

New Zealand's Climate Change Commission report: the critical need to address the missing health co-benefits of reducing emissions

Tim Chambers, Simon Hales, Caroline Shaw, Michael Baker, Jude Ball, Christine Cleghorn, Nick Wilson

ABSTRACT

The Climate Change Commission's draft report and recommendations provide a pathway towards achieving the New Zealand Government's commitment to net zero emissions by 2050. However, the Commission has not adequately considered the health co-benefits of climate change mitigation. In this viewpoint, we assess how the Commission has considered health co-benefits in the key response domains. Extrapolating UK evidence to the New Zealand context suggests climate change mitigation strategies that reduce air pollution, transition the population towards plant-based diets and increase physical activity via active transport could prevent thousands of deaths per year in coming decades. Substantial health co-benefits would also arise from improved housing, cleaner water, noise reductions, afforestation and more compact cities. The Commission's draft report only briefly mentions many of these health co-benefits, and some are completely absent. We recommend the Commission's final report: (i) use health co-benefits as an explicit frame; (ii) ensure the government's Treaty of Waitangi obligations are met in all the domains covered to maximise benefits for Māori health and wellbeing; (iii) build on the successful COVID-19 response that demonstrated rapid, science-informed and vigorous government action can address major global health threats; (iv) include both public health expertise and Māori health expertise among its commissioners; (v) explain how health co-benefits are likely to generate major cost-savings to the health system.

The Climate Change Commission's (the Commission's) draft report (the Report) and recommendations provide a useful pathway towards achieving the New Zealand Government's commitment of net zero emissions by 2050.¹ But the Commission's draft advice does not adequately consider how climate change actions could produce health co-benefits or potentially exacerbate existing health inequities. The evidence for mitigation-related health co-benefits is substantial.^{2,3} Indeed, extrapolating recent international evidence⁴ to the New Zealand context suggests that climate change mitigation could ultimately prevent thousands of premature

deaths per year in coming decades. This impact could be through dietary changes, increased active transport and reductions in air pollution. Unfortunately, the Commission makes no such quantitative estimates of the health impacts of its proposed policies, thus overestimating cost relative to the benefits of climate action. This omission is despite extensive international work and local research documenting the likely high magnitude of these health co-benefits. In this viewpoint, we assess how the Commission has considered health co-benefits in the key response domains and provide evidence that could be used to improve its response.

Food environment and dietary patterns

The Report is largely focused on the industrial “food production” system and does not mention the word “diet” (eg, human diet) despite the huge potential co-benefits from a move towards more plant-based diets.⁵ It notes that “Transitioning to a low emissions economy will require New Zealanders to change some aspects of their lives,”¹ yet reducing consumption of meat and dairy is omitted from the examples provided. New Zealand research demonstrates a shift towards more plant-based diets could lower greenhouse emissions, improve health, lower costs to the public and lower healthcare costs.^{6–8} One New Zealand study demonstrated that, if New Zealanders adopted the New Zealand Dietary Guidelines, diet-related emissions would reduce by 4–42%, depending on the degree of dietary change and food waste minimisation.⁷ The estimated lifetime health gains for the current New Zealand population were 1.0–1.5 million quality-adjusted life-years, and the estimated healthcare system cost-savings were NZ\$14–20 billion. Another New Zealand study showed the large health gains and cost-savings from a modelled junk food tax and a saturated fat tax,⁹ with some of these benefits arising from reductions in meat consumption. Finally, the health co-benefits of improved diets also include potential reductions in health inequities as Māori and Pasifika disproportionately suffer chronic diseases (cardiovascular disease, diabetes and some cancers) related to New Zealand’s obesogenic food environment.

