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Chronic disease and climate change

Chronic disease and climate change: understanding co-benefits and their policy implications

GUEST EDITORS

***Anthony G. Capon*[A,B,E] *and Chris E. Rissel*[C,D]**

[A]*National Centre for Epidemiology and Population Health, The Australian National University*
[B]*Faculty of the Built Environment, The University of New South Wales*
[C]*Health Promotion Service, Sydney South West Area Health Service*
[D]*School of Public Health, University of Sydney*
[E]*Corresponding author. Email: tony.capon@anu.edu.au*

Abstract: Chronic disease and climate change are major public policy challenges facing governments around the world. An improved understanding of the relationship between chronic disease and climate change should enable improved policy formulation to support both human health and the health of the planet. Chronic disease and climate change are both unintended consequences of our way of life, and are attributable in part to the ready availability of inexpensive fossil fuel energy. There are co-benefits for health from actions to address climate change. For example, substituting physical activity and a vegetable-rich diet for motor vehicle transport and a meat-rich diet is both good for health and good for the planet. We should encourage ways of living that use less carbon as these can be healthy ways of living, for both individuals and society. Quantitative modelling of co-benefits should inform policy responses.

Chronic diseases are by far the leading cause of death in the world and their impact is steadily growing.[1] Australia is no exception.[2] Despite a currently increasing life expectancy, our country is in the grip of an epidemic of chronic disease; for example during 2006 obesity overtook tobacco smoking as the leading risk factor for disease burden in Western Australia.[3] We can anticipate similar transitions in all Australian States. The interplay between physical and mental health, and the links between chronic disease and depression, warrant integrated approaches to the prevention of physical and mental health problems.

At the same time, Australia's per capita greenhouse gas emissions are the highest of any OECD (Organisation for Economic Co-operation and Development) country and among the highest in the world.[4] Greenhouse gas emissions contribute to climate change which effects health in a number of ways.[5,6] Climate change was recently described in the *Lancet* as the biggest global health threat of the 21st century.[7]

Chronic disease and climate change both demand strong public policy responses. The case for aligning policy responses to climate change and public health was cogently argued in the recent series of papers in the *Lancet* on health and climate change.[8] The authors reported research on the ancillary health effects of policies to reduce greenhouse gas emissions in the transport, food, housing and energy sectors. This special issue of the *Bulletin* presents some Australian perspectives on the co-benefits for health from action to mitigate climate change in association with the Australian

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Academy of Science's 2010 Fenner Conference on the Environment which addressed this theme (see abstract of keynote address on page 114).

The concept of co-benefits

A co-benefit is an additional benefit arising from an action that is undertaken for a different principal purpose.[9] Putative co-benefits from action on climate change (i.e. additional benefits beyond greenhouse gas reductions) include reduced air pollution, increased levels of physical activity, a healthier diet, improved energy security through a more diverse energy supply and less dependency on oil, a reduction in traffic congestion, and new employment opportunities. In other sectors, this approach to co-benefits is sometimes referred to as a 'no-regrets approach' because, even in the absence of a need to act on climate change, there are already strong arguments for many of the proposed actions.

Figure 1 is a diagrammatic representation of the concept of co-benefits for health. Decisions made by individuals, governments and industry have potential direct human health impacts (1) via pathways including nutrition and level of physical activity, and indirect human health impacts (2) via the health of ecosystems (e.g. climate change). It follows that there can be co-benefits for health from actions to address climate change. For clarity, the arrows are presented as uni-directional, however there are relationships in both directions.[10]

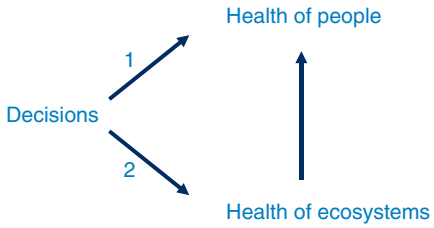

Figure 1. The 'biosensitivity' triangle to illustrate the concept of co-benefits.

Understanding current human situations

There is value in understanding epidemics of chronic disease from an evolutionary perspective. Human beings are now living in very different ways than our hunter-gatherer ancestors did. The evolutionary health principle postulates that if an animal's environment changes in a significant way, then it is likely that the animal will be less well adapted to the new conditions and will consequently show signs of physiological or behavioural maladjustment.[11] From an evolutionary perspective, chronic disease can be seen to substantially arise from human maladaptation to the current ready availability of fossil fuel energy (Box 1). Further information about this perspective has been presented in two special issues of the *NSW Public Health Bulletin* on *Cities, Sustainability and Health* in 2007 (Vol. 18 Issue 3–4 and Issue 11–12) (available at: http://www.publish.csiro.au/issue/4094.htm).

The papers in this issue

The papers in this issue of the *Bulletin* build on the *Lancet*'s Health and Climate Change Series[12] and present Australian perspectives on co-benefits for health from action on climate change. Giles-Corti and colleagues explore the theme of urban land transport addressed by Woodcock et al.[13] This paper considers the co-benefits of investing in active transportation, with a focus on policy options to optimise societal objectives aimed at creating healthy, socially and environmentally sustainable communities.

Friel, consistent with the *Lancet* article on food and agriculture,[14] describes the relationship between food security, chronic disease and climate change. She demonstrates how a key climate change mitigation policy – the reduction of greenhouse gas emissions from the agriculture sector

Box 1. From coal mines and oil wells to waistlines, via motors

During the second half of the 20th century, the ready availability of fossil fuel energy enabled sedentary ways of working, moving and recreating. Most Australians now use labour-saving devices on a daily basis. We use washing machines, vacuum cleaners and dishwashers in the home, and motor lawn mowers and leaf blowers in the garden. Power-assisted tools make the the workplace easier. We use escalators, lifts and movable walkways to propel ourselves around buildings, and motor vehicles to move around cities and towns. Increasingly, our children choose video games over active recreation.

At the same time, we live in an era in which food is readily available and relatively cheap (especially, energy dense foods). Our food supply is highly dependent on fossil fuels for fertilisers, transport and other inputs.

As individuals, our fat stores arise from an energy imbalance – too much energy in, and too little energy out. If we think about obesity from an energy system perspective, the combination of sedentary ways of living and food intake in excess of need has been enabled by the ready availability of fossil fuel energy in recent years. Therefore obesity can be seen as a 'carbon store' on our waistlines which was originally sourced from coal mines and oil wells.

Is this a sustainable way of living?

through a reduction in consumption of animal source foods – can improve food security and reduce the levels of cardiovascular diseases and some cancers.

Dennekamp and Carey describe the increasing evidence that air pollution contributes to an unacceptable burden of chronic disease and premature mortality, particularly from cardiovascular and respiratory causes. They argue that the action now required to mitigate climate change also has the potential co-benefit of improving air quality and reducing the incidence of chronic disease. Unsurprisingly, they highlight fossil fuel combustion, primarily from motor vehicles and energy generation, as being at the heart of both climate and health-related problems.[15]

Berry and colleagues, taking a focus on Aboriginal well-being and its strong relation to connectedness to traditional country, argue that public health policy must build on Aboriginal people's determination to care for country, traditional knowledge, formidable resilience and self-determination. They posit that Aboriginal-initiated natural resource management directed at climate change adaption supports caring for land and country with mental health, social and emotional wellbeing co-benefits.

Box 2. Active travel – a Win-Win-Win

Active travel is a good example of a 'Win-Win-Win' because active travel is good for health, good for the environment, and good for the hip-pocket. First, physical activity is essential to maintain and improve health. One of the most sustainable ways to build physical activity into your daily routine is to use active forms of travel (walking, cycling, or public transport) to places you need or want to go to, such as work, study, entertainment.[18] Replacing a sedentary motor vehicle trip with walking, cycling, or public transport (which usually involves some walking at either end) increases your activity levels. Second, not using private motor vehicles for even some trips, means less pollution and greenhouse gas emissions, which is also good for the environment. Third, active travel is less costly than owning and driving a motor vehicle when costs of purchase, insurance, registration, maintenance and running a motor vehicle are all taken into account.

Glossary of terms used in this issue

Adaptation* Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, for example, anticipatory and reactive, private and public and autonomous and planned. Examples include heat wave early warning systems and growing more vegetation in cities to reduce the urban heat island.

Airshed** A body of air bounded by topography and meteorology in which a substance, once emitted, is contained. It is the geographical boundary for air quality standards.

Chronic disease A term applied to a diverse group of diseases such as heart disease, cancer and arthritis, which tend to be long lasting and persistent in their symptoms or development. Although these features also apply to some communicable diseases, the term is usually confined to non-communicable diseases.

Co-benefits* The benefits of policies implemented for various reasons at the same time, acknowledging that most policies designed to address greenhouse gas mitigation have other, often at least equally important, rationales (e.g. related to objectives of development, sustainability, equity and health).

Greenhouse gas* Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

Mitigation* Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks.

Trip chaining involves planning ahead and using one journey to achieve a number of objectives. For example, a public transport trip may be preceded or followed by a walking and/or cycling trip, either simply to get to or from the public transport stop, or to achieve another objective such as stopping at the newsagent to collect a newspaper to read on the bus.

*Core Writing Team. Pachauri RK, Reisinger A, editors. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: IPCC; 2007.
**National Environment Protection Council (NEPC) definition at: http://www.ephc.gov.au/sites/default/files/AAQ_IssScoPpr__AAQ_Review_Draft_200510.pdf

Thompson, Whitehead and Capon describe a new research and workforce development program focused on health and the built environment, recently established in the Faculty of the Built Environment at The University of NSW, with funding from the NSW Department of Health. The NSW Healthy Built Environments Program will foster cross-disciplinary research, deliver education and workforce development, and advocate for health as a primary consideration in built environment decision making. This program will employ an understanding of the co-benefits for health from action on climate change in the framing of research projects, education and advocacy.

Implications for policy and practice

There is increasing recognition that strategies to mitigate climate change can have substantial benefits for both health and climate protection, and that these mitigation strategies are both cost-effective and socially attractive.[16] A Win-Win-Win approach (Box 2), based on the concepts of the triple bottom line,[17] and also known as 'people, planet, profit' or 'the three pillars', captures an expanded spectrum of values and criteria for measuring organisational (and societal) success – economic, ecological and social.

Some climate change strategies may look appealing, but are not the whole solution. An example is electric cars. While electric cars do not directly produce emissions, drivers are still sedentary and don't have the health advantages of active travel. Further, if vehicles remain the same size, and take up the same amount of space, then it will make no difference to traffic congestion problems (which are estimated to cost Australia $64 million a year). If, as is likely, the electricity used in electric cars comes from coal-fired power plants, then the net effect on greenhouse gas emissions may be negative. Increasing active urban travel, and discouraging private motor vehicle use, will provide larger health benefits than policies focusing on lower emission motor vehicles.[13]

An understanding of co-benefits for health from action on climate change should inform policy responses to both chronic disease and climate change. Quantitative modelling of these co-benefits from an Australian perspective, including economic modelling, should be an urgent priority, preferably in advance of national decision making about carbon regulation. An understanding of co-benefits could assist prioritisation of policy interventions in the health sector and other relevant sectors (e.g. transport, energy, agriculture). Potential for unintended consequences for health, and health equity, should be carefully weighed.

An understanding of co-benefits may also have direct implications for clinical practice. For example, a diabetes education consultation for a patient with early diabetes could include information about building active forms of travel into daily life. To be effective, this will require health workers to work with other sectors (e.g. urban and transport planning) to reduce barriers to healthy ways of living.

The take home message about co-benefits is that low carbon ways of living are healthy ways of living. Health workers and health systems should promote this positive message.

Acknowledgment

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The public health benefits of reducing greenhouse gas emissions

Andrew Haines

Public Health and Primary Care,
London School of Hygiene and Tropical Medicine, UK

Abstract of the keynote address at the 2010 Fenner Conference, Australian Academy of Science, Canberra, 22–23 June 2010 (reproduced with permission).

Climate change will harm human health, and successful strategies to reduce greenhouse gas emissions will restrict that harm. But studies published in *The Lancet*[1] late last year showed that appropriate mitigation strategies will themselves have additional and independent effects on health, most of them beneficial. The potential value of these co-benefits has not so far been given sufficient prominence in international negotiations.

These studies, supported by a global partnership of funders, were undertaken by an international multidisciplinary group of researchers with the aim of informing discussions at the 2009 Copenhagen conference of parties to the UN Framework Convention on Climate Change. Each focused on one sector which is a major source of greenhouse-gas emissions. These sectors are: household energy use, urban land transport, electricity generation, and food and agriculture. A fifth study reviewed the effect on health of short-lived greenhouse pollutants, which are produced in several sectors.

Each of the sectoral studies examined the health implications of actions in both high-income and low-income countries designed to reduce the release of carbon dioxide (CO_2) and other greenhouse gases through a number of case studies. In line with the recommendations of the UK Committee on Climate Change, each would yield reductions by 2030 that are broadly consistent with the aim of meeting a global 50% reduction target (compared with 1990) by 2050, and an 80% reduction in emissions for high-income countries. The studies demonstrate the potential improvements in health through a range of mechanisms such as increasing active transport (walking and cycling) in cities, reducing exposure to indoor and outdoor air pollution and reducing consumption of animal source saturated fats. These co-benefits can offset, at least in part, the costs associated with implementing strategies to reduce greenhouse gas emissions. Future research should be directed at exploring the potential co-benefits in a range of settings, reducing uncertainties and assessing the health effects of other strategies, such as biofuels or carbon capture and storage, which were not covered by this program of research. It is clear however that a lower carbon and more sustainable economy could result in substantial improvements in public health.

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 10.1071/NB10050

Air quality and chronic disease: why action on climate change is also good for health

***Martine Dennekamp*[A,C] *and Marion Carey*[B]**

[A]*Monash Centre for Occupational and Environmental Health, Monash University*

[B]*Monash Sustainability Institute, Monash University*

[C]*Corresponding author. Email: martine.dennekamp@med.monash.edu.au*

Abstract: There is increasing evidence that air pollution contributes to the burden of chronic disease and premature mortality, particularly from cardiovascular and respiratory causes. Action now urgently required to mitigate climate change has the potential co-benefit of improving air quality and reducing the chronic disease burden. Fossil fuel combustion, primarily from motor vehicles and energy generation, is a major contributor to anthropogenic climate change and air pollution-related health conditions. Action to reduce greenhouse gas emissions by improving energy efficiency, departing from carbon-intensive energy generation, facilitating mass transit and active transport options, also has the potential for significant public health benefits.

The first evidence of severe adverse health effects caused by ambient air pollution came from studies in the early twentieth century, which showed a relationship between episodes of extremely elevated concentrations of air pollution and elevated morbidity and mortality. The London smog episode of December 1952, which resulted in about 4000 excess deaths,[1] led to the modern era of research into the effects of air pollution on human health. At present, a large body of evidence demonstrates that air pollution, even at concentrations below the current air quality standards, is associated with adverse health effects in humans.[2–5] Climate change is expected to cause a decline in air quality.[6] The good news is that action on climate change has the potential to reduce levels of air pollutants, resulting in significant public health benefits.

Air pollution is a complex chemical mixture whose effects on the individual can vary in time and place, making it difficult to differentiate between the effects of individual pollutants. The most common outdoor air pollutants in Australia that are relevant to health are: particulate matter (of varying size); ground-level ozone; oxides of nitrogen; carbon monoxide; and sulphur dioxide. There is an Australian Ambient Air Quality (AAQ) National Environment Protection Measure (NEPM) for many, but not all, of these pollutants. National Environment Protection Measures are legally binding standards for each level of government. Each jurisdiction is required to monitor and report performance in relation to the standards.

