved opportunities and collaboration for chronic disease prevention. For example, big data screening is expected to become much more common. Cybercare ('healthcare in cyberspace') and telehealth also have the potential to prioritise prevention rather than treatment, using more sources of data through telemedicine, wearables and genomics. An important component is using and linking different sources of data, including for use in simulation modelling, to better guide decisions about investment and interventions for chronic disease prevention.

The use of big data also presents some possible harms for prevention. There are risks to privacy, security and confidentiality for data collection and linkage; questions around responsible data stewardship and governance must be addressed before implementation. Leveraging the potential of big data for prevention will require appropriate legal frameworks and standards for data gathering, storage and sharing to safeguard citizens’ privacy without reducing the possible benefits of data sharing and linkage.

Despite these challenges, effective utilisation of big data is seen as a major priority for chronic disease prevention in the 21st century.
Additional topics

Eight additional topics were identified in the review process which were not grouped under the five major themes. These topics include additional risk factors for chronic disease as well as other broader topics relevant for prevention research.

Tobacco and alcohol

Tobacco and alcohol have been combined as a single topic as they were often discussed in tandem in the literature. Researchers suggest that both are associated with harmful products and industries, and require improved governance and regulation in order to prevent chronic disease.73

The peer-reviewed literature identified the importance of following what has occurred in tobacco control, focusing on taxation measures, policies and regulations for other harmful products such as alcohol.135 Tobacco use and smoking remain one of the most significant preventable risk factors for chronic disease, particularly in low and middle-income countries. Tobacco control is seen by many as a priority area for prevention research and policy going forward to maintain and increase the health gains that have been achieved in Australia and worldwide.

Mental health

Mental health was not an explicit focus for this review and the search terms used may have excluded mental health literature. As a result, only a small number of the identified peer-reviewed publications discussed mental health in the context of chronic disease prevention, though we do note there is a complex reciprocal relationship between mental health and chronic disease. Some authors did criticise the chronic disease strategies and frameworks for not including mental health as a major priority, given the global burden of morbidity and mortality associated with poor mental health and suicide.70,102

Mental health was discussed in terms of the possible co-benefits of the built environment and physical activity interventions48, the opportunities for improved mental health through a planetary health approach78, and the importance of using systems thinking to consider climate change with mental health promotion and prevention.81

The grey literature discussed integrated biopsychosocial approaches to better manage mental and physical health and wellbeing, particularly from early childhood, and the impact on equity for vulnerable population groups.54,87 Addressing the complexities of physical and mental co-morbidities requires further work to bring these areas of research together, with appropriate funding streams and models of care.

Life-course approach

A life-course approach to chronic disease prevention looks at prevention through all stages across the lifespan, including from maternal and child health through to healthy ageing.

The approach necessitates a long-term focus for prevention, prioritising opportunities to act early to prevent chronic disease while simultaneously minimising behavioural risk factors and other social and environmental determinants that contribute.136

A particular focus of the life-course approach in both the grey and scientific literature is building good foundations for health and wellbeing by investing in the maternal and early-infancy periods (‘the first 1,000 days’) as well as adolescent health and the pre-conception period of life.137-139 Childhood obesity was highlighted as a priority area for a life-course approach to prevention in research and policy.100

Multisectoral approach

Researchers and policy makers advocate those in the health sector work with non-health sectors to drive systems change, and for civil society, government and private sector to work together. Multisectoral and intersectoral approaches to address and prevent chronic disease are frequently proposed in the grey and peer-reviewed literature as the way forward for prevention, given the co-occurring risk factors and co-morbidities of chronic disease.134
Generating political commitment beyond the health sector is viewed as particularly important for addressing more complicated chronic disease risk factors, including poor diet and air pollution. However, while multisectoral approaches are well promoted, there is a degree of concern expressed in the scientific literature about the challenges of this collaboration for public health, particularly in terms of the conflicting priorities between public and private sector.

Another way that a multisectoral approach is promoted is the idea of ‘culture for health’ that involves strengthening civil society and community action for chronic disease prevention. The Global Syndemic Commission of The Lancet refers to ‘double duty’ and ‘triple duty’ actions across multiple sectors to address the three pandemics of obesity, undernutrition and climate change.