Plant products typically produce far fewer greenhouse gas emissions compared to animal products.¹⁰ Indeed, New Zealand meat and dairy products still produce approximately five times the greenhouse gas emissions per gram of product of the highest plant-based emitter, rice.⁷ Plant-based milk and meat, which is becoming increasingly price competitive, is estimated to contribute around 4% of the greenhouse gases per unit of protein and use less land and water compared to meat and dairy.¹¹

The Report also says that “red meat and dairy products from Aotearoa are already some of the least emissions intensive in the world.”¹ However, the lifecycle

assessment for lamb and beef emissions have point estimates that fall within the confidence intervals of global averages, suggesting there is no statistically meaningful difference between New Zealand and the international pattern of global emissions for lamb and beef.⁷ Further, such comparative analyses can be misleading because they typically don’t consider that dairy and meat production still generate the largest dietary emissions by far, as well as having other land-use consequences (eg, the native bush that was removed to allow for livestock grazing). For example, one New Zealand Government report noted that “The exclusion of carbon losses arising from forest harvesting, deforestation and scrub clearance has a significant impact on the overall estimate of net emissions and removals.”¹² The ideal analysis of agriculture/food impacts should also account for the carbon costs of using coal in the milk drying processes often used in New Zealand, which was not considered in one study of the carbon footprint of New Zealand milk.¹³ Finally, greater independence from industry-produced or funded livestock lifecycle assessments is required to ensure the validity of the results.

Physical activity benefits from active transport

The Report states: “There are significant co-benefits from increasing alternative types of transport. In particular, walking and cycling benefit health.”¹ Two New Zealand publications on the benefits of active transport for health are referred to in the Report.^{14,15} But, considering that this might be the second most important area for health gain, there is still a marked lack of detail on these benefits.⁴ This deficit includes the minimal consideration of increased use of electric bikes, despite their rapid uptake in many cities internationally. Other relevant New Zealand-based modelling work was not mentioned. For example, this other work reported that switching short vehicle trips to walking and cycling could generate large healthcare cost-savings (range: NZ\$127 million to NZ\$2.1 billion) and reduce greenhouse gas emissions by up to 194 kilotonnes CO₂e/year.¹⁶ Another modelling study that

considered health aspects of bicycling (relating to physical activity, injury and air pollution) reported that “transforming urban roads over the next 40 years, using best practice physical separation on main roads and bicycle-friendly speed reduction on local streets, would yield benefits 10-25 times greater than costs.”¹⁵ Improved walking and cycling infrastructure would particularly improve transport options for Māori, Pasifika and low-income New Zealanders.¹⁶

International and local examples show that a rapid and substantial mode shift towards active and public transport is highly achievable.^{17,18} For example, an evaluation of New Zealand’s “model communities” found a 30% net increase in active transport in intervention cities compared with control cities over a three-year period.¹⁹ Yet this potential is not reflected in the Report’s mode shift assumptions, which are modest (“walking, cycling and public transport can be increased by 25%, 95% and 120% respectively by 2030”).¹ Instead, the Report puts emphasis on the electrification of New Zealand’s transport fleet, a strategy that will not increase physical activity or address other problems associated with car-dependency, such as the safety of children and other vulnerable road users, traffic congestion, cost of road maintenance or use of valuable urban land for storing cars.²⁰

Benefits from reduced air pollution

Another co-benefit of using less fossil fuel for energy, heating and transportation that only received brief mention in the Report is improved health from reduced air pollution. The Report refers to one New Zealand study on the harm from air pollution to health, which estimated particulate matter emissions cause adverse health outcomes, including over a thousand premature deaths, with a cost of NZ\$8 billion per year.²¹ The Report also mentions further government encouragement for working-from-home arrangements, which may reduce air pollution from commuter traffic. Nevertheless, there is still a marked lack of detail in this important area for health co-benefits. Two other relevant papers were not mentioned: one on the association

between air pollution and mortality for New Zealand,²² and the other on the impact of the COVID-19 lockdown on improved air quality in New Zealand, which highlights the potential gains that can be made.²³ Fortunately, New Zealand estimates of health impacts attributable to ambient air pollution are currently being updated and can be included in future reporting.

Health inequities

The Report is reasonably good at considering some aspects of inequities—but these are predominantly around income inequality. The Report notes the health impacts of climate change would likely be spread unevenly across the population, with more vulnerable groups being more exposed.¹ It includes a vision of ensuring the low emissions transition takes opportunities to reduce inequities and consider intergenerational equity. However, the Report does not fully outline the potential of climate actions to reduce existing health inequities by reducing exposures disproportionately borne by disadvantaged groups (eg, cold, damp homes, poor food environments, air pollution and traffic injuries). This gap is despite existing health inequities being of major concern from the perspective of preventable health loss, an ethical perspective and a Te Tiriti o Waitangi (Treaty of Waitangi) perspective.