Particulate matter

Particulate matter (PM) includes airborne solid or liquid particles including dust, pollens, soot and aerosols from combustion activities. The most common measure of particulate air pollution is the routinely monitored PM_{10} (particles with a diameter less than 10 μm) in the ambient air. However in the past decade, interest has shifted towards the fine particle fraction of PM_{10}, $PM_{2.5}$ (particles with a diameter less than 2.5 μm), as particles of this size are able to penetrate deeper into the lungs and have the potential to be more damaging. In Australia, there is an air National Environment Protection Measure for PM_{10}, however, unlike the United States of America (USA), there is only an advisory reporting standard for $PM_{2.5}$. Advisory reporting standards do not have a time frame for compliance, and are used to gather data nationally to review the case for adoption of a compliance standard in the future.

Ozone

Ozone is a secondary pollutant formed, in the presence of sunlight, from the reaction of volatile organic compounds (emitted by the burning of fuels and evaporation from vegetation) and oxides of nitrogen (emitted by burning of fuels). Hot, dry weather conditions are conducive to ozone formation: it is sometimes called summer smog. Ozone is routinely monitored at ground level and has an enforceable National Environment Protection Measure.

This article will concentrate on ambient particulate matter and ozone as these are the most well researched air pollutants and their concentrations are most likely to be of increasing concern under climate change scenarios.[6]

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How does air pollution contribute to chronic disease?

There is an extensive literature on the cardiorespiratory impacts of ambient air pollution, reporting a wide range of adverse health outcomes including exacerbation of chronic respiratory and cardiovascular disease, increased risk of cancer and premature mortality (Table 1).[7,8]

Sensitivity to the effects of air pollution differs according to individual susceptibility, age, and pre-existing health conditions. Young children, elderly people, those with chronic cardiac disease, and chronic respiratory disease such as asthma and chronic obstructive pulmonary disease, are generally more likely to be affected.[9]

There is good evidence that ambient air pollution can trigger the acute symptoms of, and exacerbate, both cardiac and respiratory disease. Recent evidence has supported a causal link between the development of asthma in children and exposure to traffic air pollution as well as the exacerbation of established asthma.[8,10–12] However, at present there is insufficiently strong evidence to support a causal association for chronic disease in all instances.

Plausible biological mechanisms supported by experimental evidence exist whereby air pollution has the potential to cause cardiovascular disease,[13] through, for example, contributing to a chronic inflammatory state increasing the risk of coronary atherosclerosis.[14] However more population-based research is needed to confirm this hypothesis.

Particulate matter

Increased particle concentrations in ambient air have been associated with long-term effects on mortality as well as increased risks for admissions for cardiac and respiratory disease, including chronic obstructive pulmonary disease, pneumonia and ischaemic heart disease.[15] In children particulate air pollution has been associated with increased chronic cough, and bronchitis.[16] Globally, ambient PM air pollution has been estimated to be responsible for at least 0.8 million premature deaths and 6.4 million lost life years.[17]

Pope et al.[18] in the USA found that each 10 μg/m^3 elevation in ambient fine particulate air pollution was associated with approximately a 4%, 6% and 8% increased risk of all-cause, cardiopulmonary and lung cancer mortality, respectively. Chen and Goldberg[19] reviewed 17 cohort studies and 20 case-control studies published 1950–2007 and found a 6% increase in non-accidental mortality for every increase of 10 μg/m^3 in ambient fine particles, independent of age, gender and geographical regions. They then estimated that exposure to fine particles would lead to approximately 5000 deaths a year in Canada. Among these deaths, 1100 deaths would be from lung cancer and 2700 deaths would be from cardiovascular diseases. Kunzli et al.[20] estimated the impact of total ambient air pollution on public health in Austria, France and Switzerland as a total mortality of 6%, or more than 40 000 attributable cases a year. About half of this pollution was attributed to motor vehicle traffic.

Ozone

Ozone exposure can cause lung inflammation resulting in decreased lung function and symptoms of respiratory irritation even in healthy people. It can also exacerbate bronchitis, emphysema and asthma.[21] The effects of long-term ozone exposure have until recently not been clear, but they may contribute to chronic lung disease,[21,22] and there is recent evidence of adverse effects on respiratory mortality.[23]

Australia

In Australia, significant associations have also been found between mortality and ambient air pollution.[24,25] A study investigating the health effects of air pollution on daily mortality in Brisbane, Melbourne, Perth and Sydney found the strongest associations with particulate matter, nitrogen dioxide and ozone. For example, a 10 μg/m^3 elevation in $PM_{2.5}$ concentration was associated with approximately a 1% increase in the daily total number of deaths.[26]

Respiratory morbidity has been reported in association with outdoor air pollution in a number of Australian regions including the La Trobe Valley,[27] the Newcastle and Wollongong areas of New South Wales (NSW)[5] and the Melbourne region.[28]

What is the link between air quality and climate change?

Common sources of air pollutants and greenhouse gases

An important connection between climate change and ambient air quality is that greenhouse gas emissions which drive climate change, and the pollutants described earlier, frequently stem from common sources: primarily fossil-fuel combustion. The most important greenhouse gases emitted by carbon-intensive energy generation and motor vehicle use are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) (Figure 1). Ozone, also a greenhouse gas, can be formed near combustion sources, depending on the meteorological conditions. Fossil fuel combustion also results in the emission of the main ambient air pollutants affecting health which include particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) (Table 1).

Interconnection between meteorological variables and ambient air pollution levels

Greenhouse gases have an effect on climate which in turn has an effect on air pollutant levels,[29] because factors like

Table 1. Major air pollutants, their sources, related health effects and current Australian Ambient Air Quality standards

Pollutant	Sources	Health effects^	NEPM* standard
Particulate matter (PM_{10} and $PM_{2.5}$)	Motor vehicle engines (particularly diesel engines), burning solid fuel, fossil fuel and plant material, bushfires, oil and gas extraction, coal and ore mining, manufacturing, windblown dust, paved and unpaved roads	– Decreased lung function – Increased respiratory symptoms – Exacerbation of asthma and other respiratory conditions – Exacerbation of cardiovascular disease – Premature mortality	PM_{10}: 50 μg/m^3 over 24 hours# $PM_{2.5}$: 25 μg/m^3 over 24 hours ($PM_{2.5}$ is only an advisory reporting standard)
Ozone (O_3)	Secondary pollutant, formed when burning of fuels (motor vehicles or industry) occurs in sunny conditions	– Decreased lung function – Inflammation of the lung – Increased respiratory symptoms and airway reactivity – Exacerbation of asthma and other respiratory disease – Decreased exercise capacity	0.10 ppm over 1 hour$ 0.08 ppm over 4 hours$
Sulphur dioxide (SO_2)	Mainly from fossil fuel combustion-energy generation. Also mining, manufacturing	– Increased respiratory symptoms – Exacerbation of respiratory disease	0.20 ppm over 1 hour$ 0.08 ppm over 1 day$ 0.02 ppm over 1 year
Nitrogen dioxide (NO_2)	Motor vehicle engines, energy generation, mining and other industry	– Increased respiratory symptoms – Increased airway reactivity – Exacerbation of respiratory disease	0.12 ppm over 1 hour$ 0.03 ppm over 1 year
Carbon monoxide (CO)	Motor vehicle engines, energy generation, other industry and bushfires, solid fuel burning	– Decreased exercise capacity – Exacerbation of ischaemic heart disease	9.0 ppm over 8 hours$

^Adapted from Bernard SM, Samet JM, Grambsch A, Ebi KL, Romieu I. The potential impacts of climate variability and change on air pollution-related health effects in the United States. Environ Health Perspect 2001;109(Suppl 2): 199–209.
*National Environment Protection Measures.
#Not to be exceeded more than 5 days per year.
$Not to be exceeded more than 1 day per year.

temperature, humidity, wind and precipitation can affect air pollutant emission, chemistry, deposition and transport.[30] Climate change may enhance the adverse effects of ambient air pollutants due to chemical and physical interactions in the atmosphere. Adverse effects of ozone have been observed during the warmer seasons with evidence of synergistic effects between high temperature and ozone. Similar interactions between effects of ambient PM and temperature have been reported.[31] Ozone in the troposphere can also act as a powerful greenhouse gas.

The interaction between increasing temperature and ambient air pollution in relation to health effects has also been found in Australia. For example, a study of temperature, air pollution and total mortality in summers in Sydney over the period 1994–2004 found that maximum temperature and sulphur dioxide air pollution had significant interactive effects on mortality.[32] Temperature has also been found to modify the health effects of particulate matter in Brisbane.[33] Furthermore, modelled effects of climate change in south eastern Australia predict that increasing bushfire risks will result in increasing levels of fine particles and volatile organic compounds.[34]

Emissions from transport sources

According to National Greenhouse Gas Inventory data for 2007, motor vehicle transport was responsible for 14.6% of greenhouse gas emissions in Australia.[35] Transport emissions are also a major source of ambient air pollutants affecting health. A 2005 Australian Department of Transport working paper found motor vehicles were the principal source of nitrogen oxides and carbon monoxide in capital city airsheds (the geographical boundary for air quality standards), and that a high proportion of motor vehicle particulate emissions were very fine particles.[36] The motor vehicle share of PM_{10} in capital city airsheds was 43% for Sydney, 31% for Brisbane, 33% for Melbourne, 19% for Adelaide, 20% for Perth and 10% for Hobart. The same study estimated that in the year 2000, motor-vehicle-related ambient air pollution accounted for between 900 and 2000 premature deaths in Australia.[36]

In Melbourne it is estimated that motor-vehicle emissions are responsible for 80% of the carbon monoxide, 60% of the nitrogen oxides, 40% of the volatile organic compounds and 30% of particulate matter in the outdoor air.[37]

Emissions from energy generating sources

In Australia 53.9% of greenhouse gas emissions come from stationary energy combustion (2007 data).[35] Of the electricity generated in Australia, 81% is generated from coal, 13% from natural gas, 5% from hydro and 1% from other sources (including oil and wind).[39] Electricity generation in Victoria, NSW region (includes the Australian Capital Territory) and Queensland is mainly fuelled by coal. In Western Australia, South Australia and the Northern

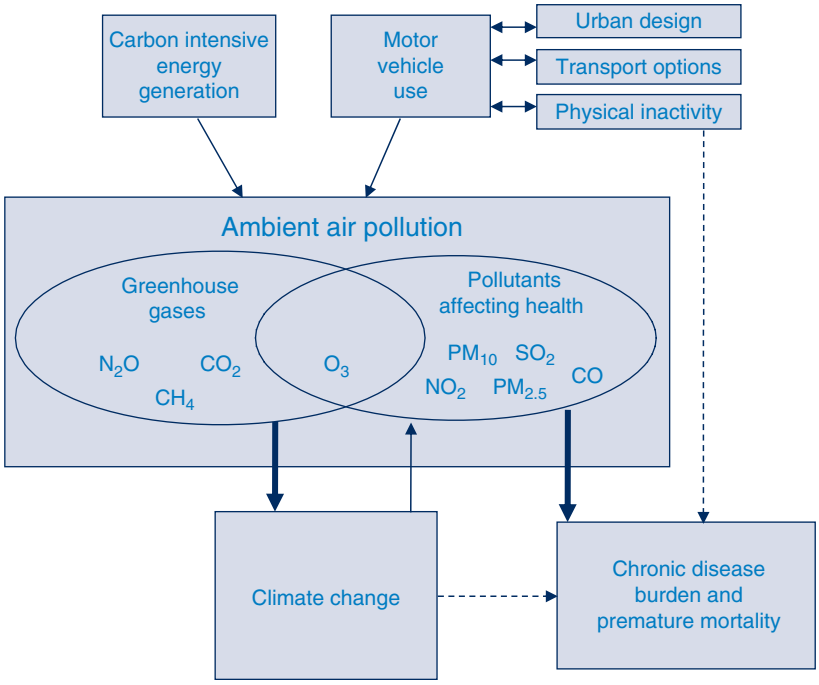

Figure 1. Schematic representation of the interconnections between climate change, air pollution* and chronic disease.
***CH_4 (methane), CO (carbon monoxide), CO_2 (carbon dioxide), NO_2 (nitrogen dioxide), N_2O (nitrous oxide), O_3 (ozone), PM_{10} (particles with a diameter less than 10 µm), $PM_{2.5}$ (particles with a diameter less than 2.5 µm), SO_2 (sulphur dioxide).**

Territory most electricity is generated by natural gas. Tasmania uses mostly hydrogeneration.[39]

Electricity generation and industrial production are major sources of $PM_{2.5}$ and PM_{10} emissions in Australia, often more so outside capital city airsheds.[38,40] For example, in the Sydney metropolitan airshed, industry contributes to 37% of PM_{10} emissions, but if the NSW Greater Metropolitan Region is considered (which includes the Newcastle and Wollongong regions as well as the greater Sydney region), 62% of PM_{10} emissions are from industry, primarily coal mining.[40]

Why would action to mitigate climate change help reduce the burden of chronic disease?

Policies that aim to reduce the rate of climate change by reducing greenhouse gas emissions are likely to produce a mutual benefit for health and the environment by reducing health-damaging ambient air pollutants and the related chronic cardiac and respiratory disease burden. While to date in Australia these two problems have been addressed by separate policies, to achieve the best outcome for climate and health, integrating them would be more effective.[41]

Figure 1 shows the interconnections between climate change, ambient air pollution and chronic disease. Action to mitigate climate change can potentially reduce the chronic disease burden because of decreasing air pollutant concentrations affecting health, increasing physical activity as an alternative to vehicle use[42–44] and reducing the risk of other climate change-related impacts such as heatwaves, bushfires and dust storms.

Transport

Policies that aim to reduce motor vehicle use by increasing the use of alternative transport, and active transport such as walking and cycling, are also likely to reduce the risk of chronic non-communicable diseases such as obesity, cardiovascular disease and diabetes.[45]

Woodcock et al. used comparative risk assessment methods to estimate the benefits of alternative transport scenarios for London and Delhi, modelling health effects of ambient $PM_{2.5}$.[43] The scenario with the largest health gains for London (combined increased active travel and lower-emission motor vehicles) produced an estimated 10–19% reduction in the number of years-of-life lost from ischaemic heart disease, as well as reductions in cerebrovascular disease, depression, dementia and diabetes. This outcome did require large increases in distances walked and cycled and a 37% reduction in car use. The authors concluded that important health gains and reductions in CO_2 emissions could be achieved through replacement of urban trips in private motor vehicles with active travel. However to achieve this level of health benefit, effective policies to increase distances walked and cycled and reduce car use are needed, with creation of safe and attractive urban environments for mass active travel.

Ozone standards have been exceeded every year since 1994 in the Sydney region, with levels sometimes reaching as much as double the standards.[40] Since 1998, there has been no improvement in levels of ambient ground-level ozone in greater metropolitan Sydney.[40] Despite improvements with fuel and vehicle emissions standards, the number of vehicles on the road has increased. Around a third of the car trips made in Sydney are less than 3 km and more than half are less than 5 km.[34] Increasing the proportion of these short trips that are walked or cycled could have significant health and climate benefits.

Examples, such as the 1996 Olympic Games in Atlanta, illustrate what can be achieved relatively quickly. Traffic restrictions were put in place for the Games along with increased availability of alternative transport. During this time, peak daily ambient ozone concentrations decreased approximately 30% from baseline, which was associated with a significantly lower rate of asthma events.[46]

Energy generation

Modelling by Markandya et al.[44] of changes in electricity production to reduce CO_2 emissions with concomitant reductions in $PM_{2.5}$ showed health gains in all countries studied, although gains were greatest in developing countries. Changes of modes of electricity generation were estimated to reduce not only carbon dioxide emissions but also particulate air pollution and consequently mortality. They predicted that by pursuing a climate target solely for electricity generation, 104 life-years per million people would be saved every year in the European Union (48 000 in total).

In Australia, major sources of pollution from energy generation and coal mining are often outside of capital city airsheds, e.g. Newcastle, Wollongong and the Latrobe Valley. However changes to these industries to reduce greenhouse gas emissions still have the potential to reduce the health impact on the local population.

