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Dear Professor Weeramanthri,

Telethon Kids Institute submission to the Climate Health WA Inquiry

Thank you for the opportunity to make a submission to the Climate Health WA Inquiry.

Telethon Kids Institute's mission is to improve the health, development and lives of children and young people through excellence in research and the application of that knowledge. The current and future impacts of climate change – the biggest global health threat of the 21st century¹ – on children's health are thus of major concern to us.

Climate change is already having, and will continue to have, negative impacts on human physical and mental health. While these impacts are yet to be fully explored, we do know that children and young people are particularly vulnerable.² Research has found, for example, that children currently suffer around 90% of the disease burden from climate change.³

As the science underpinning the climate models used by leading international scientists improves, the projected outcomes become more alarming. Australian climate scientist Joëlle Gergis, a lead author on the United Nations Intergovernmental Panel on Climate Change's (IPCC) sixth assessment report, recently wrote:

*"We know that CO₂ concentrations have risen from pre-industrial levels of 280 parts per million (ppm) to approximately 410 ppm today, the highest recorded in at least three million years. Without major mitigation efforts, we are likely to reach 560 ppm by around 2060. When the IPCC's fifth assessment report was published in 2013, it estimated that such a doubling of CO₂ was likely to produce warming within the range of 1.5 to 4.5°C as the Earth reaches a new equilibrium. However, preliminary estimates calculated from the latest global climate models (being used in the current IPCC assessment, due out in 2021) are far higher than with the previous generation of models. Early reports are predicting that a doubling of CO₂ may in fact produce between 2.8 and 5.8°C of warming."*⁴

The IPCC and increasing numbers of individual scientists warn this would have dire consequences for human health, food production, and human society more broadly.⁴⁻¹¹

The health sector is simultaneously a significant contributor to climate change and uniquely poised to tackle the health implications of this change.

In the attached submission we address the Inquiry's terms of reference, including critical issues we believe should underpin the health system's approach to climate change and child health. Identifying needs and co-designing, implementing, monitoring, and evaluating specific, place-based solutions to climate change will require robust evidence and data from across Western Australia.

Telethon Kids Institute, through its diverse research platforms, and unique data linkage and analytics capabilities, is well positioned to help build the evidence base around climate change and health and assist with informing policy and practice.

Thank you for the opportunity to make a submission on this critical issue. We look forward to reading your final report.

Yours sincerely



Professor Jonathon Carapetis
Executive Director

Responses to the Inquiry's particular points of interest

Overview

Critical issues the Telethon Kids Institute believes should underpin the health system's approach to climate change and child health include:

- Sections of the Australian population most vulnerable to climate change (including children, young people, and Aboriginal and Torres Strait Islander people) must be included in the co-design of climate and health programs and policies. Non-Aboriginal people have much to learn from Aboriginal and Torres Strait Islander cultures about sustainable land use practices and living through climate change.
- We need to recognise we are in a state of climate emergency. An example of this can be found in the Newcastle upon Tyne Hospitals NHS Foundation Trust in the UK. The Trust has set a target to become carbon neutral by 2040 and has joined an international movement comprising a growing number of governments and councils that have declared we are in a climate emergency with current and future severe impacts on the health of people and the planet.¹²
- Given climate change is a health issue, state-funded research is urgently needed to determine the magnitude and timescale of its effect on health in Western Australia – especially on those most vulnerable. This knowledge is currently lacking and is essential to allow timely and appropriate planning of future health services.
- The health sector contributes considerably to pollution and climate change, yet lags behind universities and other sectors, such as local government, in the transformation towards sustainability. We need to think more broadly and creatively – beyond traditional 'green initiatives' such as energy efficiency and recycling – about how we can deliver quality health care without contributing to climate change or other environmental degradation.
 - The health system has a significant carbon footprint, and is responsible for 7% of Australia's total CO₂ emissions (approximately equating to the entire emissions of the population of South Australia).¹³
 - Hospitals produce approximately half of this footprint (including 34% from public hospitals).¹³
 - We could learn from models such as the National Health Service (NHS) in the UK, which has a Carbon Reduction Strategy aimed at helping to drive change towards a low carbon society, and is supported by the Sustainable Development Unit to meet its legal targets in the Climate Change Act.¹⁴
 - Measures to reduce the system's climate impact could include the installation of renewable energy technologies at hospitals (e.g. QEII campus) and other government buildings. This would also reduce energy costs for government.
 - The NHS is already acting and saving in this area. Between 2007 and 2015, despite an 18% increase in admissions, the NHS was able to reduce greenhouse gas emissions by 11%.¹⁵ By 2017, the focus on environmental sustainability was producing savings of £90 million per annum.¹⁶
 - What's good for the climate is also good for the health of our communities. There are many health co-benefits associated with reductions in greenhouse gas emissions, including reducing the burden of chronic diseases like asthma.
- The United Nations Intergovernmental Panel on Climate Change (IPCC) states that we need to be at net zero carbon emissions globally by 2050, with developed countries reaching that goal much sooner to enable those with limited resources the space to reach development goals.¹⁷ To do our part to limit global warming to safe levels, Western Australia – including the health sector – must urgently transition to net zero emissions by 2030.