Other health co-benefits

The health co-benefits presented above are not an exhaustive list. In Appendix Table 1, we outline other health co-benefits that are also important from health, social and cultural perspectives. These co-benefits include: (i) improved health from warmer and drier homes (with improved house designs and increased use of insulation); (ii) improved cardiovascular and mental health from reduced noise pollution (with a shift to electric vehicles, increased use of rail and shipping for freight and any reduction in air transport); (iii) improved water quality from increased reforestation and livestock reductions (reducing nitrates and enteric pathogens from livestock agriculture); (iv) improved mental health, reduced injury and improved physical health and wellbeing

from more compact cities and less urban sprawl (less commuting time, better access to central city services via walking and cycling).

Our recommendations to the Commission

Health co-benefits should be used to explicitly frame the Commission's final report. The advantage of this approach is that it identifies meaningful value for the public and it is likely to create better support for action.²⁴ The idea that we can reduce emissions and simultaneously improve wellbeing (often with immediate and local effect) is far more appealing than a technical and sectoral approach to reducing emissions. Furthermore, the Commission should include reducing health inequities as a co-benefit. To assist them in this work, the Commission should include both public health expertise and Māori health expertise among its commissioners.

Health and other co-benefits should also be quantified and included in cost-benefit analyses of proposed emission-reduction strategies. Given the likely size of the health and societal wellbeing co-benefits of taking actions to reduce New Zealand's emissions, we think it is quite possible that a full cost-benefit analysis that includes these components would be positive. This conclusion makes arguing about whether or not the economic impact is under 1% of GDP (as the Climate Change Commission has estimated) somewhat superficial and premature. Indeed, there is a need for a full cost-benefit analysis that captures the co-benefits we have outlined. New Zealand researchers have already conducted health and economic analyses on various interventions that involve emissions reductions and health co-benefits.^{7,15,16,25} The challenge now is to integrate such findings with the higher-level economic modelling performed by the Commission to produce more comprehensive understanding of the likely impacts on society as a whole. There should also be consideration of whether GDP is the appropriate metric to be considering as the outcome of modelling. Recognising the limited nature of GDP, the New Zealand Treasury has already moved towards a wellbeing framework.²⁶ The Commission's

modelling also needs to consider the wider range of outcomes that are important to people. The Commission should consider ways to minimise any strategies that could exacerbate health inequities and develop compensatory mechanisms to counter these (eg, expanding winter heating subsidies and home insulation subsidies for those at risk of fuel poverty).

The Commission also needs to do more to ensure that the government's Treaty of Waitangi obligations are met in all the domains covered. The sector-specific plans to reduce emissions within the Report do not reflect the values of He Ara Waiora, the analytical framework to improve Māori wellbeing that the Commission states it used to inform their work. The Commission needs to develop more meaningful and enduring partnership with Māori to fully embed these values in their work.

The Commission should also build on the experience of New Zealand's successful response to the COVID-19 pandemic. This response to another major global health threat has shown the benefits of rapid, science-informed, vigorous government action (albeit with some aspects being far from optimal,^{27,28} such as increased psychological stress for some²⁹ and uneven economic shocks to particular communities). A key aspect of the response was the successful communication of the need for collective action for the long-term good of all—a message that is also relevant to climate action and one New Zealanders have shown willingness to respond to. Ultimately, the COVID-19 response demonstrated how a collective response can achieve both public health and economic benefits.³⁰

Lastly, the Commission's final report should explain how these health co-benefits are likely to generate major cost-savings (eg, by reducing healthcare costs and improving productivity from improved health). Therefore, the overall impact on the New Zealand economy of responding to climate change may be much less than estimated by the Commission. Indeed, in the long run, the economic issues of countries responding to climate change pale into insignificance compared with the potentially catastrophic disruptions to planetary systems and human societies that uncontrolled climate change could cause.