Conclusions

Ambient air pollution is a significant contributor to both climate change and chronic disease. Effective policy needs to incorporate and understand the synergies between climate change and air pollution and the resulting health impacts. Moving away from carbon-intensive energy generation and motor vehicle dependence has the potential to reduce greenhouse gas emissions and the risk of harmful climate change. This action is necessary not only to reduce the range and severity of impacts from climate change, but

also to reduce the morbidity and mortality that continues to be associated with poor air quality.

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Editorial Manager
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Editorial correspondence
Please address all correspondence and submissions to:
The Editor, *NSW Public Health Bulletin*
Locked Mail Bag 961
North Sydney NSW 2059 Australia
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Telephone: +61 2 9424 5876
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The co-benefits for health of investing in active transportation

***Billie Giles-Corti*[A,D], *Sarah Foster*[A], *Trevor Shilton*[B] *and Ryan Falconer*[C]**

[A]*Centre for the Built Environment and Health, School of Population Health, The University of Western Australia*

[B]*Heart Foundation of Australia, Perth*

[C]*Formerly*[A]*, now Sinclair Knight Merz, Perth*

[D]*Corresponding author. Email: billie.giles-corti@uwa.edu.au*

Abstract: Amid growing concerns about the impact of rising obesity and physical inactivity levels, climate change, population growth, increasing traffic congestion and declining oil supplies, multiple sectors are now promoting active transportation as an alternative to driving. This paper considers the health benefits and co-benefits of investing in active transportation, enabling comparison of policy options to optimise societal objectives aimed at creating healthy, socially and environmentally sustainable communities. Policies promoting the use of both energy-efficient motor vehicles and increased active transportation would almost double the impact on greenhouse gas emissions and would reduce disease burden by increasing physical activity. More co-benefit and economic analyses research is required to inform 'joined-up' policy solutions.

Amid growing concerns about the effect of increasing levels of obesity and physical inactivity, climate change, population growth, increased traffic congestion and declining oil supplies, many sectors are now promoting active transportation as an alternative to driving motor vehicles.[1] While the outcomes sought range from improved health and traffic management through to environmental protection and the mitigation of climate change, promoting active transportation is increasingly recognised as a way to advance multiple agendas.

Active transportation includes travel by foot, bicycle and other non-motorised means (e.g. foot-powered scooters)[2] and it often forms part of a trip chain for public transport users.[3] A number of reviews emphasise the importance of active transportation from health, economic, social, environmental and traffic management perspectives.[4–11] They highlight environmental interventions that would facilitate a shift from motor vehicle-dependent suburbs to communities accessible by active modes, supported by high quality public transport (Box 1).

Box 1.

Trip chaining involves planning ahead and using one journey to achieve a number of objectives. For example, a public transport trip may be preceded or followed by a walking or cycling trip, either simply to get to or from the public transport stop, or to achieve another objective such as stopping at the newsagent to collect a newspaper to read on the bus.

Despite this evidence, there remains some distance between theory and practice. This paper seeks to contribute to the debate by discussing the health benefits and co-benefits of investing in policies and interventions to increase active transportation.

Active transportation from a health perspective

Building the habitual use of active transport into daily routines is one means to increase physical activity.[2,5,10] Yet active transportation has rapidly declined in most developed countries over the past 3 decades.[12–17]

Globally, physical inactivity ranks second only to tobacco as a behavioural risk factor contributing to the burden of disease,[18] and is a major risk factor for numerous chronic diseases and their determinants (e.g. cardiovascular disease, diabetes, colon and breast cancer and mental health).[19] Physical inactivity globally causes about 1.9 million deaths each year,[18] and in Australia alone over 13 000 deaths each year.[20] Worldwide 60% of adults[21] and approximately half of Australian adults are insufficiently active to benefit their health.[22] Furthermore, physical inactivity and sedentary behaviour are independent risk factors for obesity.[19] Globally, an estimated 20 million children and 1.3 billion adults are either overweight or obese,[23] as are two-thirds of men, one-half of women[24] and one-fifth of children in Australia.[25]

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The societal benefits of even a modest increase in those who are physically active could be large. For example, a five-percentage point increase in the proportion of people doing 30 minutes each day of moderate activity could save around 600 Australian lives per year, with significant savings to the health system.[26] A longitudinal study of Scandinavian adults found that, after adjustment, mortality rates in workers who cycled to work were 28% lower than others.[27] Similarly, a Chinese study found a 20–50% lower risk of premature mortality in women who regularly exercised or cycled for transportation.[28] A British study identified that children who walked or cycled to school were fitter than those who travelled by bus or car, with fitness 30% higher in boys who cycled and seven-fold higher in girls.[29]

Increasing physical activity levels is also an essential component of interventions required to combat obesity.[21] A recent study of walking, cycling and obesity levels in Europe, North America and Australia found an inverse relationship between population active transportation and obesity levels, providing additional support for the benefits of promoting active transportation.[30]

Other health benefits would follow if vehicle miles travelled could be reduced. Motor vehicle transportation reduces air quality and contributes to the risk of respiratory diseases (e.g. asthma) and a range of chronic diseases, including cardiovascular disease.[31,32] In Australia, 1% of the burden of disease and injury is attributed to urban air pollution.[20]

Urban air pollution varies by location, with particulate matter accumulating at traffic lights where flows are interrupted and vehicles idle. Pollution is, therefore, concentrated near major transport arteries, which are heavily trafficked and often congested.[33] Studies emphasise that those living on or near busy roads (within 300 metres) are exposed to significantly higher levels of pollutants.[34,35] Transport mode choice also influences pollutant exposure. Counter intuitively, vehicle drivers and their passengers may inhale up to 18 times more air pollution than those outside the vehicle,[36,37] even compared with cyclists on busy streets.[38]

Benefits of active transportation in sectors outside of health

Beyond these significant health impacts, promoting active transportation confers numerous other social, environmental and economic benefits.

Social benefits

Pedestrian and cycling-friendly neighbourhood designs can facilitate incidental contacts between neighbours and appear to foster social capital (i.e. social networks, norms and trust).[39,40] Numerous studies show positive associations between social capital and physical and mental health, and health promoting behaviours.[41–43] Social capital may promote positive social norms while simultaneously controlling antisocial behaviours that can fuel feelings of insecurity.[42]

Increased pedestrian traffic also has the potential to influence neighbourhood safety by generating natural surveillance. Jane Jacobs asserted that urban environments with diverse land-uses would increase public safety and minimise fear by creating lively streets, monitored by local business proprietors and residents.[44] Although greater pedestrian numbers can increase public nuisance crimes (e.g. littering, drug sales), pedestrian traffic appears protective against serious personal crime, which typically occurs when pedestrians (and, therefore, surveillance) are scarce.[45]

The provision of walkable neighbourhoods, with frequent accessible public transport is also an important strategy to limit 'transport poverty' (e.g. households without access to public transport).[44] It also prevents marginalisation of other vulnerable subgroups with restricted mobility (e.g. children, older people and people with disabilities).[46,47]

Reducing fossil fuel dependency

Motorised travel is dependent on oil and is responsible for almost half the world's oil use.[1] Over-reliance on fossil fuels is a concern because of its impact on greenhouse emissions[48] and because it is a diminishing energy source. Globally, there is a need to diversify how populations are mobilised[49] to mitigate declining oil supplies. While a shift to energy efficient vehicles is one part of the solution, a more comprehensive approach is required that also involves reducing vehicle miles travelled and increasing the transport choices available to people.

Environmental benefits and climate change mitigation

Motor vehicle travel can be detrimental to environmental health.[1] In 2004, it was estimated that around 17% of carbon dioxide emissions associated with global energy use were from road transport.[48] Transport emissions are rising faster than emissions from other sectors and are projected to be 80% higher than current levels by 2030.[48] Moreover, personal motor vehicles are said to consume more energy and emit more greenhouse gas emissions per passenger-kilometre than other rail and road transport modes.[48] Vehicle-generated greenhouse gas emissions are key contributors to global warming and climate change, making them important drivers for action.

Ewing and colleagues recently lamented the futility of global warming solutions that do not curb vehicle miles

travelled.[50] Citing the United States of America (USA) policy to prioritise increasing fuel efficient cars and reducing fuel's carbon content, they argued this policy overlooks vehicle miles travelled, the most important contributor to emissions.[50] They estimated that if 60% of new US housing growth occurred in transit-oriented developments, about 85 million metric tonnes of CO_2 could be saved annually by 2030.[50] Thus, while restraining personal vehicle ownership and use need to be policy priorities,[48] this can only succeed if land use and transportation investments in pedestrian, cycling and transit infrastructure are prioritised.

Another compelling reason for curbing vehicle miles travelled is traffic congestion. Internationally, traffic congestion is a growing concern, given that over half the world's population already lives in cities; by 2030, it is predicted that the urbanised population will reach five billion.[51] Given the link between traffic congestion and air pollution, the rapid motorisation and urbanisation of developing countries are troubling. For example, between 2000 and 2020, Chinese emissions of carbon hydroxide, dioxide (CO_2) and monoxide, sulphur dioxide, volatile organic compounds, and nitrous oxide are predicted to rise up to 20-fold.[52]

Economic benefit

From a health perspective there are economic benefits associated with investing in active transportation. In Australia, recent estimates indicate the direct and indirect costs to the Australian economy are $13.8 billion for physical inactivity,[53] and the direct costs $21 billion for obesity and overweight.[54] The annual costs of obesity and physical inactivity will continue to grow if current levels continue unabated.[55–58]

In New Zealand (NZ), Woodward modelled the impact on the health budget of a 5% increase in bicycle trips of less than 7 km (equivalent to levels in 1980).[17] After accounting for additional costs associated with cycling injuries and fatalities, he estimated the annual net health savings amounted to $200 million, or around 1.6% of NZ's annual health budget. A comparable impact in Australia would save around $1.7 billion on Australia's 2007–08 health expenditure.[59]

Changes to neighbourhood design could also produce benefits for the local micro-economy. Increasing population densities and boosting local pedestrian and cycling traffic flows can increase the economic viability of cafes and corner stores, and improve access to jobs and services without increasing congestion or vehicle emissions.[6]

The co-benefits of investing in active transportation

As depicted, investment in active transportation has the potential to produce substantial co-benefits across multiple sectors,[60] including health.[61,62] When benefits across multiple policy areas are considered concurrently, the term co-benefits is used. For example, the City of London's congestion tax not only reduced traffic by 30%, and CO_2, NO_x (refers to NO and NO_2) and large particulate emissions by 16–20%, it also increased walking and cycling.[63]

Yet to date, relatively few studies have quantified the co-benefits of different approaches to changing modes of transport and the impacts on CO_2 and health.[64] Using Comparative Risk Assessment methods, Woodcock and colleagues estimated the effect of alternative transportation scenarios on health and carbon emissions, compared with business-as-usual.[64] Table 1 summarises the results for London, indicating the co-benefits that could be derived from implementing strategies that increased both lower-emission motor vehicle use and active transportation (i.e. a two-fold increase in distances walked and an eight-fold increase in distances cycled from a very low base). Compared with a strategy focused solely on lower emission vehicle use, a combined intervention would almost double reductions in greenhouse emissions in London and would substantially reduce premature deaths and years of life lost to disability.

Nevertheless, to have an impact, active transportation requires land-use planning and infrastructure investment that creates pedestrian and cycling-friendly communities.[62,65] Numerous studies now point to the importance of the built environment as a determinant of active transportation.[2,3] Moreover, studies have recently begun to demonstrate the effectiveness of infrastructure investments in changing behaviour,[62] and their cost effectiveness as a public health[66,67] or transport and health[68] intervention. Ignoring the implementation of complementary strategies (e.g. congestion pricing, increased transit use) or co-benefits, Ewing and colleagues[65] recently estimated that a change in land-use planning in the USA (from urban sprawl to compact development) could reduce vehicle miles travelled by 20–40% and transportation greenhouse emissions by 7–10% by 2050.

However few studies have comprehensively considered the co-benefits of land-use and transportation planning, including the co-benefits of strategies required to avoid negative impacts. For example, despite the benefits of compact urban development, strategies may be required to mitigate heat island effects (e.g. urban tree plantings, building living and lighter roofs) that could beneficially affect health. Moreover, in economic analyses, consideration of co-benefits is embryonic,[68] yet this approach could substantially increase benefit-cost ratios associated with infrastructure investment.[67] Together these are fruitful lines of future enquiry for multidisciplinary research teams that could provide evidence to help prioritise strategies.

Table 1. Anticipated environmental and public health impacts of different land transportation strategies to reduce greenhouse gas emissions in London (adapted from Woodcock et al. 2009)[64]

Estimates	Business as usual: 2030 projection	Lower carbon emission motor vehicles alone	Increased active transportation alone	Both lower carbon emission motor vehicles and increased active transportation
Change in transport CO_2 from 1990 (%)	4↑	35↓	38↓	60↓
Per person tonnes transport CO_2 emissions	1.17	0.73	0.69	0.45
Air pollution (particulate matter with aerodynamic diameter of $\leq$2.5 μm) concentrations (μg/m^3)	8.2	7.8	7.7	7.4
Health effects (per million population) in 1 year compared with business as usual				
Premature deaths		17	530	541
Years of life lost		160	5188	5295
Disability-adjusted life years		160	7332	7439

Conclusion

As societies confront the economic, social and environmental effects of climate change, population growth traffic congestion and the burden of chronic disease, there is a unique opportunity to view the benefits of active transportation through a multi-sector lens. This paper shows that by taking a co-benefits approach to transport policy-reform, there is an opportunity to minimise carbon emissions and improve health. Studying the co-benefits of policy-options however is at the nascent stage. There are enormous opportunities to extend this approach to examine the co-benefits of active transportation encompassing broader perspectives e.g. reducing traffic congestion to achieve broader societal objectives related to socially and environmentally sustainable communities.

More multidisciplinary research is required that informs 'joined-up' policy solutions that cut across multiple policy agendas. The language of co-benefits is useful as it helps breaks down policy silos and presents additive (rather than discrete) benefits that could be incorporated in economic analyses to assess cost-effective strategies. Moreover, it could inform debate and facilitate assessment of policy alternatives to optimise outcomes for the community. Thus, articulating co-benefits should be at the forefront of future policy-reform discussions. An active transportation intervention not only tackles climate change, it could also deliver powerful co-benefits related to preventive health, social capital, traffic congestion and the economy.

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NSW Premier's Council for Active Living

Peter McCue

Premier's Council for Active Living NSW
Email: peter.mccue@heartfoundation.org.au

The NSW Premier's Council for Active Living (PCAL) aims to strengthen physical and social environments to enable active living. PCAL comprises representatives from NSW Government (linking infrastructure and service delivery agencies), business and the community sector; it reports to the Premier. The Council provides advice to government and promotes guidelines, policy and legislation to increase the level of physical activity of all people in NSW. PCAL's priorities include active travel, healthy urban planning and the liveability of NSW cities and towns.

The Council's activities are informed by better practice recommendations that highlight the need for high-level interagency collaboration as a key component of a comprehensive strategy to increase health promoting physical activity.[1] Most other Australian states and territories have established similar inter-sectoral groups.

Since 2008, the Council has hosted an ongoing high-level Active Transport Roundtable with Executive representation from health, environment, transport and planning agencies. The Roundtable has led to the implementation of a number of initiatives including a new NSW State Plan Active Transport Target, the development of interagency tools such as a NSW specific Workplace Travel Plan Resource, better practice Active Travel Case Studies and a range of NSW Government policy changes such as the mandatory provision of end-of-trip facilities within NSW Government workplace refurbishments.