One specific multisectoral approach proposed in both the scientific and grey literature is ‘Health in all Policies’ (HiAP), where health is integrated in the decision-making process in all of the policies and practices of government. This is usually achieved by employing a ‘whole-of-government’ approach, with cross-departmental collaboration established at the highest government level. However, despite appetite for HiAP approaches, there are limited examples of how to operationalise and evaluate it. Some helpful examples in the grey literature come from South Australia and California. In California, governance tools for operationalising and strengthening HiAP approaches include interdepartmental committees, joined-up health targets and evaluation, financial support and funding mechanisms, and robust accountability frameworks.

Particular emphasis in grey literature is made to health impact assessments (HIAs) to support implementation of HiAP by informing decision makers (including those outside the health field) about the health impacts of various policy options. In the scientific literature, HIAs also have the potential to generate evidence that can be used in simulation and systems modelling. But while the skills required for ‘Public Health 3.0’ includes the ability to promote and work with a HiAP approach, it remains a challenging area for prevention research.

A major barrier identified is producing multisectoral evidence, such as evidence gained through natural experiments in the built environment and transport. These interventions require cross-agency, cross-sector and cross-disciplinary interventions and evidence. Other examples provided are air pollution and climate change, which require policy making and evidence generation outside the health sector, with health and non-health co-benefits. While there were limited examples of the successful operationalisation of multisectoral approaches for prevention research, we identified two examples of large-scale collaborative, multisectoral partnerships for health in Canada and the UK.

Systems thinking

Systems thinking and complex systems approaches are growing in popularity in the peer-reviewed prevention literature. Many researchers argue that the complexity of casual factors of chronic disease cannot be resolved with ‘business as usual’ in terms of policy or research. New approaches are required that focus on the underlying systems and power structures, which have been reinforcing unsustainable production and consumption patterns with negative impacts on health including chronic disease.

Chronic disease represents a significant challenge for public health research, and prevention requires a complex systems approach that moves beyond clinical interventions and limited measures of effectiveness. Systems approaches to prevention can help address the clustering of risk factors in individuals and populations. Systems science methodologies have been highlighted particularly for their potential to help inform decision-makers on causes and solutions to chronic disease, with some literature also identifying the importance of new modelling tools and techniques to inform and support systems thinking.

Systems of major focus in chronic disease prevention research include food systems and transport systems. Complex systems thinking is more likely to occur in the scientific literature that explores the links between chronic disease prevention and environmental concerns such as climate change.

However, the grey literature tends to not explicitly use systems thinking, with few examples evident of how systems thinking is used to improve prevention strategies. Reports from the UK advocate the need for complex systems approaches to help predict long-term impacts of preventive interventions and offer better understanding of the wider social, cultural and political context in which risk factors, health behaviours and health outcomes are embedded.
Pursuing a systems approach is seen to enable thinking beyond isolated intervention approaches in the aim of breaking down silos and working with broader stakeholder groups. Further, promoting chronic disease prevention and health equity through a complex systems framework advances policy discourse around how processes and outcomes within a system affect change. A small number of examples of complex systems approaches being applied to prevention are found in the peer-reviewed literature, for example from New Zealand and the UK. These examples indicate systems or complexity thinking are useful, such as informing a ‘whole of government’ approach to prevention.

**Low and middle-income countries**

Many grey and peer-reviewed publications identified that low and middle-income countries (LMICs) are a priority area for prevention research in the future. Much of the mortality and morbidity associated with chronic diseases is found in LMICs; this is projected to substantially rise in the future with significant demographic and epidemiological transitions. As over 90% of future urban population growth is projected to be in LMICs, these countries will face difficulties in distributing finite resources such as healthy food, clean water and health services that are required for effective chronic disease prevention.

The double burden of communicable (infectious) and chronic diseases also poses major challenges to integrate chronic disease prevention in the health systems of many LMICs. Social determinants of health such as poverty exacerbate chronic disease and increase inequality, thus making effective prevention efforts more challenging. Fourteen mega-countries (populations >100 million) have 65% of the global burden of cardiovascular disease mortality, with most of these coming from LMICs. Some research highlighted that risk factors such as air pollution were leading causes of morbidity and mortality, especially in LMICs, and this is projected to worsen with increasing urbanisation.