Appendix

Appendix Table 1: Our analysis of the coverage of health co-benefits in the Climate Change Commission Report not covered in the main text.

Potential health co-benefit of climate change action	Summary of coverage of health co-benefits	Further details and comments
Improved health from warmer and drier homes (with improved house designs and increased use of insulation)	Some mention and brief quantification	<p>The Report notes: “An evaluation of the Warm Up New Zealand programme found that the health benefits from insulating lower income households were substantial, resulting in savings in health costs of more than \$800 a year on average” (with cross referencing to published work).^{25,32} The evidence documentation also refers to a New Zealand report on gas heating and its role in mouldy homes and indoor air pollution.³³</p> <p>Comment: This is the only health co-benefit where the Report provides some quantification. Nevertheless, key published literature on the health co-benefits of improved insulation in homes^{34, 35,36} is not referred to. Also, that retrofitting insulation has a favourable cost-benefit ratio in the New Zealand setting³⁷ is not mentioned. Improved housing for Māori, Pasifika and low-income New Zealanders is also likely to reduce health inequities given the New Zealand evidence for how dampness and mould contributes to young children’s hospitalisation rates for acute respiratory infections in these groups.³⁸</p>
Mental health, injury physical health and wellbeing benefits from more compact cities and less urban sprawl (less commuting time, better access to central city services via walking and cycling)	Brief mention only	<p>Health co-benefits of urban form are considered in the Report: “Where urban form encourages cycling and walking, alongside efficient, affordable and interconnected public transport networks.” It cites work that states: “If designed appropriately, urban form and transport can increase physical activity, improve air quality, reduce road traffic injuries, increase social cohesion, and achieve maximum health benefits from services and facilities.”</p> <p>Comment: But despite the above, the health co-benefits are not explored in any further detail in the Report. This is despite the health benefits and greenhouse gas reduction benefits of active transport being modelled for New Zealand.¹⁶ There is no mention of the mental health and wellbeing benefits of reduced traffic congestion and reduced long daily commutes by private car. It is not mentioned that good design of green space can potentially ensure that urban intensification can maintain the health and wellbeing benefits of access to parks etc. Furthermore, there is the issue of how urban sprawl can exacerbate inequities. That is, Māori, Pasifika and low-income New Zealanders can be forced to the periphery of urban areas where rents/house prices are lower, but then face greater commuting costs and poorer access to public services. Finally, more compact cities would facilitate a mode shift to more active transport and public transport and evidence suggests that such a mode shift also reduces overall road traffic injury risk and deaths.³⁹</p>

Appendix Table 1: Our analysis of the coverage of health co-benefits in the Climate Change Commission Report not covered in the main text (continued).

Potential health co-benefit of climate change action	Summary of coverage of health co-benefits	Further details and comments
Improved mental health and cardiovascular health from reduced noise pollution (as a result of decreased private vehicle use, increased use of rail and shipping for freight and any reduction in air transport)	Very brief mention	The Report mentions this potential benefit in brief and general terms (eg, “quieter streets”). Comment: There is a marked lack of detail in the Report. There is no mention of the evidence that suggests that exposure to traffic noise is associated with mental health and cardiovascular problems (depression, high blood pressure, myocardial infarction, heart failure and stroke in adults, hyperactivity/inattention and “total difficulties” in children and adolescents). ⁴⁰⁻⁴³ Health inequities could also be reduced as Māori, Pasifika and people on low incomes are more likely to live in noisy areas (eg, near arterial roads and airports).
Improved water quality from increased reforestation and livestock reductions (reducing nitrates and enteric pathogens from livestock agriculture)	Very brief mention	The Report mentions “cleaner water” as a potential benefit of reforestation and mentions the issue of “pathogen loss into waterways.” The Report also considers reduced livestock numbers and reduced land used for livestock farming as options, and these would also be likely to reduce water pollution. Comment: Enteric pathogen contamination of waterways is an important issue in New Zealand as indicated by a major water-borne outbreak of <i>Campylobacter</i> infection in Havelock North. ⁴⁴ The water contamination issue has also been considered in the context of giardiasis. ⁴⁵ Nitrate pollution of water is also a likely risk factor for colorectal cancer, ^{46,47} as well as emerging evidence of it being a risk factor for birth defects and other cancers. ⁴⁸
Other reduced health harm and water treatment costs arising from increased reforestation	Briefly implied	The Report notes that establishing new native forests on less productive land offers erosion control benefits. Comment: But the Report fails to draw linkages with reforestation and: (i) lower risk of flooding; (ii) lower water treatment costs.