- We recommend that, like the NHS, the WA Department of Health has clear targets and develops policies to be sustainable.
 - Given the transition to a low carbon society will likely have a range of consequences, the health sector must also help to ensure this transition is achieved in an equitable way.
- There are limits to growth. A climate that sustains human health is only possible with system change and a reorientation of values toward an emphasis on sustainable production and resource usage.¹⁸
- We need to speak up. The public health system and the broader health sector must play a major role in speaking publicly on the scale of the crisis: explaining the link between climate and health; articulating and advocating for the need for immediate large scale emissions reductions and adaptation planning; and partnering with other government departments to bring about the societal level changes that are needed.

Specific Responses

The following points are a compilation of evidence and responses submitted by specialty research groups at the Telethon Kids Institute for consideration by the Committee.

Highlight particular challenges, strengths, opportunities or initiatives relevant to WA, that may not be evident from the national or international literature.

1. Developmental Pathways Project

The Developmental Pathways Project (DPP) is a collaboration between Telethon Kids Institute, UWA and eight State government agencies. The DPP, along with its partners, has established the linkage of Health and non-health data in order to explore the “wicked” problems facing our children and youth. Like the complex social and economic factors that influence health, interconnections between climate change and the environment are linked with social and economic factors as well as human health and wellbeing. Climate change, including severe weather events, has the potential to affect any health outcome that is seasonal or associated with weather and climate, and is expected to increase the prevalence and magnitude of a wide range of health risks.

Changes in climatic conditions and extreme weather events are associated with three broad categories of health impacts, including those:

- directly related to weather/climate.
- resulting from environmental changes that occur in response to climatic change.
- resulting from consequences of climate-induced economic dislocation, environmental decline, and conflict.

Climate change may therefore have wide reaching impacts on population health, including injuries, illness and death associated with:

- heat-related illness.^{19 20}
- poor air quality.²¹
- food, water and vector-borne disease.²²
- airway diseases.^{23 24}
- nutrition²⁵ and exercise.
- safety from bushfires, floods, cyclones, heatwaves and other catastrophes.²⁶
- social dislocation, migration, poor mental health, conflict and violence.²⁷

Western Australia covers 2.5 million square kilometres, extending from tropical latitudes in the north through the mid-latitudes to the south coast. The state comprises regions with diverse climatic influences and varied weather phenomena. The health impacts that may arise in WA will reflect its unique climatic and socio-economic parameters.

To address these potential health impacts it will be necessary to bring together leading government and non-government organisations, researchers, analysts, policy makers and service providers to develop data and analytic capabilities, and utilise existing meteorological, environmental, epidemiological, and broader human health and wellbeing data under uncertain and changing climatic conditions. Such capabilities are necessary to detect, measure and address the health effects of climate change over the long term, and enhance understanding of:

- environmental exposures and health using integrated models.
- ‘hot spots’ (areas with increased environmental and human health risks) for targeted prevention and intervention.
- services required for vulnerable populations (including children, the elderly, pregnant women and Aboriginal communities).

Effectively preparing for and responding to the health impacts of current and projected climate change will require ongoing assessment, action and evaluation to ensure the long-term success of climate mitigation and adaptation initiatives, plans and actions.

2. The ORIGINS Project

ORIGINS, a research partnership between Telethon Kids and the Joondalup Health Campus, supports the *Canmore Declaration: Statement of Principles for Planetary Health*²⁸ which includes the following:

“Improving the health of all natural and anthropogenic systems depends on: mutualistic values; planetary consciousness; advocacy; unity of purpose; recognition of biopsychosocial interdependence; emotional bonds between people and the land; efforts to counter elitism, social dominance and marginalization; meaningful cross-sectoral and cross-cultural narrative; self-awareness; and a personal commitment to shaping new normative attitudes and behaviours.”

ORIGINS acknowledges:

- The need to recognise that climate change is on the continuum of dysbiotic drift ('life in distress') on all scales and in all systems – and cannot be viewed in isolation. That includes the microscale that has direct implications for human health.
- The need to encourage ecological approaches to health in general – which is more likely to make planetary health 'personal' and connect human health to the larger scale issues like climate change.
- The need for an Indigenous perspective, which is often neglected in the planetary health agenda.
- The need for more narrative approaches when engaging on these issues.