Some researchers are critical particularly of the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020, arguing that its scope is insufficient to drive real change, with specific criticism that evidence for effective prevention came mostly from high-income countries. Many priority areas for action in prevention and research in LMICs have been identified, such as improving public health law and regulation in LMICs; healthy urban planning; and environmental health and pollution. LMICs are seen as particularly vulnerable to harmful products and industries that contribute to chronic disease; the global development of harmful industries has not been matched by preventive, population-based, globalised measures. It is also noted that climate change will increase chronic disease risk in LMICs and create further barriers for prevention which will need to be addressed by researchers and policy makers.

**Evidence gaps**

While ‘evidence gaps’ is not a topic generally in the grey literature, the peer-reviewed literature identified gaps in terms of the implications for the future of prevention research. The gaps could be characterised in terms of a ‘knowledge’ evidence gap, or a ‘policy and practice’ evidence gap. For example, some researchers identified gaps in knowledge for more neglected areas of prevention, such as air pollution and environmental health.

Environmental health is seen as challenging in particular for prevention research because of the complexity of chronic disease epidemiology and issues such as climate change. There are also gaps in knowledge regarding the efficacy and benefits for new technologies including mHealth for prevention. Other evidence gaps include the lack of long-term studies for population-level prevention strategies and eating patterns to improve health. The grey literature emphasises the need for more research on prevention and management of chronic disease in terms of multi-morbidities. Another identified gap in knowledge was poor understanding of how to create environments and conditions conducive to improved health equity, for example through population-level interventions across the life course, or individual-level interventions tailored to vulnerable or disadvantaged groups.

Others identified policy and practice evidence gaps of how to translate prevention research into real-world change and improvement for health. Some are critical of organisations such as WHO for lacking the ‘how’ to translate chronic disease prevention evidence into policy action. Examples given for this policy and practice evidence gap include urban planning and the built environment. However, a chief evidence gap for prevention is the lack of...
intervention research; successfully addressing this gap requires collaborative, policy-relevant research through strategic alliances and long-term funding models.\textsuperscript{153}

**Implementation and/or evaluation challenges**

Another topic identified in some of the peer-reviewed literature, but less so in the grey literature, is challenges associated with implementation and/or evaluation of prevention research, which is often closely linked with evidence gaps. The challenge of effective implementation is identified as a major barrier, including translation and scalability of interventions.\textsuperscript{83,154}

Other research discusses the need for sustainability and scalability in prevention research in telehealth.\textsuperscript{155} Fragmented pools of funding are seen as a major barrier to effective implementation and scale-up of prevention efforts.\textsuperscript{156} Systems modelling is proposed as a type of approach that could be better used in prevention research to improve decision-making and guide implementation.\textsuperscript{133,148} However, lack of capacity and training are viewed as major impediments to such tools and methods being more widely used.

Poor political leadership and investment, coupled with industry interference, are common implementation barriers and identified in the grey literature as undermining prevention efforts.\textsuperscript{29}

Some propose that chronic disease prevention requires more flexible evaluation methods beyond the traditional evidence hierarchy of clinical trials, including other types of experimental methods and natural experiments.\textsuperscript{157,158} Other suggest that the evidence needs to include the cost-effectiveness of different programs to help guide investment and improvement.\textsuperscript{159}

Generating ‘meaningful’ evidence for prevention also requires appropriate funding and evaluation models to measure longer term outcomes and impact.\textsuperscript{157} Canada is one example of a country that has changed the way it funds prevention research in order to improve implementation and evaluation.\textsuperscript{143} Another example from the UK was a proposed model of evaluation for a complex systems approach to prevention.\textsuperscript{144}
Discussion

This review and analysis of the current and future trends indicates further opportunities for the future of chronic disease prevention research. These discussion points are based on our interpretation and analysis of the topics and themes, and what these may represent for future prevention research.