At the request of the NSW Premier, PCAL oversaw the development and resourcing of an updated NSW Bike Plan. An interagency governance model jointly led by the NSW Roads and Traffic Authority and the Department of Environment, Climate Change and Water was used to ensure the Bike Plan not only incorporated the development of key strategic cycling infrastructure but also actions describing how agencies will collaborate with stakeholders to implement relevant behaviour change programs. Background studies were commissioned to inform development of the Bike Plan including a cost/benefit analysis.[2] Results demonstrated significant positive returns from proposed shared-pathway infrastructure development due to health, environmental (including reduced greenhouse gas emissions) and congestion co-benefits.

Another priority area in which PCAL has facilitated interagency collaboration has been the promotion of supportive urban environments for active living. PCAL has summarised in its *Why Active Living Statement* the key evidence demonstrating the health, environmental, economic and social benefits of physical activity and characteristics of the built environment that promote active living.

Accumulation of the evidence base linking the built environment to active living, health and greenhouse emissions has in turn led to the incorporation of evidence-based active living indicators within the Division of Local Governments Long-term Integrated Strategic Planning Reform Manual. The intention of the indicators is to provide local councils with a selection of evidence-based measures that will help demonstrate progress towards the development of more supportive environments for active living. Director-General requirements to consider active living principles within relevant State projects such as the Bonnyrigg Housing Redevelopment have also emerged.

PCAL has also developed a number of resources to facilitate implementation of Healthy Planning principles at the local government level. *Designing Places for Active Living* is a web-based product which provides key design considerations for walking and cycling routes, public transport, streets, open spaces, shopping centres and workplaces as well as links to key references and other resources for more detailed guidelines and specifications. NSW better practice case studies demonstrating the translation of the key design considerations into practice are also provided. *Development and Active Living*[3] provides relevant matters (by NSW Planning Development Type) for consideration in the preparation of Local Environment Plans and Development Control Plans and in the assessment of major development applications.

Further information about PCAL, links to the PCAL resources outlined above and other active living-related tools are available at: www.pcal.nsw.gov.au

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Climate change, food insecurity and chronic diseases: sustainable and healthy policy opportunities for Australia

Sharon Friel

Australian Research Council Future Fellow, The National Centre for Epidemiology and Population Health, The Australian National University

Email: Sharon.friel@anu.edu.au

Abstract: Food provides a link between the population health and climate stabilisation agendas. This paper argues that a broader view of food security for the 21st century in Australia and internationally is needed – one that judges the food system for its nutritional quality, social value and impact on the environment. If done well, climate change mitigation and adaptation policies provide ways to achieve this. This paper focuses on mitigation strategies, and describes how the reduction of greenhouse gas emissions from the agricultural sector through a reduction in consumption of animal source foods can improve food security and reduce the levels of chronic diseases such as cardiovascular diseases and some cancers.

In the mid-1970s, the World Food Conference defined food security in terms of a food supply that could ensure the availability and price stability of basic foodstuffs at the international and national level: 'food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.'[1]

This paper argues the need to expand the framing of food security to include not just quantity of food but also its nutritional quality, the wider social context and environmental dimensions. By using such a framing, food insecurity would encompass both a lack of food and a lack of good nutrition. The definition of food and nutrition insecurity encompasses the unhealthy transition from plant-based diets to diets of highly refined foods and meat and dairy products that contain high levels of saturated fats; a transition that is occurring in all but the poorest countries.[2] A more comprehensive understanding of food insecurity also recognises that it is not just nutritional health that is compromised in food-poor households, but also social behaviour when, due to issues of affordability and access, people cannot eat, shop for, provide or exchange food in the manner that has become the acceptable norm in society.[3] The paper emphasises the critical relationship between climate change and the food system, with consequences for food security, dietary options and chronic disease risks among different social groups.

The paper also discusses how food security in 21st century Australia and internationally requires the focus of food policy to evolve from seeking to increase the amount of food available for consumption, to also consider wider public health and environmental consequences.

Food insecurity in a country like Australia

The world faces high levels of food insecurity; while 1 billion people have insufficient calorie or protein intake and experience undernutrition in relation to micronutrients; in many countries, poor nutritional quality and an excess calorie intake has caused a global obesity epidemic.[4]

Insufficient food

In Australia a substantial proportion of the population are nutritionally compromised through lack of food: 15% of young people, 20% of people in the second lowest income quintile and rental households, 23% of unemployed and single parent households,[5] 71% of refugees resident in Australia for less than a year,[6] and 7% of the general population surveyed in South Australia[7] reported having run out of food at times during the previous 12 months and not being able to buy more. In New South Wales (NSW), 5.3% of people aged 16 years and over experienced food insecurity in 2005.[8] The prevalence is much higher among socially disadvantaged households; 22% of low income households in South West Sydney reported having run out of food at times during the previous 12 months and not being able to buy more.[9]

Nutritional insecurity

A significant proportion of the Australian population while not lacking sufficient food, consume a diet that is

nutritionally imbalanced, leading to nutrition insecurity. For example, in 1995 (the most recent nutrition survey for Australia), saturated fat accounted for around 13% of total energy intake by Australian adults, higher than the recommended maximum level of 10%. Analysis of the 2004–05 National Health Survey shows that 86% of people aged 12 years and over consumed fewer than the National Health and Medical Research Council recommended five serves of vegetables per day, and 46% consumed fewer than two serves of fruit.[10]

The relationship between food insecurity and chronic diseases

Diet plays a prominent role in premature death from many chronic health conditions. Undernutrition leads to increased susceptibility and reduced resilience to chronic diseases and cognitive dysfunction among nutritionally compromised populations. Overconsumption together with a reduction in physical inactivity are among the leading causes of obesity, cardiovascular disease, type 2 diabetes and certain types of cancers.[11,12]

Almost a quarter of Australia's disease burden is attributable to diet-related risk factors.[10] Although declining between 1987 and 2006, cardiovascular disease remained the most common cause of death in NSW in 2006 (16 245 deaths). A proportion of the non-communicable diseases that dominate the NSW health burden (Figure 1)[13] could be prevented through action which seeks to ensure food and nutrition security.

Food, social systems and food insecurity

The nature of the global and Australian food systems – from the underlying conditions of governance and trade, issues of agricultural production, food procurement and distribution, consumer price of food, excessive marketing of energy-dense, nutrient-poor foods and food waste – affects food security and health risk through matters of food availability, nutritional quality and affordability.[14]

Like most other risk factors for chronic diseases in Australia, food insecurity is more prevalent among socially disadvantaged groups. Having enough money to buy food; being able to travel to retail outlets selling the range of commodities desired in contemporary societies; having food storage and cooking facilities; enjoying a choice of cuisines and food practices appropriate to one's cultural identity; and having the personal skills and knowledge to prepare nutritionally balanced meals influence the social distribution of food and nutrition security and thereby chronic disease risk.[15]

Climate change – an additional determinant of food insecurity

In addition to existing food and social system inadequacies, there is growing recognition of the additional stress on food insecurity presented by climate change. The drought-prone and long-term drying conditions in Australia and in other subtropical regions around the world, higher temperatures, rising sea levels, increasing frequency of flooding, and

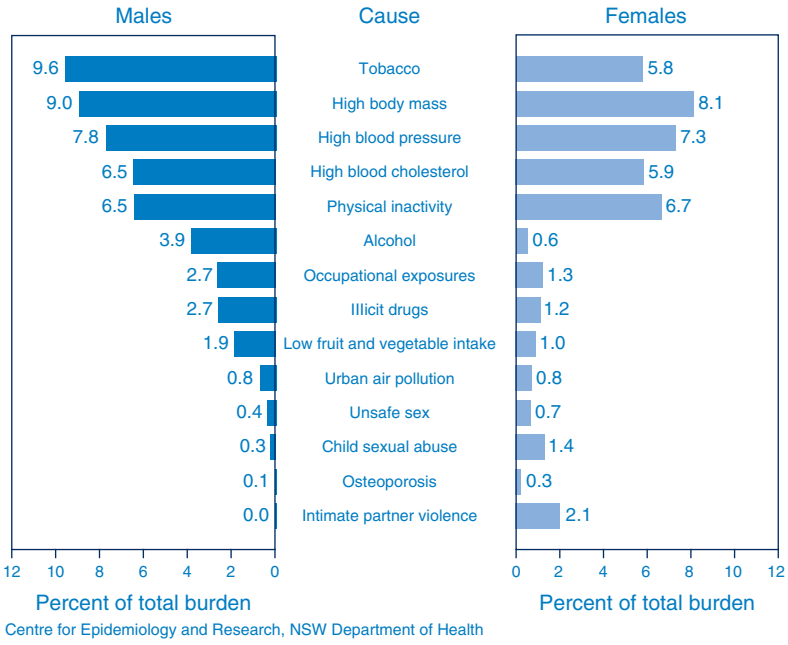

Figure 1. Disability adjusted life years for males and for females, by risk factor, NSW 2003.
Source: The health of the people of New South Wales – Report of the Chief Health Officer. Sydney: NSW Department of Health. Population Health Division; 2008.

acidification of oceans contribute to impaired yield, quality and affordability of food in many countries.[16] Further, climate change-induced disturbances to traditional living, hunting and eating patterns among rural and remote Indigenous populations may also affect food security through reduced options for physical mobility and increased reliance on imported energy-dense processed foods, thus potentially amplifying obesity, cardiovascular disease and diabetes.[17]

In Australia climate change is affecting the availability and price of food. Usually one of the world's largest grain exporters, severe drought in the last decade has led to two years (2001–02 and 2007–08) of net grain importing.[18] Similarly, fresh food such as fruit and vegetables are produced and distributed largely domestically however prolonged drought and the frequency of climate change-induced extreme weather events affect the availability of fruits and vegetables and therefore the consumer price. A recent report estimated that between 2005 and 2007 there had been a 33% increase in the price of vegetables and a 43% increase in fruit prices because of the drought.[19]

Rising food prices most affect the poor. In Australia, the cost of consuming a diet based on national health guidelines already uses about 40% of the disposable income of welfare-dependent families compared to 20% of an average income household.[20] Climate change-related additional price increases will add potentially unmanageable financial pressures on some households, leading to food insecurity as well as physical and mental distress. As the cost of the collective basket of household goods starts to increase more rapidly, and income does not, all but the wealthy in Australia and elsewhere will likely feel the effects, putting substantially more people at risk of food insecurity.[21]

The food system's contribution to climate change

There is a bi-directional relationship between climate change and food systems. All stages in the food system produce greenhouse gases and therefore contribute to climate change. The agricultural production stage represents the single biggest contributor to the overall food sector emissions. According to calculations by the Intergovernmental Panel on Climate Change (IPCC) agriculture along with the associated deforestation and land use changes account for about 29% of global emissions.[22,23] Production of foods from animal sources (livestock) is the major contributor to emissions from the agricultural sector.

In Australia, 16.3% (88.1 metric tonne carbon dioxide equivalent [MtCO2-e]) of the total 541.2 million MtCO2-e emitted in 2007 came from the agriculture sector (this figure excludes agriculture-associated land use change greenhouse gas emissions).[24] NSW's agriculture sector produced 17.5 MtCO2-e in the same time period – the second largest contribution by the States and Territories to greenhouse gas emissions from the agriculture sector.[25] Australia's livestock emissions were 61.0 MtCO2-e in 2007, representing 69% of the sector's total emissions (Figure 2).

Livestock give rise to nitrous oxide, both from pasture land and from the arable land used to grow feed crops and methane, from digestive processes of ruminant animals. This enteric fermentation process by ruminant animals is by far the biggest contributor to carbon dioxide equivalent emissions in Australia (57.6 MtCO2-e in 2007). It is both the volume of emissions associated with ruminant animals that are a concern and the type of emissions (the global warming potential of methane is 23 times that of carbon dioxide). The emissions per unit of livestock product vary

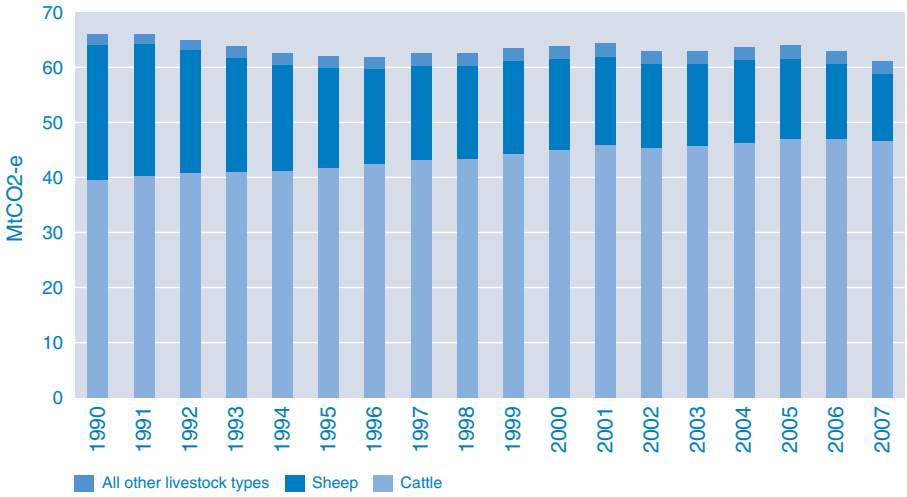

Figure 2. Trends in metric tonne carbon dioxide equivalent ($MtCO_2$-e) emissions from livestock, Australia.
Source: Department of Climate Change. National Greenhouse Gas Inventory accounting for the KYOTO target. Canberra: Department of Climate Change; 2009.

according to the type of animal and the feeding regimen used, but appear higher in beef, sheep and dairy compared with poultry farming.[24]

In combination with world population growth projections, the increasing demand for agriculturally intensive animal foods, such as meat and dairy products, point to an approximate doubling in global meat consumption by the mid-21st century.[26] This has serious ramifications for climate change and local environments. It is also a concern for food security and human health.[27] While animal-source products are important sources of essential macro and micro nutrients, they are also significant contributors of saturated fats in the human diet and of cardiovascular disease.[11] Colorectal cancer is also strongly related to levels of animal-source dietary intake, particularly red meat.[28]

Improving food security through climate change mitigation policy

As described, many of the underlying causes of food insecurity and chronic diseases are also greenhouse gas-emitting processes.[29] Actions to mitigate climate change are therefore actions that prevent the growth of food insecurity and the associated disease burden in Australia and globally.

Given that the agricultural production stage represents the single biggest contributor to the food system's total emissions and that the bulk of emissions from agriculture are due to livestock production, a key strategy to mitigate climate change – in Australia and other high income countries – would sensibly focus in this area. A recent international research program on the health co-benefits that would result from actions to reduce greenhouse gas emissions in a number of different sectors identified that, combined with technological improvements in farming practices, a 30% reduction in production and population-level consumption of animal-source foods would be needed to meet select national emissions targets.[30] Modelling the health effects of a 30% reduction in consumption of animal-source foods (the major dietary source of saturated fat) estimated a 15% reduction in the years of life lost from ischaemic heart disease in the United Kingdom and 16% in Sao Paulo, Brazil.[31] Given that animal-source foods and associated saturated fats are common risk factors for other non-communicable diseases, dietary change would not only prevent ischaemic heart disease but also some cancers and possibly reduce obesity.

A forthcoming paper using Australia as a case study describes the modelled effects of a theoretical reduction in ruminant red meat consumption on colorectal cancer incidence in Australian adults and on greenhouse gas emissions from on-farm activities in the livestock sector. Under a scenario of 50 g/person/day red meat consumption,[27] the estimated preventable proportion for colorectal cancer incidence among males was 10.7% (771 cases in 2005), while reducing annual emissions from livestock by 13.3 MtCO2-e (approximately 22% of emissions).[32]

Conclusion

Food security is no longer only about making food available, accessible and affordable. Climate change and the implications for the type and cost of foods available to Australians as well as preventing further dangerous climate change mean that sustainability must be placed at the heart of the food system. As Lang describes, this means judging food production and consumption for their impact on the environment, health, quality and social values.[33] Climate change mitigation policy provides a major opportunity to improve food security and human health as well as planetary health.