Competing interests:

Caroline Shaw declares funding from the Health Research Council outside the submitted work. Christine Cleghorn declares a financial relationship with Horticulture NZ outside the submitted work.

Acknowledgements:

A short version of this document was published in *The Conversation* and benefited from editorial input from this publication. Between the submission and publication of this article, the Commission's final advice to the government was released. The final report put greater emphasis on active transport and made greater acknowledgement of the potential health co-benefits of climate action. Yet these benefits were not incorporated into financial modeling. The potential cost-savings from diets less reliant on animal products remain absent in the final report. There remains a lack of public health expertise among the commissioners, and attention to Treaty of Waitangi obligations and health equity impacts is insufficient. We cover these issues in more detail on the Public Health Expert Blog: <https://blogs.otago.ac.nz/pubhealthexpert/health-co-benefits-need-to-be-adequately-considered-in-the-climate-change-commissions-final-advice/>

Author information:

Tim Chambers: Department of Public Health, University of Otago, Wellington.

Simon Hales: Department of Public Health, University of Otago, Wellington.

Caroline Shaw: Department of Public Health, University of Otago, Wellington.

Michael Baker: Department of Public Health, University of Otago, Wellington.

Jude Ball: Department of Public Health, University of Otago, Wellington.

Christine Cleghorn: Department of Public Health, University of Otago, Wellington.

Nick Wilson: Department of Public Health, University of Otago, Wellington.

Corresponding author:

Tim Chambers, Department of Public Health, University of Otago, Wellington

tim.chambers@otago.ac.nz

URL:

www.nzma.org.nz/journal-articles/new-zealands-climate-change-commission-report-the-critical-need-to-address-the-missing-health-co-benefits-of-reducing-emissions

REFERENCES

1. He Pou a Rangi – the Climate Change Commission. 2021 Draft Advice for Consultation. Wellington (NZL): He Pou a Rangi - The Climate Change Commission;2021. Accessed 24 Mar 2021. Available from: <https://www.climatecommission.govt.nz/get-involved/our-advice-and-evidence/>.
2. Gao J, Kovats S, Vardoulakis S, Wilkinson P, Woodward A, Li J et al. Public health co-benefits of greenhouse gas emissions reduction: A systematic review. *Sci Total Environ*. 2018;627:388-402. <https://doi.org/10.1016/j.scitotenv.2018.01.193>
3. Quam VG, Rocklöv J, Quam M, Lucas RA. Assessing greenhouse gas emissions and health co-benefits: a structured review of lifestyle-related climate change mitigation strategies. *International Journal of Environmental Research and Public Health*. 2017;14(5):468. <https://doi.org/10.3390/ijerph14050468>
4. Hamilton I, Kennard H, McGushin A, et al. The public health implications of the Paris Agreement: a modelling study. *Lancet Planet Health*. 2021;5:e74-83. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7887663/pdf/main.pdf>.
5. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S et al. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet*. 2019;393(10170):447-492. [https://doi.org/10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4)
6. Wilson N, Nghiem N, Ni Mhurchu C, Eyles H, Baker MG, Blakely T. Foods and dietary patterns that are healthy, low-cost, and environmentally sustainable: a case study of optimization modeling for New Zealand. *PLoS One*. 2013;8(3):e59648. <https://doi.org/10.1371/journal.pone.0059648>
7. Drew J, Cleghorn C, Macmillan A, Mizdrak A. Healthy and climate-friendly eating patterns in the New Zealand context. *Environ Health Perspect*. 2020;128(1):17007. <https://doi.org/10.1289/EHP5996>