Expanding the scope of prevention

The identified themes and additional topics reflect an expansion of what chronic disease prevention means for both researchers and policy makers. In much of the literature there was both an implicit and explicit linking of human health with the natural environment and ecosystem. It suggests a shift away from a disease-specific, risk factor-based approach to chronic disease, towards a more holistic, systems-based consideration of health and prevention that encapsulates both human and planetary health.

The importance of a planetary health approach, though not specifically used as a term in the grey literature, also reflects the global policy shift to the Sustainable Development Goals (SDGs), in which human prosperity, wellbeing and eradication of poverty is tied to environmental sustainability. Though we note prevention of chronic disease is not a specific goal, achieving the SDGs could have a positive impact for prevention; for example, requiring new ways of working to encourage effective multisectoral action, partnerships and policy coherence, and identifying common solutions to shared problems.79

Climate change is a topic that was discussed specifically in terms of its impact on prevention and management of chronic disease. The possible alignment of prevention with other policy areas and disciplines represents opportunities for synergy between sectors and disciplines. This might involve a co-benefits approach to address both climate change and chronic disease with systems-level interventions that could produce a win-win in health and other sectors, such as the double and triple-duty actions proposed by The Lancet Global Syndemic commission.21

While the Intergovernmental Panel on Climate Change report28 and the more recent MJA-Lancet Countdown report on health and climate change160 did not explicitly discuss chronic disease prevention, there is a clear opportunity given the magnitude of climate change to explore the co-benefits of climate change mitigation and adaption for the prevention of chronic disease, and vice versa.

Increasing the use of systems thinking

A key finding from this review is the evolution of systems and complexity thinking in prevention at local, national and global levels, including an increasing application of systems science methods and tools in prevention research. While few grey literature reports explicitly or implicitly referred to systems and complexity thinking, this approach was found in about a quarter of the scientific literature that was reviewed. It could be argued that systems thinking and complexity should be embedded across all the themes, given the importance for food, transport, urban settings, ecology and determinants of health.

An important theme for future research in systems and complexity thinking is the strategic alignment and integration of goals with other disciplines and sectors for mutual benefit, identifying the possible synergies, opportunities, benefits and impacts for health. This requires new collaborations and partnerships bringing together data streams and funding. It will also require skills to strengthen capacity for public health prevention research using systems and complexity thinking, including the application of systems dynamic modelling and agent based modelling for prevention.161 Increasing the use of systems thinking is likely to help with more complex approaches in prevention research going forward.

Moving beyond the ‘what’ to the ‘how’

Another major finding of this review is that we have the ‘what’ needed to prevent chronic disease, but a less clear picture of the ‘how’ to do it. This was reflected by much of the peer-reviewed literature describing either the problem of chronic disease and/or describing possible prevention solutions. We found much fewer publications
appraising or evaluating the application of prevention solutions, though we note that the terms ‘implementation’ and ‘evaluation’ were not used as part of the search strategy. This is a challenge as without the publication of rigorous peer-reviewed evidence, it is difficult for governments and other groups to include this evidence in their documents and publications.

This review suggests that the next decade of prevention research and policy must move into the ‘how’ arena, incorporating appropriate and flexible models of evaluation for interventions in real-world settings. This will be challenging for interventions across multiple sectors, though it should be noted that many highlighted the greatest gains for prevention were to be found outside the health sector, such as in healthy urban planning, more sustainable food systems, and improved public health regulations and laws.

However, there remains a question as to the readiness of public health to work effectively with these sectors and the possible trade-offs or compromises. What strategies and partnerships will be necessary to facilitate more of the ‘how’? Moving beyond traditional domains and sectors also asks difficult questions in terms of expanding the borders of inter-disciplinary and cross-disciplinary research, which research funding agencies and higher education institutions are already grappling with.

The potential for new technologies to improve prevention strategies is an important aspect of the ‘how’ of prevention for the next decade. The further development of novel tools in precision medicine and public health, artificial intelligence, digital health and big data represent significant opportunities for prevention but will require effective regulatory mechanisms, ethical data stewardship and engagement of citizens in decision-making processes. The risk with focusing too much on high-tech, highly individualised approaches to prevention is that focus is shifted away from the structural determinants that are driving chronic disease, such as inequality, poverty, power, and macroeconomic policies. The future of prevention research and policy should be able to balance both approaches, but we found few applications of such an approach in the literature.