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The Healthy Built Environments Program: a joint initiative of the NSW Department of Health and the University of NSW

***Susan M. Thompson*[A,D], *Andrew Whitehead*[B] *and Anthony G. Capon*[A,C]**

[A]*Faculty of the Built Environment, University of New South Wales*
[B]*Centre for Health Advancement, NSW Department of Health*
[C]*National Centre for Epidemiology and Population Health, The Australian National University*
[D]*Corresponding author. Email: s.thompson@unsw.edu.au*

Abstract: The built environment is increasingly viewed as an important determinant of human health. Consequently creating environments that promote health and wellbeing is one of the NSW Department of Health's key preventive health priorities. This article describes a new program focused on improving health through the quality of the built environment. Recently established in the City Futures Research Centre, Faculty of the Built Environment, University of NSW, the Healthy Built Environments Program receives funding from the NSW Department of Health. The Program will foster cross-disciplinary research, deliver education and workforce development, and advocate for health as a primary consideration in built environment decision making. The Program brings the combined efforts of researchers, educators, practitioners and policymakers from the built environment and health sectors to the prevention of contemporary health problems. The Program's vision is that built environments will be planned, designed, developed and managed in ways that promote and protect the health of all people.

In recent years, there has been rising international interest in, and concern about, links between human health, the built environment and ecological sustainability.[1–3] There is increasing evidence that the physical form of our cities affects health.[1–7] Neighbourhoods where it is easy to cycle or walk from home to shops and places of employment have been shown to positively contribute to human and environmental health.[4–7] Conversely, localities that are more spread out, with segregated land uses, disconnected street patterns and limited public transport, are associated with car dependency, less physically active lifestyles of their residents and greater social isolation.[4–7] These urban forms also contribute to climate change with excessive greenhouse gas emissions created by dependency on cars.

Urban planning has a long association with health. The discipline originated out of concern for human health[8] and as far back as a century ago was strongly aligned with public health objectives to prevent the spread of disease. Nevertheless, this close relationship between health and urban planning was not sustained as planning moved to focus on urban policy development, design and environmental sustainability, while public health largely pursued a medical model.[9] Today however, there is a gradual re-alignment of the two as understanding grows of the role that the built environment plays in supporting human health. This paper introduces a recent New South Wales (NSW)-based initiative – the Healthy Built Environments Program (HBEP). Arising from health concerns, the Program is uniquely situated within an urban planning and design context, and will have a strong environmental sustainability focus.

How did we get here?

At the international level, recognition of the need to embrace a broader understanding of health goes back to the 1970s when the World Health Organization (WHO) commissioned the development of a program of public health reform which today is known as Health21.[3,10] In 1986 this led to the declaration of the Ottawa Charter for Health Promotion and the establishment of the WHO Healthy Cities Project. In 1992 the United Nation's Agenda21 emerged from its Earth Summit Conference in Rio de Janeiro, Brazil, linking environmental sustainability and human health.[3] Both Health21 and Agenda21 today underpin the WHO Healthy Cities Project, which links health and sustainable development at the local level.[3] Healthy Cities Projects in Australia include Onkaparinga (formerly Noarlunga) in South Australia[10] and the Illawarra in NSW.[11]

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In Australia, the health sector has led policy initiatives to bridge health and the built environment. Most recently, the Australian Government undertook national reviews of health promotion and the health system more generally.[12,13] The views of urban planners and designers have informed key recommendations emerging from these reviews. Multiple perspectives have been encouraged in other forums. For example, the Australian Academy of Science 2006 Fenner Conference, *Urbanism, Environment and Health*, brought together researchers, policymakers, industry and community across a range of disciplines and sectors.[14] Other significant integrative work includes that of the Victorian Division of the Heart Foundation and its *Healthy by Design* resource.[15] In NSW, the Premier's Council for Active Living seeks to strengthen the physical and social environments in which communities engage in active living.[16] Also in NSW, health impact assessment (HIA) has been identified as a 'key tool for affecting change and to strengthen health input into planning decisions'.[17]

Box 1. Intersectoral partner organisations in the Healthy Built Environments Program

Academic
Faculty of the Built Environment, University of NSW
- City Futures Research Centre
- Centre for Health Assets Australasia
- Planning and Urban Development Program
- Landscape Architecture Program
- Interior Architecture Program
- Visiting Associate Sue Holliday

Faculty of Medicine, University of NSW
- Public Health and Community Medicine

State Government
Sydney South West Area Health Service Population Health
- Population Health Directorate
- Centre for Research, Evidence Management and Surveillance
- Centre for Health Equity Training, Research and Evaluation
- Health Promotion Service
- Public Health Unit
- Multicultural, HIV/AIDS and Hepatitis C Services
- HIV and Related Programs

Local Government
- Western Sydney Region of Councils (WSROC)

Non-government organisation
- Heart Foundation NSW

Industry
- Arup
- Danny Wiggins, Planning, Facilitation and Education Services
- Willana Associates, Urban Planning and Facilities Management

The Healthy Built Environments Program

With the built environment increasingly viewed as an important determinant of health, creating environments that promote health and wellbeing is one of the NSW Department of Health's preventive health priorities. The importance of preventive health has been identified by the NSW Government in its State Plan,[18] with further clarification about the role that urban planning plays in relation to human health in the NSW State Health Plan.[19] While evidence continues to emerge, the NSW Department of Health is aware that more is needed, in particular, information about the impacts of different patterns of urban development on health and the costs and benefits of these impacts.

Consequently, the Department has established the Healthy Built Environments Program at the City Futures Research Centre in the Faculty of the Built Environment at the University of NSW (http://www.fbe.unsw.edu.au/cf/hbep). This 5-year Program will foster interdisciplinary research, deliver innovative education and workforce development, and provide leadership on health and the built environment.

The Program brings together a multidisciplinary team from academic, government, private and non-government organisation (NGO) sectors with expertise across health, urban planning and design, and their inter-relationships (Box 1). The Program is situated in one of Australia's largest faculties of the built environment, which includes all of the design and planning disciplines across scales from individual buildings (their interiors and what is between

Box 2. *Healthy Planning*: an interdisciplinary educational course of the Healthy Built Environments Program

Healthy Planning is an undergraduate course at the University of NSW. It promotes interdisciplinary approaches as the most effective way to understand the role of the built environment in contemporary health problems. Recent research examining the relationships between the built environment and human health is presented, in the context of a broader perspective on social and environmental sustainability. While there are formal lectures on the latest research and case studies in healthy planning, the principal learning focus is on students working together in interdisciplinary teams. They undertake a detailed neighbourhood audit in which selected urban areas are investigated to determine the level of support for healthy behaviour including physical activity, healthy eating and social interaction. Learning outcomes are focused on interdisciplinary knowledge and practice. The course demonstrates how by working together, cooperatively and with mutual respect and understanding, built environment and health professionals can make a significant contribution to the achievement of healthy cities and societal wellbeing.

Table 1. The three main areas of focus and the related principal activities of the Healthy Built Environments Program

Focus	Concerns	Major activities
Research	• Interdisciplinarity • Comprehensiveness • Policy and practice relevance	• Undertake literature review • Identify major research gaps • Determine research strategy with key priorities for NSW • Synthesis and communication of latest research findings • Leverage research grants from funding agencies such as ARC and NHMRC (Box 3) • Undertake research projects by academics and post graduate students
Workforce development and education	• Capacity building • Interdisciplinarity • Enabling current work force • Enabling future work force	• Assessment of NSW Health knowledge and skills needs • Capacity building for NSW Health staff using key tools[20,21] • Development of resources to assist both education and research (e.g. newsletters and website) • Teach in health and the built environment: continuation of existing courses and development of new offerings • Collaborations between Built Environment and Medical Faculties
Leadership and advocacy	• Government sector (state and local) • Private sector • NGO sector • Community sector • Professional organisations[#] representing urban planning, public health and environmental health	• Establishment of advisory committee of key stakeholders across health and built environment • Participation in community and media events to promote healthy built environments • Build on current Faculty work in environmental sustainability and climate change mitigation • Seek private sector sponsorship opportunities with planners, architects and developers • Build on well established links with relevant policy makers at state and national levels

ARC: Australian Research Council. NHMRC: National Health and Medical Research Council. NGO: Non-government organisation.
[#]For example, Planning Institute of Australia; Public Health Association of Australia; Australian Institute of Environmental Health.

them), through neighbourhoods, to the urban region, city and beyond. The backgrounds of the Program's co-directors Thompson (an urban planner) and Capon (a public health physician) reflect the need for multiple perspectives. Thompson has been leading an undergraduate healthy planning subject since 2007 (Box 2). A new postgraduate course with strong links to the Healthy Built Environments Program has recently been approved by the Faculty's Education Committee.

Positioning the Program within a built environment faculty offers the opportunity to influence the built environment professions and industries to incorporate healthy planning provisions in strategic direction, policy formulation and decision making. With an already established research and educational focus on environmental and social sustainability, the opportunities to develop integrated strategies that bring human health concerns into alignment with environmental issues are considerable.

Table 1 presents the principal activities of the Program across its three main themes: research, workforce development and education, and leadership and advocacy. Box 3 provides two examples of research projects in the Program.

Challenges in moving forward

There are important potential obstacles to progress on healthy built environments. These include different ways of understanding health, and evidence about health, and the need for effective interdisciplinary collaboration.

Epidemiology is the established method for understanding the distribution of health and disease in populations and

Box 3. Research projects in the Healthy Built Environments Program

Two health and built environment research projects are currently underway within the Healthy Built Environments Program. The first brings together industry partners NSW Landcom and Heart Foundation, and the Sydney South West Area Health Service. The Australian Research Council (ARC) has funded an investigation into how urban environments support human health. Tracking residents' behaviours over several years, the aim is to identify environmental design features, social interventions and locational qualities in selected neighbourhood sites which positively benefit human health. The research uses a multidisciplinary approach with its team from urban planning, development and health. The second project is funded by the Australian Housing and Urban Research Institute (AHURI). A focussed investigation for one year, it examines the health impacts of housing. The study will identify the current level of knowledge and major research gaps, prioritise these, and propose ways to best explore the highest priority research and policy development needs. An 'Investigative Panel' comprising leading researchers, public health and housing policy officials from across Australasia and New Zealand will be convened to do this.

For further information about these and other projects see the research page of the Healthy Built Environments Program web site: http://www.fbe.unsw.edu.au/cf/hbep/research/

has enabled the identification of many major risks to health. Epidemiology in its current form is however less useful for understanding the complex interplay between multiple biophysical, social and economic factors and the health of people in urban environments. Consequently, it has been argued that epidemiology needs to adopt and develop methods to understand such complexities by drawing insights from ecology.[22] From the planning perspective, Corburn's 'relational view of place', where he argues for combining laboratory and field site views of urban health, is another methodological model that may be useful in formulating different understandings of health.[1]

A related challenge is to overcome the constraints imposed by disciplinary boundaries and different traditions of evidence. Lawrence[23] argues for integrative and interdisciplinary approaches in responding to links between the built environment and health. An effective interdisciplinary approach acknowledges individual disciplinary expertise and brings it together with expertise in other disciplines to create new knowledge. The web-based resource, *Healthy Spaces and Places*, launched last year, is an example of an effective interdisciplinary initiative (Box 4).

Box 4. *Healthy Spaces and Places*

Healthy Spaces and Places is a web-based resource that includes practical tools, case studies and guidelines for planning and developing sustainable communities to encourage healthy ways of living.[24] It is a national initiative of the Planning Institute of Australia, the Australian Local Government Association and the National Heart Foundation, with funding from the Australian Government's Department of Health and Ageing. It is also an excellent demonstration of cross-disciplinary collaboration.

Conclusion

Interest in the role that environments play in supporting good health, both physical and mental, is high in many countries. In Australia this heightened interest is reflected at national, state and local government levels. Increasingly urban planners and health professionals are working productively together in both strategic policy development and specific service delivery. In order to make progress in climate change mitigation and human physical and mental health improvements, an important challenge will be to shift the way we understand health in the context of built environment and sustainability discourse. The Healthy Built Environments Program, with its interdisciplinary approach, positioned in a faculty of the built environment and with a focus on environmental and social sustainability, is well placed to meet this challenge.

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Mind, body, spirit: co-benefits for mental health from climate change adaptation and caring for country in remote Aboriginal Australian communities

***Helen L. Berry*[A,B,J], *James R. A. Butler*[C], *C. Paul Burgess*[D], *Ursula G. King*[B], *Komla Tsey*[E,F], *Yvonne L. Cadet-James*[E,G], *C. Wayne Rigby*[H] *and Beverley Raphael*[B,I]**

[A]*Faculty of Health, The University of Canberra*

[B]*College of Medicine, Biology and Environment, The Australian National University*

[C]*CSIRO Sustainable Ecosystems and Climate Adaptation Flagship, Brisbane*

[D]*Menzies School of Health Research, Charles Darwin University*

[E]*The Cairns Institute, James Cook University*

[F]*School of Education, James Cook University*

[G]*School of Indigenous Australian Studies, James Cook University*

[H]*Faculty of Nursing, Midwifery and Indigenous Health, Charles Sturt University*

[I]*School of Medicine, University of Western Sydney*

[J]*Corresponding author. Email: Helen.Berry@canberra.edu.au*

Abstract: The evident and unresolved health disparity between Aboriginal and other Australians is testament to a history of systematic disenfranchisement. Stigma, lack of appropriate services and the expense of delivering services in remote settings make it impossible to adequately address mental health needs, including suicide, solely using a mainstream medical approach. Nor do mainstream approaches accommodate the relationship between Aboriginal health and connectedness to land, whether traditional or new land, remote or metropolitan. This review describes how caring-for-country projects on traditional lands in remote locations may provide a novel way to achieve the linked goals of climate change adaptation with co-benefits for social and emotional wellbeing.

There are links between the natural environment, cultural identity and health, especially among the world's indigenous peoples (we refer to indigenous peoples globally and Aboriginal Australians locally).[1] In Australia, the natural environment is threatened: the overwhelming weight of evidence suggests continuing and potentially catastrophic climate change, largely due to human actions.[2–4] Exposure to climate-related adversities will increase, and the most vulnerable communities and regions will be worst affected.[5] Reflecting a lack of research, policy and services for climate change and health in Australia, a *Tri-Ministerial Press Release* of 27 January 2009 on the health risks of climate change in Australia called for research to identify 'who will be most vulnerable and the action governments, individuals and communities can take to reduce the risks'.[6]

This paper describes how caring-for-country projects may provide a novel way to achieve the linked goals of climate change adaptation and co-benefits for remote Aboriginal social and emotional wellbeing. We summarise what is known about the environmental and health benefits of caring for country (defined in Box 1), together with the relationship between social processes in communities and mental health, and then link these in a proposed conceptual framework that illustrates how climate change adaptation may deliver co-benefits for wellbeing.