8. Cleghorn CL, Wilson N. The benefits of constraining processed meat and red meat consumption in New Zealand: a public health perspective. *N Z Med J*. 2016;129(1445):115-121. <https://www.ncbi.nlm.nih.gov/pubmed/27857245>.
9. Blakely T, Cleghorn C, Mizdrak A, Waterlander W, Nghiem N, Swinburn B et al. The effect of food taxes and subsidies on population health and health costs: a modelling study. *Lancet Public Health*. 2020;5(7):e404-e413. [https://doi.org/10.1016/S2468-2667\(20\)30116-X](https://doi.org/10.1016/S2468-2667(20)30116-X)
10. Wilson N, Cleghorn CL, Cobiac LJ, Mizdrak A, Nghiem N. Achieving healthy and sustainable diets: a review of the results of recent mathematical optimization studies. *Adv Nutr*. 2019;10(Suppl_4):S389-S403. <https://doi.org/10.1093/advances/nmz037>
11. Sims R, Barton B, Bennett P, Isaacs N, Kerr S, Leaver J et al. Transition to a low-carbon economy for New Zealand. Wellington (NZL): Royal Society of New Zealand;2016. Accessed 24 Mar 2021. <https://royalsociety.org.nz/assets/documents/Report-Transition-to-Low-Carbon-Economy-for-NZ.pdf>.
12. Ministry for the Environment. Net emissions and removals from vegetation and soils on sheep and beef farmland. . Wellington (NZL): Ministry for the Environment;2021. Accessed 24 Mar 2021. Available from: <https://www.mfe.govt.nz/publications/climate-change/net-emissions-and-removals-vegetation-and-soils-sheep-and-beef-farmland>.
13. Ledgard S, Falconer S, Abercrombie R, Philip G, Hill J. Temporal, spatial, and management variability in the carbon footprint of New Zealand milk. *Journal of Dairy Science*. 2019. <https://doi.org/10.3168/jds.2019-17182>
14. Mandic S, Jackson A, Lieswyn J, Mindell J, García Bengoechea E, Spence J et al. Turning the tide: From cars to active transport. University of Otago, 2019. <https://www.otago.ac.nz/active-living/otago710135.pdf>.
15. Macmillan A, Connor J, Witten K, Kearns R, Rees D, Woodward A. The societal costs and benefits of commuter bicycling: simulating the effects of specific policies using system dynamics modeling. *Environ Health Perspect*. 2014;122(4):335-344. <https://doi.org/10.1289/ehp.1307250>
16. Mizdrak A, Blakely T, Cleghorn CL, Cobiac LJ. Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: A modelling study. *PLoS One*. 2019;14(7):e0219316. <https://doi.org/10.1371/journal.pone.0219316>
17. Pucher J, Dill J, Handy S. Infrastructure, programs, and policies to increase bicycling: an international review. *Preventive Medicine*. 2010;50:S106-S125.
18. Mueller N, Rojas-Rueda D, Salmon M, Martinez D, Ambros A, Brand C et al. Health impact assessment of cycling network expansions in European cities. *Preventive Medicine*. 2018;109:62-70. <https://doi.org/10.1016/j.ypmed.2017.12.011>
19. Keall M, Chapman R, Howden-Chapman P, Witten K, Abrahamse W, Woodward A. Increasing active travel: results of a quasi-experimental study of an intervention to encourage walking and cycling. *J Epidemiol Community Health*. 2015;69(12):1184-1190. <https://doi.org/10.1136/jech-2015-205466>
20. Litman T. Win-win transportation emission reduction strategies. Victoria (AUS): Victoria Transport Policy Institute 2021. Accessed 16 Apr 2021. <https://www.vtpi.org/wwclimate.pdf>.
21. Kuschel G, Metcalfe J, Wilton E, Hales S, Rolfe K, Woodward A. Updated health and air pollution in New Zealand study, Volume 1: summary report. Wellington (NZL)2012. Accessed 24 Mar 2021. <https://www.mfe.govt.nz/sites/default/files/media/Air/updated-health-and-air-pollution-new-zealand-study-summary-report.pdf>.
22. Hales S, Blakely T, Woodward A. Air pollution and mortality in New Zealand: cohort study. *J Epidemiol Community Health*. 2012;66(5):468-473. <https://doi.org/10.1136/jech.2010.112490>
23. Patel H, Talbot N, Salmond J, Dirks K, Xie S, Davy P. Implications for air quality management of changes in air quality during lockdown in Auckland (New Zealand) in response to the 2020 SARS-CoV-2 epidemic. *Sci Total Environ*. 2020;746:141129. <https://doi.org/10.1016/j.scitotenv.2020.141129>
24. Leining C. Not a problem, someone else's problem, my problem or our opportunity?: Shifting attitudes and behaviour on mitigating climate change. Wellington (NZL): Motu Economic and Public Policy