**Addressing persistent inequities in health**

The importance of chronic disease prevention in addressing health and social inequities is a core area for the future of prevention research. While we did not explicitly search for equity and similar terms as part of this review, addressing inequities to improve and better target chronic disease prevention was highlighted in much of the scientific and grey literature.

We note that while Australia has numerous frameworks, action plans and guidelines for addressing the social and cultural determinants of health, such as the National Strategic Framework for Chronic Conditions, inequities in health persist and will continue to do so without sustained, meaningful investment in understanding and addressing the core drivers of chronic disease.

Addressing the persistent and ongoing inequities in health and chronic disease needs to acknowledge the intersection between some themes, such as personalised prevention and the determinants of health. Focusing too much on pursuing the new technologies offered by big data, digital health and precision medicine may have negative consequences, such as widening existing disparities, individualising chronic disease, and drawing attention away from structural and systems-based approaches required for the complexities of prevention.

Considering one theme without considering the ways in which these themes intersect may therefore inadvertently miss opportunities for improving equity in health – a core value of public health.

**The politics of prevention**

Finally, one area of the future of prevention research implied in many of the identified topics, but not specifically mapped during the process of thematic analysis, was the political nature of prevention. This includes the power of different actors, groups and systems and their influence on individual and population health outcomes. Investment in prevention policy, funding and research is often contested and depends on numerous factors including the current political and policy landscape, as well as the values of society and government.

Some of the international commentary on chronic disease prevention, grey literature and high-profile peer-reviewed publications identified the political drivers of chronic disease, particularly the undue influence in the policy making process from private sector companies creating and selling products harmful to human and
planetary health. Others criticised the individual, lifestyle-based approach to prevention which ignores issues of inequity and power, given that many of the more effective prevention interventions tend to be economic actions such as fiscal policies and other legislation implemented by governments. This suggests that prevention is a politically contested space for researchers, policy makers and governments. We must recognise and understand these barriers to ensure prevention research is used for effective action in public health.

Peer review

A draft of this report was shared for comment with The Australian Prevention Partnership Centre’s leading investigators and partners from January to February 2020. This group included academic and policy experts and opinion leaders working across a broad range of prevention research and policy. The feedback received on the existing themes and discussion section have been incorporated into the final text of this report.

Overall, the organisation of topics and themes was widely supported. It was noted that several of the themes have overlapping boundaries and could be categorised in multiple ways. Other additional considerations highlighted in the consultation as important issues for the future of prevention research were as follows:

- Equity is an important and ongoing concern, particularly for implementing solutions that address the current inequities for socioeconomically disadvantaged groups, Aboriginal and Torres Strait Islander people, and culturally and linguistically diverse populations. Racial inequities, racism and the impact of other forms of structural disadvantage on health were also noted as critically important issues to inform future prevention research.

- The funding of prevention and prevention research must be addressed, including models for sustainable investment and innovative funding mechanisms.

- Recognising the impact of political factors, especially political will, ideology and vested interests on prevention and the funding of prevention research. Also noted was the need for research on how best to tackle inequities of power, influence and impacts of vested interests on decision making. For example, through advocacy and strategic partnerships.

- The role of citizen engagement in the policy process, and promoting co-design and participatory approaches such as community-based participatory research and citizen science.

- There were some divergent views about the value and opportunity-cost of precision prevention; both as an important area for future research, and as potentially displacing important investments in primary prevention.

- Acknowledging the potential co-benefits in other areas of health and wellbeing for reducing chronic disease and improving health outcomes – for example, that mental illness is both a risk factor for as well as a co-morbid condition with poor physical health, including the major chronic diseases. Injury prevention was identified as another area with co-benefits for chronic disease prevention.

Limitations

While this review provides a starting point for further conversation and to generate debate about what priorities may be needed, in Australia and globally, to address the problem of chronic disease, we note some methodological limitations.