The health disparity between Aboriginal and most other Australians is well documented, as is the importance for Aboriginal people of lifelong connectedness to healthy country.[10,11] While we focus here on traditional lands, we acknowledge the importance for Aboriginal wellbeing of connectedness to new lands. Indeed, the last two centuries have seen people displaced from their traditional lands,[12] with remnants of populations relocated to remote area townships.[13] This movement has been associated with poor health outcomes for Aboriginal people[14,15] and for lands and seas. In their present state, many of these lands cannot offer their traditional custodians the benefits of connectedness to healthy country. Climate change poses a new threat to these lands, through physical, ecological and sociocultural

Box 1. Caring for country: definition

For Aboriginal peoples, 'country' encompasses an interdependent relationship between Aboriginal peoples and their ancestral lands and seas.[7] 'Country is multi-dimensional – it consists of people, animals, plants, Dreamings, underground, earth, soils, minerals and waters, air … People talk about country in the same way that they would talk about a person.'[8] 'Caring for country' means participation in inter-related activities on Aboriginal lands and seas with the objective of promoting ecological, spiritual and human health. It is also a community-driven movement towards long-term social, cultural, physical and sustainable economic development in rural and remote locations, contributing to the conservation of globally-valued environmental and cultural assets.[9] Aboriginal landowners deliver a broad suite of environmental services, including:

- Border protection
- Quarantine
- Wild fire abatement and carbon sequestration
- Controlling invasive weeds and feral animals
- Conserving biodiversity
- Fisheries management
- Water resource management
- Sustainable commercial use of wildlife
- Cultural maintenance.

changes.[16] Aboriginal and Torres Strait Islander people are particularly vulnerable: for example, many of the Torres Strait Islands' 7000 people live just 2 metres above sea-level.[17] Land degradation disproportionately disadvantages those living closest to the land,[18] especially Aboriginal Australians, who have and need a strong connection to land,[10,19] and already live with endemic, historically-based, 'whole person, whole community' disadvantage.[20,21] While we acknowledge the importance of Aboriginal connectedness to land, whether traditional or new, urban or remote, this paper focuses on rural and remote settings because Aboriginal people are over-represented here and disadvantage is even greater than it is in cities.[22]

Despite 'whole person, whole community' disadvantage, Aboriginal people have demonstrated formidable cultural resilience; a central tenet in maintaining wellbeing has been to preserve and evolve traditional knowledge from generation to generation. Community-initiated promotion and re-integration of this knowledge (to care for country) could assist in adapting to – and perhaps mitigating – adverse impacts of climate change. It could simultaneously support connectedness to healthy country; promote dignity, identity and self-determination; build community strength; offer opportunities for sustainable economic development and generate powerful co-benefits for social and emotional well-being, particularly where these activities are Aboriginal led.

Aboriginal-led caring for country

Although community approaches are known to be more effective than individually-based approaches in improving mental health practices in the face of rural drought,[23,24] we do not yet know whether community-led caring-for-country projects could produce both benefits for country and personal empowerment (and its social and emotional co-benefits). However, there is growing interest in engaging rural and remote Aboriginal communities in these projects to build sustainable livelihoods. This is of interest because much of the world's biodiversity is found on indigenous traditional lands.[19] By restoring connections to country through land and sea management activities, traditional ecological knowledge is applied and re-invigorated, resulting in documented improvements in social, cultural and physical health as well as the health of the landscape. This is referred to as 'Healthy Country, Healthy People'.[13,25,26]

Healthy Country, Healthy People research in Arnhem Land has involved measuring participation in six caring-for-country activities and relating participation in these activities to prospective health indicators (Boxes 2 and 3). These studies demonstrated benefits for clinically-measured body mass index,[13] waist circumference, blood pressure, diabetic status, albumin : creatinine ratio, glycosylated haemoglobin, high density lipoprotein, lipid ratio and five-year cardiovascular risk.[25] Health screening also demonstrated that caring for country was associated with significantly lower levels of general psychological distress.[25] In addition, greater physical activity (associated with caring-for-country projects) is linked to better mental health directly and because it improves physical health, itself strongly linked to mental health.[27,28] These studies provide preliminary evidence for potential social and emotional wellbeing benefits.

As 20% of Australia's land mass is Aboriginal estate, much of it of high conservation value, there is considerable potential for establishing livelihoods based on providing environmental stewardship, resulting in linked social,

Box 2. Case study: Healthy Country, Healthy People

At the request of traditional landowners in central Arnhem Land, the Northern Territory, a transdisciplinary team of medical, ecological and social researchers investigated whether caring for country was associated with better health outcomes and better landscape health. A questionnaire measuring caring-for-country participation was developed and validated in the study population[7] and associations with health outcomes were explored.[29] Controlling for sociodemographic characteristics and health behaviours, greater participation was associated with significantly better health, including diet, physical activity, mental health and lowered risk of diabetes, kidney disease and cardiovascular disease;[29] and landscape conservation outcomes were superior to those in surrounding areas where stewardship had been disrupted, potentially increasing the landscape's resilience to climate change.[30,31]

Box 3. Case study: Aboriginal Australians caring for country

Climate change poses risks to Aboriginal peoples[32] but also presents opportunities to invest in climate change mitigation projects. One example is the West Arnhem Land Fire Abatement project where Aboriginal landowners have reinstated landscape burning regimes to prevent late season wild fires, generating tradable savings in greenhouse gas emissions.[33] Participation in caring for country-related programs seems to deliver significant health promotion,[34] in addition to delivering globally significant conservation outcomes.[26,35] Importantly, these initiatives reflect the wishes of Aboriginal landowners – to develop sustainable enterprises based on their continued association with ancestral lands and seas.[36]

> 'Our identity as human beings remains tied to our land…Destroy this relationship and you damage – sometimes irrevocably – individual human beings and their health.'[37]

cultural and biodiversity benefits.[38] Despite the practical difficulties of translating this idea into practice,[19] this opportunity is now recognised in the Commonwealth's Department of Environment, Water, Heritage and the Arts *Caring for Our Country Business Plan*. Funds are being made available to record and apply traditional ecological knowledge to protect biodiversity, while also aiming to build Aboriginal community capacity and partnerships. While this is evidently an empowerment approach, which (theoretically) ought to be beneficial for social and emotional wellbeing, these projects have not been considered in terms of such benefits.

Though there are as yet no programs addressing potential climate change impacts on Aboriginal health and wellbeing, government initiatives, including *Caring for Our Country*, have funded Aboriginal ranger programs to undertake land and sea management. These initiatives build on Aboriginal knowledge of local ecosystems and climatic patterns[39] and provide a partial template for how caring for country activities might support climate change adaptation *and* improved health. Encouragingly, many communities are independently engaging partners to enhance their own opportunities to care for their country. Examples of activities include feral animal and weed control, habitat restoration, monitoring climate change and bush tucker harvesting. These projects are of particular interest because they have been initiated by the communities themselves, rather than by governments or researchers.

Strong people in strong communities

Cohort studies of the life-course dynamics of social and emotional wellbeing, together with research into community connectedness and mental health, might suggest a reason why caring for country is related to greater wellbeing. This body of research indicates that there are, respectively, two important features of those who are best placed to withstand long-term adversity. Such people tend to be 'competent selves', people who respect themselves, are goal directed and engage actively with their problems,[40] and live in functional communities that can and do sustain them.[41] These communities are often described as having high levels of social capital (see below) which is strongly linked to better mental health,[42–44] including in Australia.[45] Further, social capital may be even more important for Aboriginal Australians' wellbeing than it is for other Australians.[46] Of considerable importance in the context of continuing adverse climate change, social capital might be the key mediator of the relationship between climate change and mental health.[47]

The notion of a unique relationship between social capital and wellbeing among Aboriginal Australians is consistent with a view that social capital is a meaningful concept (and related to health) in remote Aboriginal communities but that it has to be re-interpreted to make sense: its components (such as norms, networks and trust) are best understood in terms of relationships with and obligations to *specific* land, around which life is organised. For example, among the Yolngu people of the Northern Territory living

in the homelands, norms are interpreted in terms of ways of perceiving and acting (mulkurr) that are directed by detailed knowledge of and respect for the footprints (djalkiri) – that is, the ecology – of their traditional lands; social networks (gurrutu) are place-specific knowledge of how entities such as individuals, groups, clans, totems, languages and ceremonies are related; and trust (maarr) is about powerfulness arising from collective identity and respect for the (land-related) responsibilities it confers.[11] In Australia, it has long been acknowledged that, to reduce the current preventable burden of disease, we must address lack of control as one aspect of a broader experience of Aboriginal powerlessness.[48,49] For Aboriginal people, this control and the responsibility that accompanies it are fundamental issues of trust.

Community control of resources and decision making have featured prominently in strategies to improve Aboriginal health.[50–52] Yet these initiatives, which are focused directly on health, do not address the stigma that surrounds mental health[53] or its social causation:[54] direct approaches are not necessarily the only or the best way, and nor do they address the need for connectedness to country or the dual threats to country posed by displacement (and associated environmental degradation) and climate change. Indeed, Aboriginal leaders have noted that effective health promotion activities might well emerge from outside the health sector.[55]

The first cohort study of how social and emotional needs in indigenous communities might be approached outside health-focused approaches was conducted by psychiatrist Alexander Leighton.[56] His stories of how a small indigenous rural 'slum' in Canada (the Road) became a connected, thriving and productive community[57] provide a template for how natural resource management projects might help redress Aboriginal disadvantage and adapt to climate change. Through successfully completing indigenous-led projects apparently unrelated to health, residents of the Road became practised at cooperating spontaneously to solve problems and achieve collective goals. Over time, based on continuing learning and successes, residents became creative and entrepreneurial.

The achievements of the Yolngu people in establishing homelands reflect a similar story of how people who are determined, who work project by project and who act in a context of respect for their culture can, with initially minimal infrastructure support, build a happy, healthy and, ultimately, sustainable place to live.[11] Caring-for-country projects could do likewise.

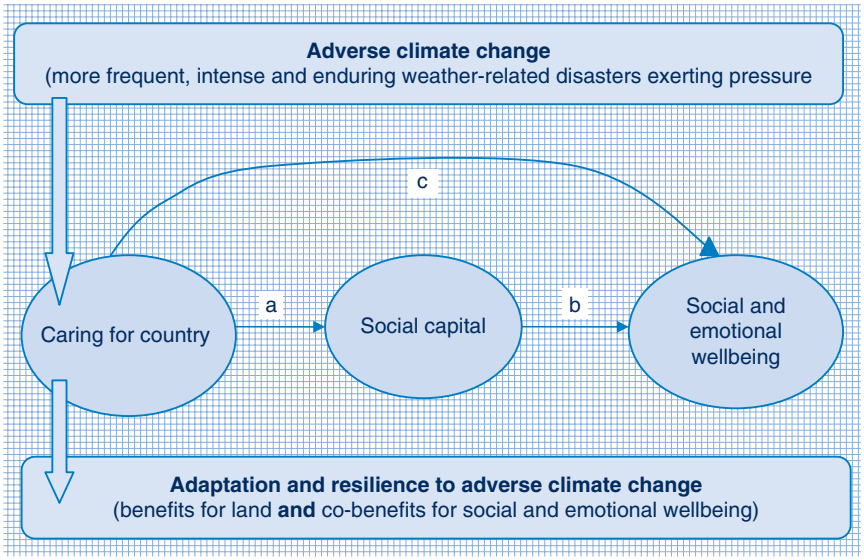
Climate change, caring for country and wellbeing: a conceptual framework

Figure 1 is a conceptual framework representing our proposed relationship between Aboriginal-initiated and led caring-for-country projects and social and emotional wellbeing in the context of adverse climate change. We anticipate that caring-for-country projects, initiated partly in response to climate change, would strengthen Aboriginal-specific social capital (arrow 'a') as a result of (i) caring for and reconnecting – or connecting more deeply – with traditional lands, and (ii) the community development-like activities required to undertake such projects. Increases in social capital would, in turn, be associated with improved social and emotional wellbeing (arrow 'b') creating positive feedback loops whereby better health would contribute to enhanced social capital and greater engagement with caring for country. We have cited evidence that caring for country is directly related to improved health (arrow 'c'), but it is not known why this is, or whether caring for country project outcomes would differ across climate zones and, thus, be generalisable. This proposition could be tested and considered in terms of climate zone-specific climate change scenarios. Given the significance of the Aboriginal health disparity and of the need to adapt to climate change, testing these propositions empirically is a research priority.

Conclusions

The evident and unresolved health disparity between Aboriginal and other Australians bears testament to a history of systematic disenfranchisement.[16] Suicide rates and the prevalence of mental health problems, while difficult to quantify precisely,[21] are of grave concern. Stigma,[53] lack of (culturally-appropriate)[58] services[22] and the expense of delivering services in remote settings make it impossible to adequately address these health needs solely using a mainstream medical approach.[18,47] Nor do mainstream approaches accommodate the relationship between Aboriginal health and connectedness to healthy traditional land. Caring-for-country projects, particularly when Aboriginal-initiated, may provide a way to achieve the linked goals of climate change adaptation with co-benefits for social and emotional wellbeing. However, it is not yet clear to what extent they may build social capacity, nor how such impacts may be manifested in different biocultural and climatic contexts. Culturally-engaged and community-focused scientific knowledge is needed in this emerging field. More important perhaps is the need to promote a more informed, insightful and respectful policy debate about the potential impacts of adverse climate change on Aboriginal health and its connectedness to land.

We propose that, especially in severely disadvantaged communities,[59] most mental health problems are socially caused and must be socially solved;[54] mainstream mental health services, essential though they are, cannot alone address social and emotional wellbeing. Caring-for-country projects offer an opportunity to address climate change adaption and social and emotional wellbeing together.



Key:
a direct relationship in which greater caring for country is hypothesised to be causally related to higher levels of social capital
b direct relationship in which higher levels of social capital are related to better social and emotional wellbeing in Aboriginal communities
c direct relationship in which greater caring for country is hypothesised to be directly causally related to better social and emotional wellbeing in Aboriginal communities net of its association with social capital.

Figure 1. Hypothesised conceptual framework linking caring-for-country projects directly and indirectly (through increased social capital) to improved wellbeing. Note: In this proposed framework, social capital partially mediates the relationship between caring for country and social and emotional wellbeing.

Such projects must be Aboriginal led, respecting a collective identity in which the group is always prior to the individual,[11] and the imperative to work with (rather than 'do things to') communities in partnership with their leaders.[55]

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Biosecurity and infectious diseases

***Sarah M. Potter*[A], *Vitali Sintchenko*[B] *and Christian Enemark*[C]**

[A]*NSW Public Health Officer Training Program, NSW Department of Health*

[B]*Centre for Infectious Diseases and Microbiology, Institute of Clinical Pathology and Medical Research, Westmead Hospital*

[C]*Centre for International Security Studies, Faculty of Economics and Business, University of Sydney*

Biosecurity is a relatively new and evolving discipline, and as a concept it is understood in a number of different ways. Definitions can vary between countries, organisations and different specialist groups. In the broadest sense, biosecurity can be defined as the act of protecting the economy, the environment, and people's health from pests and disease. It includes trying to prevent new pests and diseases from arriving in the country, and helping to control outbreaks when they do occur (definition from the Australian Department of Agriculture, Fisheries and Forestry webpage: www.daffa.gov.au/animal-plant-health/pests-diseases-weeds/biosecurity). It also entails the response to natural epidemic and pandemic disease, as well as the prevention of diseases that might arise after environmental disasters such as flooding. Biosecurity does not relate exclusively to deliberate or man-made biological threats.

The potential severity of the consequences of a global outbreak of disease is indisputable. The Australian Federal Government suggests that a severe influenza pandemic has the potential to overwhelm health systems and disrupt most economic activities.[1] The worldwide outbreak of severe acute respiratory syndrome (SARS), and outbreaks of foot-and-mouth disease and bovine spongiform encephalopathy (BSE) in the United Kingdom (UK), demonstrate the potential impact of emerging infectious diseases.

In the last decade, there has been an increase in the number of outbreaks of new and emerging infectious diseases in the Asia-Pacific region, for example Nipah and Hendra viruses, SARS and avian influenza. Drug resistance and more pathogenic disease are biosecurity concerns, especially with regards to zoonotic and vectorborne diseases which may be more sensitive to changes in climate. More than 70% of emerging infectious diseases are zoonotic, and experts agree that the most likely biological threat faced by Australia comes from zoonotic disease.[2] Programs such as the One Health Initiative (http://www.onehealthinitiative.com/index.php) seek to re-integrate human and veterinary research and educational systems.