- Research;2015. Accessed 24 Mar 2021. <https://www.motu.nz/assets/Documents/our-work/environment-and-resources/emission-mitigation/shaping-new-zealands-low-emissions-future/Motu-Note-18.pdf>.
25. Grimes A, Denne T, Howden-Chapman P, Arnold R, Telfar-Barnard L, Young C. Cost benefit analysis of the warm up New Zealand: heat smart programme. Wellington (NZL)2012. Accessed 24 Mar 2021. <https://motu.nz/assets/Documents/our-work/urban-and-regional/housing/Cost-Benefit-Analysis-of-the-Warm-Up-New-Zealand-Heat-Smart-Programme.pdf>.
 26. The Treasury. Our living standards framework. Online: The Treasury;2019. Accessed 17 Jun 2021. Available from: <https://www.treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework>.
 27. Wilson N, Boyd M, Kvalsvig A, Chambers T, Baker M. Public health aspects of the Covid-19 response and opportunities for the post-pandemic era. *Policy Quarterly* 2020;16(3):20-24. <https://ojs.victoria.ac.nz/pq/article/view/6550/5715>.
 28. Wilson N, Grout L, Kvalsvig A, Baker M. Time to Stop Dodging Bullets? NZ's Eight Recent Border Control Failures. *Public Health Expert (Blog)* 2020;(16 November). <https://blogs.otago.ac.nz/pubhealth-expert/2020/11/16/time-to-stop-dodging-bullets-nzs-eight-recent-border-control-failures/>.
 29. Every-Palmer S, Jenkins M, Gendall P, Hoek J, Beaglehole B, Bell C et al. Psychological distress, anxiety, family violence, suicidality, and wellbeing in New Zealand during the COVID-19 lockdown: A cross-sectional study. *PLoS One*. 2020;15(11):e0241658. <https://doi.org/10.1371/journal.pone.0241658>
 30. Baker M, Wilson N, Blakely T. Elimination may be the optimal response strategy for covid-19 and other emerging pandemic diseases. *BMJ*. 2020;371. <https://doi.org/10.1136/bmj.m4907>
 31. Wilson N, Shaw C, Ball J, Baker M, Hales S, Chambers T. NZ's Climate Change Commission needs to account for the huge potential health benefits of reducing emissions. 2021;(3 March). <https://theconversation.com/nzs-climate-change-commission-needs-to-account-for-the-huge-potential-health-benefits-of-reducing-emissions-156036>.
 32. Telfar Barnard L, Preval N, Howden-Chapman P, Arnold R, Young C, Grimes A et al. The impact of retrofitted insulation and new heaters on health services utilisation and costs, pharmaceutical costs and mortality. *Evaluation of Warm Up New Zealand: Heat Smart*. Wellington (NZL): University of Otago, Victoria University of Wellington, Motu, Covec;2011. Accessed 24 Mar 2021. http://www.healthyhousing.org.nz/wp-content/uploads/2012/03/NZIF_Health_report-Final.pdf.
 33. Canterbury District Health Board. Unflued Gas Heaters: Position statement and background paper for the Canterbury District Health Board. Christchurch (NZL): Information Team Community and Public Health;2015. Accessed 24 Mar 2021. Available from: <https://www.cdhb.health.nz/About-CDHB/corporate-publications/Documents/CDHB%20Unflued%20Gas%20Heaters%20Position-Statement.pdf>.
 34. Howden-Chapman P, Matheson A, Crane J, Viggers H, Cunningham M, Blakely T et al. Effect of insulating existing houses on health inequality: cluster randomised study in the community. *BMJ*. 2007;334(7591):460. <https://doi.org/10.1136/bmj.39070.573032.80>
 35. Fyfe C, Telfar L, Barnard, Howden-Chapman P, Douwes J. Association between home insulation and hospital admission rates: retrospective cohort study using linked data from a national intervention programme. *BMJ*. 2020;371:m4571. <https://doi.org/10.1136/bmj.m4571>
 36. Preval N, Keall M, Telfar-Barnard L, Grimes A, Howden-Chapman P. Impact of improved insulation and heating on mortality risk of older cohort members with prior cardiovascular or respiratory hospitalisations. *BMJ Open*. 2017;7(11):e018079. <https://doi.org/10.1136/bmjopen-2017-018079>
 37. Chapman R, Howden-Chapman P, Viggers H, O'Dea D, Kennedy M. Retrofitting houses with insulation: a cost-benefit analysis of a randomised community trial. *J Epidemiol Community Health*. 2009;63(4):271-277. <https://doi.org/10.1136/jech.2007.070037>
 38. Ingham T, Keall M, Jones B, Aldridge DRT, Dowell AC, Davies C et al. Damp mouldy housing and early childhood hospital