The authors used an iterative process to code and develop the themes and topics. How trends and topics were identified, mapped and analysed was based on the perspectives of the authors involved in this review, including prior discussions and initial conversations on the future of prevention research with the Prevention Centre’s collaborators. During the screening and analysis process of the literature, the quality of the evidence was not appraised. Instead, it was summarised thematically and narratively as per the aims of a traditional literature review to provide a broad overview of the relevant literature.

We attempted to capture a globally focused view of the literature on the future of chronic disease prevention and what it may mean for the Australian context. However, we acknowledge the majority of this research originated from a small selection of predominantly high-income countries generalisable to Australia, and we excluded...
discussion of prevention research that was specifically focused on a particular country, unless it was discussed as a case study for prevention research. We have not analysed the variances in the prevention literature by geographic region and have likely missed other trends and topics that are specific to different geographic and cultural contexts.

While systematic searching was employed, the search strategy was not exhaustive, and the research questions and search strategy were not that of a systematic review. This may mean the search process is limited in terms of its replicability, though some search terms have been provided in Appendix A as an example. Several search terms were not included in our search strategy which limits the scope and extent of literature captured. For example, while the use of broad, high-level search terms was an intentional strategy to capture literature across a wide range of sources and research areas within prevention, we excluded literature in several related areas (for example, mental health; injury prevention) or literature indexed in defined sub-fields, such as systems thinking and complex intervention research. In addition to this, one person primarily screened and analysed the grey literature and one person primarily screened and analysed the peer-reviewed literature. This process may have resulted in exclusion of publications and literature that were possibly useful or relevant.
This review was envisaged as a conversation starter for The Australian Prevention Partnership Centre and our many partners and collaborators in Australia and internationally.

The review aimed to identify topics and themes in the current international literature that would assist in guiding researchers and policy makers in a local conversation about the future of chronic disease prevention.

The trends, opportunities and challenges identified in this report have a number of implications for prevention research. These include how future research priorities are determined and funded, what new or emerging methods may be needed in prevention research, and how prevention knowledge is translated and mobilised into policy action and systems change.

This report indicates a need for prevention researchers and policy makers to engage with these themes and trends to help build the relevant evidence, knowledge, skills and actions required for effective prevention of chronic disease in the 2020s and beyond.
References


120. Foundation Botnar, London School of Hygiene and Tropical Medicine, the Wellcome Trust. Next generation public health: Artificial Intelligence (AI) and Big Data for population wellbeing in low- and middle-income countries: Summary report. Basel, Switzerland: Foundation Botnar; 2019. www.fondationbotnar.org/_file/1252/nxtgenpublichealth-summaryreport.pdf


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Appendices

Appendix A: Examples of search terms

Ovid Medline

1. chronic disease/ or multiple chronic conditions/ or noncommunicable diseases/
2. Primary Prevention/ or Tertiary Prevention/ or Secondary Prevention/
3. 1 and 2
4. global health/ or public health/ or epidemiology/ or preventive medicine/ or telemedicine/
5. Policy Making/ or Environmental Policy/ or Nutrition Policy/ or Public Policy/ or Fiscal Policy/ or Health Policy/ or Policy/
6. Ecosystem/ or Sustainable Development/ or Agriculture/ or "Conservation of Natural Resources"/ or Environmental Monitoring/
7. Greenhouse Effect/ or Climate/ or Water Supply/ or Climate Change/ or Environmental Pollution/
8. Health Promotion/
9. Population Forecast/ or Forecasting/
10. Health Priorities/
11. "Social Determinants of Health"/
12. Economics/
13. Government/ or Government Regulation/
14. Politics/
15. 4 or 5 or 6 or 7 or 8 or 11 or 12 or 13 or 14
16. 9 or 10
17. 3 and 15
18. limit 17 to (english language and yr="2014 -Current")
19. 2 or 4 or 5 or 6 or 7 or 8 or 11 or 12 or 13 or 14
20. 1 and 16 and 19
21. limit 20 to (english language and yr="2014 -Current")

Scopus

("chronic disease*" OR "chronic condition*" OR "noncommunicable disease") AND (prevention OR "preventive medicine") AND (future OR trend OR forecast* OR projection OR driver* OR priorit* OR challenge* OR predict*) AND ("global health" OR "public health" OR "policy" OR "health policy" OR "sustainable development" OR "climate change" OR "health promotion" OR "health priorities" OR "government regulation") AND PUBYEAR > 2013