The Australian Government has developed strategies around biosecurity, including the refinement of communicable disease surveillance systems in Australia and overseas, and the support of effective communicable disease control and national biosecurity initiatives through policy, legislative and regulatory measures. Through the Department of Health and Ageing, border screening protocols will be further developed. The Department will also provide policy guidance to the Australian Quarantine and Inspection Service (AQIS) for human quarantine operations and administer the human quarantine aspects of the Australian quarantine legislation.[3] A national regulatory regime will be established to help limit opportunities for the illegal use of biological agents for terrorist purposes.

The *National Health Security Act 2007* seeks to bolster Australia's surveillance capacity for outbreaks of communicable disease and other health emergencies. The Act, and its associated regulations complement the revised World Health Organization (WHO) International Health Regulations (IHR) which came into effect in June 2007. The IHR represent a legal framework for international cooperation on disease surveillance and response, with the explicit purpose of preventing the spread of disease across international borders. All WHO member countries are required to develop and maintain surveillance, reporting and response mechanisms at local, national and regional levels. The IHR require that all countries report disease outbreaks of international concern to the WHO within 24 hours of learning of the outbreak, regardless of whether the outbreak falls within or outside the country's borders.[4,5] However, an ongoing issue of concern is that there is limited surveillance and response capacity across the Asia-Pacific region, which, combined with political and economic instability in some neighbouring countries, has the potential to leave Australia vulnerable to regional disease outbreaks.

Biosurveillance is an important component of biosecurity. While traditional surveillance systems have been vulnerable to incomplete and delayed reporting, advances in molecular diagnostics have enabled the rapid genotyping of biothreats, and investigation of markers which were not previously identifiable by traditional methods. The

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integration of the three fields of biosurveillance, microbial genomics and informatics offers an opportunity for the development of effective and rapid biosurveillance methods and tools.

Biosecurity includes, but is not limited to, the prevention of and response to bioterrorism. It is also concerned with the control of established and emerging infectious diseases, and changing patterns of vectors and other biological consequences of climate change. Biosecurity is a global concern which is reflected in the recent development of new legislation both within Australia and internationally.

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Murray Valley encephalitis

What is Murray Valley encephalitis?

Murray Valley encephalitis (MVE) is a viral infection caused by the Murray Valley encephalitis virus. The disease is sometimes also called Australian encephalitis. Most people with this infection remain completely well and never develop any symptoms. Some people only develop a mild illness with fever. A small proportion of those infected develop a severe viral brain infection (encephalitis).

Some people with encephalitis develop permanent neurological complications. These complications can be fatal, especially when children are affected. About 40% of affected people make a complete recovery.

MVE is transmitted by infected mosquitoes and the disease usually occurs in remote north-western Australia. MVE has rarely been seen in eastern Australia.

What are the symptoms?

Only about 1 in 1000 people who are infected develop symptoms. Symptoms may include:

- fever
- headache
- rash
- myalgia (sore muscles)
- neck stiffness
- nausea, vomiting and diarrhoea
- seizures
- tremors
- lethargy, drowsiness, confusion and unconsciousness.

Symptoms appear 5–28 days after being bitten by an infected mosquito.

People with these symptoms should see a doctor promptly, especially if they live in, or have recently visited, an area that is known to have infected mosquitoes.

How is it spread?

The virus is spread by the common banded mosquito, *Culex annulirostris*. This mosquito breeds in fresh water and tends to be found in spring, summer and autumn around natural wetlands and irrigation waters. The mosquito is especially common around the Murray Darling River basin areas in NSW during summer.

This mosquito tends to be most active after sunset and around dawn. Some water bird species are also thought to be infected with the virus. Mosquitoes become infected by feeding on infected birds and possibly other animals. An infected mosquito can then bite a human and transmit the infection.

Who is at risk?

People at greatest risk include:

- People who have recently been bitten by mosquitoes.
- Babies, young children and newcomers to areas where the virus is active because they are less likely to have immunity from previous infection.
- Babies and young children are also more likely than adults to develop severe complications and to die if they become infected.

A person who is infected with the virus is not thought to be able to transmit the virus to another person.

People with previous infection are likely to be immune from re-infection, even if they were never sick.

How is it prevented?

The only protection from MVE is to avoid being bitten by mosquitoes. This is particularly important for travellers and visitors to areas where MVE might be active.

Protection from mosquitoes is essential:

- Avoid being outside when mosquitoes are most active, particularly around sunset, early evening and dawn.
- Wear loose-fitting, light-coloured clothing with long sleeves, long trousers and socks. Mosquitoes can bite through tight-fitting clothes.
- Use insect repellent when outdoors and reapply as directed by the manufacturer. Lotions and gels are more effective and longer lasting than sprays.
- Ensure flyscreens and doors are in good order.
- If camping, sleep under a mosquito net or in a mosquito-proof tent.
- Use a knock-down insect spray before going to bed to kill any mosquitoes that are indoors.
- Remember to protect babies and young children from mosquito bites too.

How is it diagnosed?

A blood test that detects antibodies to the virus can show if someone has had a recent or past infection. People with encephalitis often undergo a lumbar puncture (spinal tap) where the virus is detected in cerebro-spinal fluid.

How is it treated?

There is no specific treatment for MVE. People with encephalitis often require treatment in an intensive care unit.

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What is the public health response?

Laboratories are required to notify cases of MVE to the local public health unit. Public health unit staff interview the cases to identify risk factors. A single report will usually lead to a search for other possible cases and further advice to the local community.

NSW Health also performs surveillance for the virus in several locations in rural NSW by monitoring flocks of chickens for recent infection and by analysing trapped mosquitoes in summer months.

For more information please contact your doctor, local public health unit or community health centre.

This factsheet is available at: http://www.health.nsw.gov.au/factsheets/infectious/influenza.html

NSW HEALTH

Communicable Diseases Report, NSW, March and April 2010

Communicable Diseases Branch
NSW Department of Health

For updated information, including data and facts on specific diseases, visit www.health.nsw.gov.au and click on **Public Health** and then **Infectious Diseases**. The communicable diseases site is available at: http://www.health.nsw.gov.au/publichealth/infectious/index.asp.

Figure 3 and Tables 1 and 2 show reports of communicable diseases received through to the end of March and April 2010 in New South Wales (NSW).

Enteric infections

Listeriosis

Listeriosis is an infection that causes septicaemia and meningitis, usually in pregnant, immunosuppressed or frail people and is linked to eating contaminated food. Listeriosis has a long incubation period of up to 70 days.

Six cases of listeriosis were reported in NSW in March and April and one death occurred. The ages of the affected people ranged from 50 to 89 years, and three (50%) were men. Five (83%) resided in the Sydney metropolitan area. The number of notifications reported is the same as for the same period in 2009. No common links between cases were identified through local public health unit investigations.

Outbreaks of foodborne disease

Nine outbreaks of suspected foodborne disease were reported in March and April 2010 affecting 68 people. Of these nine outbreaks, six were caused by *Salmonella* infection. Food vehicles found to be responsible for outbreaks of salmonellosis included tartare sauce prepared with raw egg, chicken mince, fried ice cream, mayonnaise prepared with raw egg, and pork. Other foods suspected to have caused illness included fruit kebabs, sushi and other take away food.

Gastroenteritis in institutional settings

Sixty-seven outbreaks of gastroenteritis in institutions were reported in March and April 2010 affecting 1029 people. Of these, 32 occurred in child-care centres, 29 in aged-care facilities, five in hospitals and one in a residential facility. Sixty-six outbreaks appeared to have been caused by person-to-person spread of a viral illness and one was food borne.

Viral gastroenteritis tends to peak in winter months, with up to 15 outbreaks each week reported in peak months.

Gastroenteritis in the community

The number of patients presenting with gastrointestinal illness to emergency departments in NSW decreased slightly and remains within the usual range for this time of year (includes data from 56 NSW emergency departments) (Figure 1).

Respiratory infections

Legionnaires' disease

Legionnaires' disease is a form of pneumonia caused by infection acquired from environmental sources such as water droplets (*Legionella pneumophila*) or soil (*L. longbeachae*).

Seventeen cases of Legionnaires' disease were reported in NSW in March and April 2010, including nine cases of *L. longbeachae* and eight cases of *L. pneumophila*. No common links between cases were identified through local public health unit investigations. For the same period in 2009, 11 cases of *L. longbeachae* and eight of *L. pneumophila* were reported.

Influenza

The number of patients presenting with influenza-like illness in NSW remained low (includes information from 56 NSW emergency departments) (Figure 2).

Other infections

Leprosy

A suspected case of leprosy (Hansen disease) was reported in April 2010. A man in his 30s arrived in Sydney on a commercial ship from overseas. In NSW, four cases of leprosy were reported in 2008 and there were no cases of leprosy reported in 2009.

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Leprosy is a rare but curable disease. Leprosy is caused by infection with the bacterium, *Mycobacterium leprae*. The bacterium is very similar in appearance to *M. tuberculosis*. Leprosy is transmitted through close and prolonged contact with untreated cases. The people most at risk of exposure and resultant infection are people who live in household-like conditions. Casual contact is not a risk for the transmission of leprosy.

Vaccine-preventable diseases

Measles

One case of measles was reported in an unimmunised adult with links to an outbreak in New Zealand. The case had flown while infectious and passengers seated in the surrounding rows were contacted by public health staff to help contain further spread.

Six cases of measles have been reported in NSW this year (five of these had travelled overseas, and one was a contact of a known case). In 2009, seven cases were reported in NSW for the corresponding period.

Most cases of measles in NSW are seen in travellers who return with the infection from countries where measles is endemic and who are exposed to a known case. Many people who were born since 1966 and before the mid 80s are not immune to measles because they have neither acquired the measles infection nor received two doses of a measles vaccine. Measles vaccine is now routinely given to infants at 12 months and at 4 years, and this confers long-lasting immunity.

Meningococcal disease

Ten cases of meningococcal disease were reported in NSW in March and April 2010 including 3 deaths. The ages of the affected people ranged from 1 to 72 years. Six cases (60%) were male and 5 cases (50%) resided in the Sydney metropolitan area. Of the 10 cases, six were due to serogroup B, two cases were due to serogroup W135, one case in an unvaccinated adult was due to serogroup C, and for one case the serogroup was not able to be determined. For the same period in 2009, 13 cases and one death were reported (eight cases due to serogroup B, two cases due to serogroup W135, one case due to serogroup C, and for three cases the serogroup was not able to be determined).

A free vaccine is available for infants at 12 months of age. Consequently, serogroup C meningococcal disease is now mainly seen in adults and in unimmunised children. In NSW in 2009, 80% of cases of meningococcal disease (where serogroup was known) were caused by serogroup B, for which there is no vaccine.

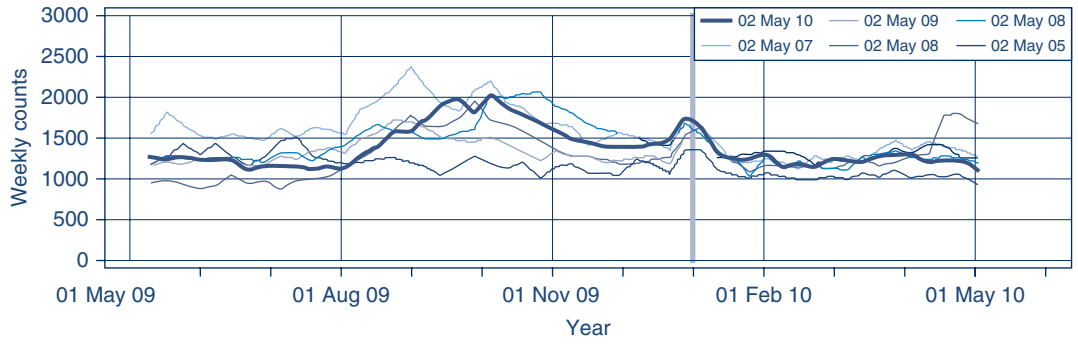

Figure 1. Total weekly counts of emergency department visits for gastrointestinal illness, April 2009 to May 2010 (thick line), compared with each of the 5 previous years (coloured lines) (includes data from 56 NSW emergency departments).

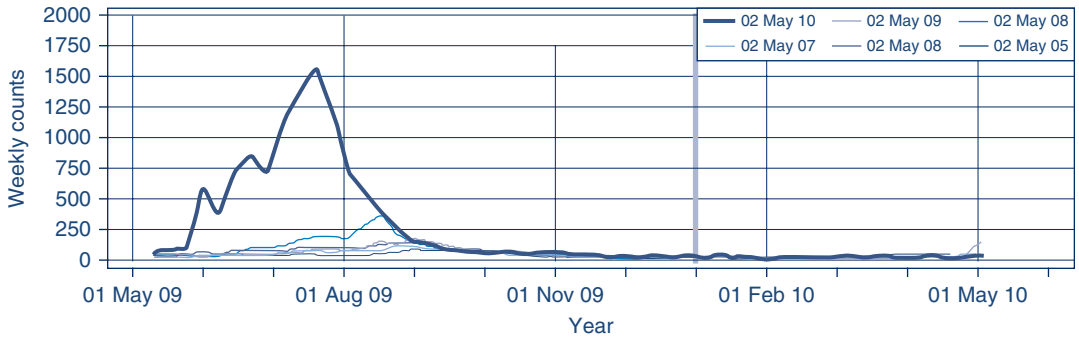

Figure 2. Total weekly counts of emergency department visits for influenza-like illness, April 2009 to May 2010 (thick line), compared with each of the 5 previous years (coloured lines) (includes data from 56 NSW emergency departments).

Pertussis (whooping cough)

During March and April, 607 cases of pertussis were reported in NSW. Notifications of pertussis have declined in NSW since a peak in 2009 of 12 567 cases. In total, 1565 cases of pertussis and no deaths have been reported up to 30 April 2010. For the same period in 2009 in NSW, 6819 cases and one death were reported.

During March and April, the greatest number of notifications was in children aged 0–4 years (113, 19%) and 5–9 years of age (133, 22%). Of all cases, 269 (44%) were male and 364 cases (60%) resided in metropolitan areas.

A free vaccine is available for infants at 2, 4 and 6 months (the first dose can be given as early as 6 weeks of age) with a booster dose at 4 years (can be given from 3 years and 6 months of age). Immunisation reduces the risk of infection; however the vaccine does not give lifelong protection, and re-infection can occur. Because pertussis immunity wanes over time, many older children and adults are susceptible to infection and can be the source of new infections in infants. For a limited time, free pertussis (dTpa) vaccine is available for all new parents, grandparents and any other adults who will regularly care for infants less than 12 months of age. Free vaccine will be provided to Year 7 and Year 10 students as part of the NSW School-based Vaccination Program from 2010.

Sexually transmitted infections

Lymphogranuloma venereum

One case of lymphogranuloma venereum (LGV) was reported in metropolitan Sydney. The infection was acquired locally.

Lymphogranuloma venereum is a rare sexually transmitted chlamydial infection that spreads through unprotected vaginal, anal or oral sexual contact, especially if there is trauma to the skin or mucous membranes. Men who have sex with men, especially those who have unprotected anal sex, are at greatest risk. The bacteria that cause lymphogranuloma venereum are rare types of chlamydia, however lymphogranuloma venereum infection is a more aggressive disease than common chlamydia infections. The infection is treated with an extended course of antibiotics.

Figure 3. Reports of selected communicable diseases, NSW, January 2004 to April 2010, by month of onset.
Preliminary data: case counts in recent months may increase because of reporting delays.
Laboratory-confirmed cases only, except for measles, meningococcal disease and pertussis.
BFV, Barmah Forest virus infection; RRV, Ross River virus infections; lab conf, laboratory confirmed;
Men Gp C and Gp B, meningococcal disease due to serogroup C and serogroup B infection;
other/unk, other or unknown serogroups.
NB: Multiple series in graphs are stacked, except gastroenteritis outbreaks.
NB: Outbreaks are more likely to be reported by nursing homes & hospitals than by other institutions.