- admissions for acute respiratory infection: a case control study. *Thorax*. 2019;74(9):849-857. <https://doi.org/10.1136/thoraxjnl-2018-212979>
39. Shaw C, Randal E, Keall M, Woodward A. Health consequences of transport patterns in New Zealand's largest cities. *NZ Med J*. 2018;131(1472).
40. Hegewald J, Schubert M, Freiberg A, Romero Starke K, Augustin F, Riedel-Heller SG et al. Traffic noise and mental health: A systematic review and meta-analysis. *Int J Environ Res Public Health*. 2020;17(17). <https://doi.org/10.3390/ijerph17176175>
41. Schubert M, Hegewald J, Freiberg A, Starke KR, Augustin F, Riedel-Heller SG et al. Behavioral and emotional disorders and transportation noise among children and adolescents: A systematic review and meta-analysis. *Int J Environ Res Public Health*. 2019;16(18). <https://doi.org/10.3390/ijerph16183336>
42. Ndrepepa A, Twardella D. Relationship between noise annoyance from road traffic noise and cardiovascular diseases: a meta-analysis. *Noise Health*. 2011;13(52):251-259. <https://doi.org/10.4103/1463-1741.80163>
43. Munzel T, Schmidt FP, Steven S, Herzog J, Daiber A, Sorensen M. Environmental noise and the cardiovascular system. *J Am Coll Cardiol*. 2018;71(6):688-697. <https://doi.org/10.1016/j.jacc.2017.12.015>
44. Gilpin BJ, Walker T, Paine S, Sherwood J, Mackereth G, Wood T et al. A large scale waterborne *Campylobacteriosis* outbreak, Havelock North, New Zealand. *J Infect*. 2020;81(3):390-395. <https://doi.org/10.1016/j.jinf.2020.06.065>
45. Winkworth CL. Land-use change and emerging public health risks in New Zealand: assessing *Giardia* risks. *N Z Med J*. 2010;123(1322):55-66. <https://www.ncbi.nlm.nih.gov/pubmed/20930892>. Published 2010/10/12.
46. Schullehner J, Hansen B, Thygesen M, Pedersen CB, Sigsgaard T. Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study. *Int J Cancer*. 2018;143(1):73-79. <https://doi.org/10.1002/ijc.31306>
47. Temkin A, Evans S, Manidis T, Campbell C, Naidenko OV. Exposure-based assessment and economic valuation of adverse birth outcomes and cancer risk due to nitrate in United States drinking water. *Environ Res*. 2019;176:108442. <https://doi.org/10.1016/j.envres.2019.04.009>
48. Ward MH, Jones RR, Brender JD, De Kok TM, Weyer PJ, Nolan BT et al. Drinking water nitrate and human health: an updated review. *International Journal of Environmental Research and Public Health*. 2018;15(7):1557. <https://doi.org/10.3390/ijerph15071557>