Google

("noncommunicable disease" OR "chronic disease*" OR "NCD") AND ("prevention" OR "preventive health") AND ("public health" OR "research" OR "health policy" OR "health promotion") AND ("future" OR "trend" OR "forecast" OR "driver" OR "priority" OR "challenge" OR "opportunity") limited to > 1st January 2014
### Appendix B: Definitions of topics

<table>
<thead>
<tr>
<th>Theme</th>
<th>Topic</th>
<th>Description of topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food production and consumption</td>
<td>Food systems</td>
<td>Any aspect of food systems, including food environments and the production, distribution or consumption of food to support nutrition and health</td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>Agriculture in the context of the food system and improving diet</td>
</tr>
<tr>
<td></td>
<td>Diet and nutrition</td>
<td>Diet, nutrition and eating patterns as important for chronic disease prevention</td>
</tr>
<tr>
<td></td>
<td>Malnutrition in all its forms</td>
<td>Malnutrition in all its forms including obesity or undernutrition, and food insecurity</td>
</tr>
<tr>
<td>Place and spaces</td>
<td>Physical activity</td>
<td>Physical activity or inactivity (including sedentary behaviour and active travel) and prevention</td>
</tr>
<tr>
<td></td>
<td>Built environment</td>
<td>Impact of built environment on health and prevention</td>
</tr>
<tr>
<td></td>
<td>Urban health and cities</td>
<td>Urban health and cities, including increasing urbanisation</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
<td>Transport systems and importance for prevention</td>
</tr>
<tr>
<td>Environment and health</td>
<td>Air pollution</td>
<td>Air pollution and respiratory disorders as part of chronic disease prevention</td>
</tr>
<tr>
<td></td>
<td>Planetary health</td>
<td>Specific term of ‘planetary health’ used</td>
</tr>
<tr>
<td></td>
<td>Climate change</td>
<td>Climate change and chronic disease prevention</td>
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<tr>
<td>Expanded determinants of health</td>
<td>Social determinants</td>
<td>Social determinants of health, including poverty and inequality</td>
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<tr>
<td></td>
<td>Commercial and corporate determinants</td>
<td>Commercial and corporate influences and determinants of health, including industry influence</td>
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<tr>
<td></td>
<td>Economic determinants</td>
<td>Economic or fiscal determinants of health including pricing and taxation</td>
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<tr>
<td></td>
<td>Legal determinants</td>
<td>Legal determinants of health including law, trade, regulation for prevention and human rights</td>
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<tr>
<td>Personalised prevention</td>
<td>Digital health</td>
<td>Digital health, including apps, wearables and eHealth/mHealth</td>
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<td></td>
<td>Precision medicine</td>
<td>Precision and personalised medicine including genomics</td>
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<td></td>
<td>Big Data</td>
<td>Big Data, including data linkage</td>
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<tr>
<td>Additional topics</td>
<td>Tobacco and alcohol</td>
<td>Tobacco and/or alcohol and chronic disease</td>
</tr>
<tr>
<td></td>
<td>Mental health</td>
<td>Mental health as a chronic disease or risk factor</td>
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<tr>
<td></td>
<td>Life-course approach</td>
<td>Focus on life-course approach to prevention, including specific age groups</td>
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<tr>
<td></td>
<td>Multisectoral approach</td>
<td>Multisectoral approaches needed to address prevention. Includes HiAP (Health in All Policies)</td>
</tr>
<tr>
<td></td>
<td>Systems thinking</td>
<td>Systems thinking and complex systems approaches needed for prevention</td>
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<tr>
<td></td>
<td>Low and middle-income countries</td>
<td>Low and middle-income countries need greater focus for prevention</td>
</tr>
<tr>
<td></td>
<td>Evidence gaps</td>
<td>Evidence gaps for prevention research and/or policy</td>
</tr>
<tr>
<td></td>
<td>Implementation and/or evaluation challenges</td>
<td>Implementation or evaluation challenges in prevention</td>
</tr>
</tbody>
</table>