NSW Population	
Male	50%
<5 y	7%
5–24 y	27%
25–64 y	53%
65+ y	13%
Rural	46%

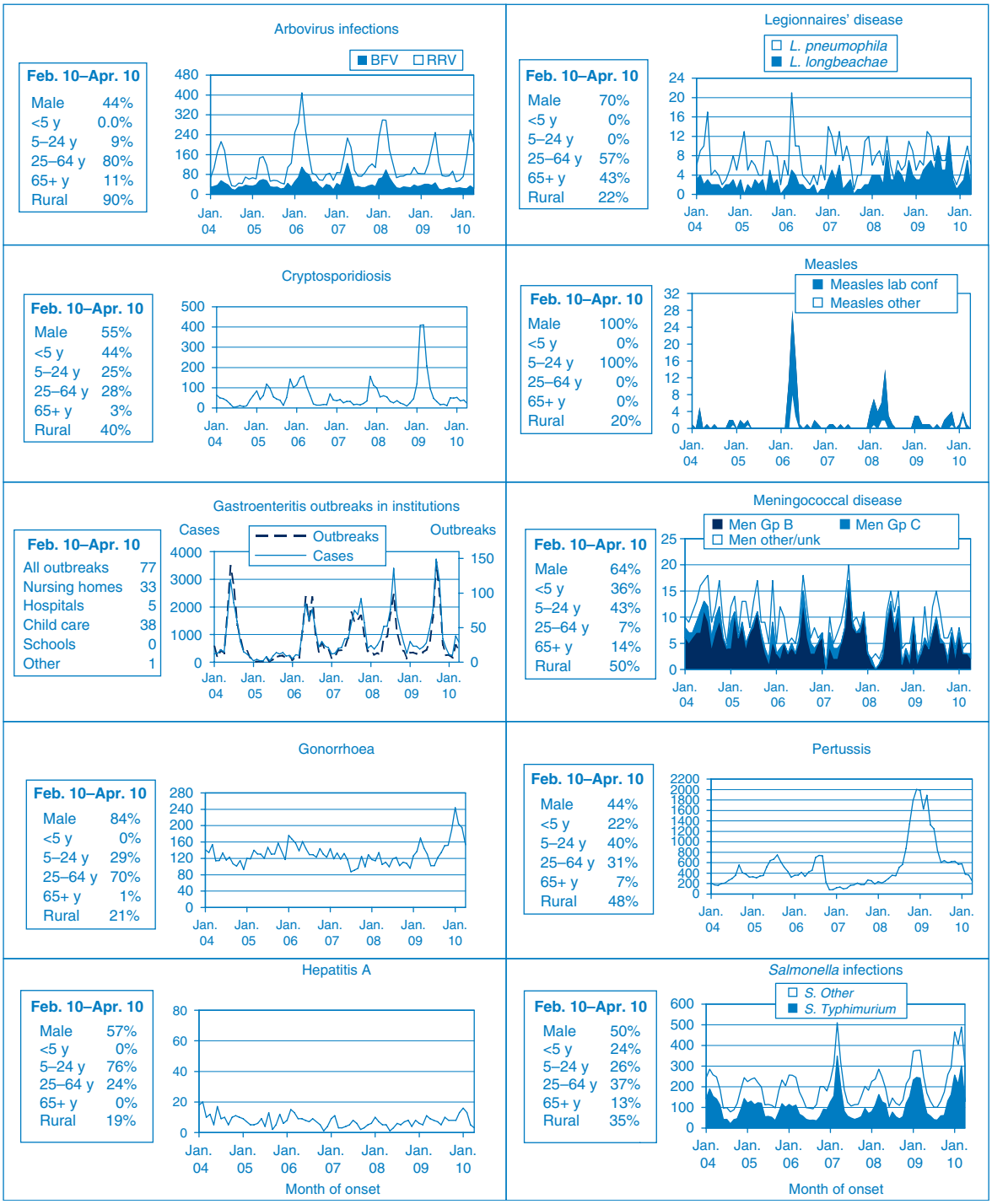

Table 1. Reports of notifiable conditions received in March 2010 by area health services

	Area Health Service (2010)																		Total	
	Greater Southern		Greater Western			Hunter New England		North Coast		Northern Sydney Central Coast		South Eastern Sydney Illawarra		Sydney South West		Sydney West			For	Year
Condition	GMA	SA	FWA	MAC	MWA	HUN	NEA	MNC	NRA	CCA	NSA	ILL	SES	CSA	SWS	WEN	WSA	JHS	March[b]	to date[b]
Bloodborne and sexually transmitted																				
Chancroid[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chlamydia (genital)[a]	64	49	16	24	28	217	54	56	85	100	126	88	289	164	132	81	147	16	1746	4659
Gonorrhoea[a]	1	–	–	–	–	18	1	3	4	3	15	5	69	42	19	2	13	2	203	671
Hepatitis B – acute viral[a]	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	11
Hepatitis B – other[a]	4	1	2	–	–	5	3	3	2	4	31	2	46	43	57	9	74	5	294	821
Hepatitis C – acute viral[a]	–	–	1	–	1	1	1	–	–	–	–	–	–	–	1	–	–	1	6	12
Hepatitis C – other[a]	12	13	4	5	8	29	5	16	30	31	25	28	54	38	50	25	35	44	459	1327
Hepatitis D – unspecified[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1
Lymphogranuloma vanereum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Syphilis	1	–	6	–	–	3	1	–	1	9	12	5	22	26	13	1	5	–	110	271
Vectorborne																				
Barmah Forest virus[a]	2	4	3	2	–	4	3	5	8	1	–	2	–	–	–	1	–	–	35	83
Ross River virus[a]	30	9	17	27	15	16	23	7	13	5	1	4	–	1	4	4	3	–	179	307
Arboviral infection (other)[a]	–	–	–	–	–	1	–	1	–	–	3	1	2	1	2	1	2	–	15	29
Malaria[a]	–	–	–	–	–	2	1	–	1	–	1	1	–	–	1	–	–	–	7	14
Zoonoses																				
Anthrax[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Brucellosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Leptospirosis[a]	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	5
Lyssavirus[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Psittacosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q fever[a]	–	1	–	1	1	–	2	1	–	–	–	2	–	–	–	–	1	–	9	36
Respiratory and other																				
Blood lead level[a]	–	–	2	2	–	3	–	–	3	–	2	1	–	–	3	–	2	–	18	42
Invasive pneumococcal infection[a]	2	2	–	–	1	1	1	–	3	1	2	2	7	4	5	2	1	–	34	81
Legionella longbeachae infection[a]	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	1	1	–	5	11
Legionella pneumophila infection[a]	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	1	1	–	4	9
Legionnaires' disease (other)[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Leprosy	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Meningococcal infection (invasive)[a]	–	–	–	–	–	1	–	–	–	1	–	–	1	–	1	–	–	–	4	16
Tuberculosis	–	–	–	–	–	3	–	1	–	1	2	3	11	–	6	1	14	–	42	109
Vaccine-preventable																				
Adverse event after immunisation	2	2	1	–	–	2	1	–	–	–	–	3	4	–	1	1	4	–	21	35
H. influenzae b infection (invasive)[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Measles	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	6
Mumps[a]	–	–	–	–	–	1	–	–	–	–	–	–	1	1	–	–	–	–	3	5
Pertussis	26	29	–	19	7	46	6	15	22	14	32	22	49	30	23	12	46	–	398	1425
Rubella[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
Tetanus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Enteric																				
Botulism	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cholera[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cryptosporidiosis[a]	2	–	–	1	1	1	1	4	1	1	14	–	3	2	3	1	8	–	43	131
Giardiasis[a]	9	1	2	6	7	20	10	11	2	17	38	7	57	28	17	11	30	–	273	716
Haemolytic uraemic syndrome	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Hepatitis A[a]	–	–	–	–	–	–	–	–	–	–	2	–	1	–	–	–	1	–	4	40
Hepatitis E[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Listeriosis[a]	–	–	–	–	–	1	–	–	–	–	2	–	–	–	1	–	–	–	4	15
Salmonellosis[a]	11	9	5	7	5	37	10	10	33	16	100	16	70	44	62	40	60	1	537	1368
Shigellosis[a]	–	–	–	–	–	–	–	–	–	–	1	3	3	2	1	–	–	–	10	25
Typhoid[a]	–	–	–	–	–	–	–	–	–	–	3	–	2	1	1	–	1	–	8	17
Verotoxin producing *E. coli*[a]	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	7
Miscellaneous																				
Creutzfeldt–Jakob disease	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
Meningococcal conjunctivitis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

[a]Laboratory-confirmed cases only. [b]Includes cases with unknown postcode.
NB: Data are current and accurate as at the preparation date. The number of cases reported is, however, subject to change, as cases may be entered at a later date or retracted upon further investigation. Historical Area Health Service configurations are included for continuity/comparison purposes and to highlight regional differences.
NB: Influenza data are reported separately, see: http://www.health.nsw.gov.au/publichealth/infectious/index.asp.
NB: From 1 January 2005, Hunter New England AHS also comprises Great Lakes, Gloucester and Greater Taree LGAs (LGA, Local Government Area), Sydney West also comprises Greater Lithgow LGA.
NB: HIV and AIDS data are reported separately in the Public Health Bulletin quarterly.
GMA, Greater Murray Area; MAC, Macquarie Area; NEA, New England Area; CCA, Central Coast Area; SES, South Eastern Sydney Area; WEN, Wentworth Area; SA, Southern Area; MWA, Mid Western Area; MNC, North Coast Area.
NSA, Northern Sydney Area; CSA, Central Sydney Area; WSA, Western Sydney Area; FWA, Far West Area; HUN, Hunter Area; NRA, Northern Rivers Area; ILL, Illawarra Area; SWS, South Western Sydney Area; JHS, Justice Health Service.

Table 2. Reports of notifiable conditions received in April 2010 by area health services

Condition	Area Health Service (2010)																			Total	
	Greater Southern		Greater Western			Hunter New England		North Coast		Northern Sydney Central Coast		South Eastern Sydney Illawarra		Sydney South West		Sydney West				For April[b]	Year to date[b]
	GMA	SA	FWA	MAC	MWA	HUN	NEA	MNC	NRA	CCA	NSA	ILL	SES	CSA	SWS	WEN	WSA	JHS			
Bloodborne and sexually transmitted																					
Chancroid[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Chlamydia (genital)[a]	49	26	15	24	32	158	39	29	55	89	133	93	276	160	142	33	126	8		1503	6162
Gonorrhoea[a]	1	3	1	–	–	17	–	4	1	6	14	6	61	39	15	–	13	–		185	856
Hepatitis B – acute viral[a]	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–		2	13
Hepatitis B – other[a]	–	1	3	1	4	5	–	–	2	8	29	6	32	24	19	11	49	3		200	1021
Hepatitis C – acute viral[a]	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	1		3	15
Hepatitis C – other[a]	12	5	4	8	7	33	12	9	23	28	27	17	42	18	28	9	28	27		340	1667
Hepatitis D – unspecified[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	1
Lymphogranuloma vanereum	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–		2	3
Syphilis	–	–	1	2	1	2	1	1	2	1	7	3	29	25	13	1	4	–		95	366
Vectorborne																					
Barmah Forest virus[a]	1	3	–	2	1	1	–	6	7	4	–	1	–	1	–	–	–	–		27	110
Ross River virus[a]	45	11	17	27	27	33	10	11	39	14	5	5	4	1	7	13	5	–		275	582
Arboviral infection (other)[a]	–	1	–	–	–	–	–	–	–	–	1	–	2	1	–	–	–	–		5	34
Malaria[a]	–	–	–	–	–	–	–	–	1	–	1	–	2	1	1	1	1	–		9	23
Zoonoses																					
Anthrax[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	1
Brucellosis[a]	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–		1	3
Leptospirosis[a]	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–		2	7
Lyssavirus[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Psittacosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Q fever[a]	–	–	–	2	1	4	1	2	1	1	–	–	–	2	–	1	–	–		15	51
Respiratory and other																					
Blood lead level[a]	1	1	4	2	–	4	–	–	–	–	1	–	2	1	1	1	1	–		19	61
Invasive pneumococcal infection[a]	1	2	–	–	5	2	–	–	1	2	2	1	4	2	3	–	2	–		29	110
Legionella longbeachae infection[a]	–	–	–	–	–	–	–	–	–	1	4	–	–	–	–	–	–	–		5	16
Legionella pneumophila infection[a]	–	–	–	–	–	–	–	–	–	–	1	1	1	–	1	–	2	–		6	15
Legionnaires' disease (other)[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	1
Leprosy	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–		1	1
Meningococcal infection (invasive)[a]	–	–	–	1	–	2	–	–	–	–	–	–	1	1	1	–	–	–		6	22
Tuberculosis	2	–	–	–	–	1	1	–	–	–	–	–	5	–	7	1	5	–		22	131
Vaccine-preventable																					
Adverse event after immunisation	6	1	2	1	3	12	–	–	1	2	3	7	7	6	2	2	10	–		65	100
H. influenzae b infection (invasive)[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Measles	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	6
Mumps[a]	–	–	–	–	–	–	1	–	–	–	–	–	–	1	2	–	–	–		4	9
Pertussis	16	15	1	8	9	38	10	16	5	3	23	13	47	20	26	12	38	–		300	1725
Rubella[a]	–	–	–	–	–	–	–	–	–	1	2	–	–	–	1	–	–	–		4	8
Tetanus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Enteric																					
Botulism	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Cholera[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Cryptosporidiosis[a]	–	2	–	1	3	4	–	1	4	1	2	–	3	3	2	2	3	–		31	162
Giardiasis[a]	10	2	2	8	10	11	8	5	3	13	32	11	49	16	7	9	28	–		225	941
Haemolytic uraemic syndrome	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	3
Hepatitis A[a]	–	–	–	–	–	–	–	1	–	–	1	–	–	3	–	–	–	–		5	45
Hepatitis E[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–		2	4
Listeriosis[a]	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–		2	17
Salmonellosis[a]	14	3	–	8	5	26	7	11	17	13	42	21	38	32	72	20	34	–		362	1730
Shigellosis[a]	–	1	–	–	–	1	–	1	1	–	–	–	–	3	–	–	–	–		7	32
Typhoid[a]	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–		3	20
Verotoxin producing *E. coli*[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	7
Miscellaneous																					
Creutzfeldt–Jakob disease	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–		1	6
Meningococcal conjunctivitis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–

[a]Laboratory-confirmed cases only. [b]Includes cases with unknown postcode.
NB: Data are current and accurate as at the preparation date. The number of cases reported is, however, subject to change, as cases may be entered at a later date or retracted upon further investigation. Historical Area Health Service configurations are included for continuity/comparison purposes and to highlight regional differences.
NB: Influenza data are reported separately, see: http://www.health.nsw.gov.au/publichealth/infectious/index.asp.
NB: From 1 January 2005, Hunter New England AHS also comprises Great Lakes, Gloucester and Greater Taree LGAs (LGA, Local Government Area), Sydney West also comprises Greater Lithgow LGA.
NB: HIV and AIDS data are reported separately in the Public Health Bulletin quarterly.
GMA, Greater Murray Area; MAC, Macquarie Area; NEA, New England Area; CCA, Central Coast Area; SES, South Eastern Sydney Area; WEN, Wentworth Area; SA, Southern Area; MWA, Mid Western Area; MNC, North Coast Area.
NSA, Northern Sydney Area; CSA, Central Sydney Area; WSA, Western Sydney Area; FWA, Far West Area; HUN, Hunter Area; NRA, Northern Rivers Area; ILL, Illawarra Area; SWS, South Western Sydney Area; JHS, Justice Health Service.

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