Human health is inextricably linked with health of the environment. At no time is this more important than in early life, when the foundations are set for all that follows. The impact of climate change and planetary health on future generations is physical, mental, social, cultural, and even spiritual. Children have the most to lose if we continue with 'business as usual' because:

- Children are more vulnerable than adults to physical trauma, psychosocial stress, nutritional deprivation, infectious agents, and heat waves associated with climate change impacts. Currently the vast majority of the global disease burden due to climate change falls on children – predominantly on the poor in developing countries.
- There are also delayed, lifelong implications. Adversity in the early environment (across all domains, ranging from air, water and food quality, through to psychological stress – and everything in between) increases the risk of many chronic diseases in later life and shortens life expectancy.
- We also now know that the effects of environmental stress are carried across generations through changes to our DNA very early in life, affecting the health of our children's children. In other words, we have not yet seen the full effects of environmental degradation on human health. The pandemic of chronic inflammatory diseases, asthma, allergies, autoimmune and metabolic diseases and mental ill-health already associated with massive urbanisation over the last 50 years, is only set to amplify if we allow the health of our environment to deteriorate further.

ORIGINS encourages families, communities and industries to:

- Adopt and promote plant-based diets with less processed foods and meat which, in addition to environmental benefits, will reduce obesity and a range of diet-related illnesses in both childhood and adulthood.²⁹
- Improve urban environments with more active transport options and fewer cars to ameliorate air quality and foster healthy, active lifestyles for growing children.

- Advocate and promote greening our environment (especially in cities) to increase physical and mental health of inhabitants, and to reduce urban heat island build-up during hot summers.
- Determine best practice interventions to curb child obesity levels. Obesity tracks across the life course so it is important that healthy behaviours start as early as possible. A key way to drive down childhood obesity is to increase children’s physical activity levels. One of the most effective and ways to do this to provide children with increased opportunities to be outdoors and be active. This will become more difficult in a hotter and more harsh climate.
- Promote awareness of the biological and psychological benefits of natural environments for individual physical and mental health, as well as the social and collective benefits (including crime reduction and reducing the health disparities of social disadvantage).³⁰
- Provide educational and practical opportunities (unstructured nature play) that increase ‘nature relatedness’ (emotional connections with nature) in children, to increase their sense of environmental awareness, responsibility, and advocacy in the future.
- Promote initiatives that increase access to greenspace (new and existing), especially for children. This includes reducing the obstacles to accessing natural environments, and the social disparities in both access and location of greenspace.

The rollout of these measures will also provide financial benefits to the wider community. Currently, air pollution from burning fossil fuels contributes to the premature death of approximately 3,000 Australians every year, with a health bill of more than \$11 billion annually.³¹ In addition to saving lives, the savings generated from averting climate change, as well as action on the practices that drive it, could be used to improve our healthcare system.

3. Childhood Disability Group

Nurture our nature for children with intellectual disability – the findings of research by the Childhood Disability group - point to a new voice in the climate change narrative, the voice of children with intellectual disability who are speaking loudly and clearly about their love and enjoyment of experiences in our natural environment which could be impacted negatively by climate change.

Intellectual disability occurs in 1.9 per 100 children, with approximately 15% of these children having severe impairment. As a group, children with intellectual disability have greater exposure to the social determinants of poor health, such as economic disadvantage. The effects of intellectual disability are pervasive for both physical and mental health.

Quality of life refers to a person’s satisfaction with the composite of their life experiences. This is critical to well-being across society. Some domains of quality of life are universal (e.g. physical and mental wellbeing) and other domains apply to particular populations. We have spearheaded research that seeks to understand the quality of life domains important to children with intellectual disability. Relevant to this submission is the component of quality of life relating to the natural environment and the outdoors – a domain not previously represented in other available measures. Elements of the natural environment we considered in our research included time spent with animals, the exploration of plant life, the sensation of land elements (eg, sand, water), and contact with diverse weather patterns (eg, wind, rain, sunshine). Participants shared stories of the children’s pleasure and satisfaction when swimming at the beach, feeling the sensation of mud on their feet while walking through a creek dam, and helping to feed the animals on the family farm. Families also spoke about the importance of time spent with pets or companion dogs. These were noted as being some of the children’s happiest moments as they became immersed in their natural environments, irrespective of the severity of the disability.

Contact with nature has the potential to promote mental health and wellbeing and enhance recovery following episodes of illness for those in the general population. Mechanisms could relate to reduction in stress or the provision of alternate stimuli that enhance cognitive processes such as memory and attention, each with positive effects on mood.

4. Lung Health Team

The Children's Lung Health team is concerned about the effects on climate change on health. The effects of climate change will have serious impacts on lung health in children.^{23 24} Poor air quality has also been shown to be strongly linked to increased child mortality in vulnerable populations in Africa.²¹ Direct effects can be observed from air pollutants in the atmosphere which can exacerbate respiratory disease or affect lung development if exposure occurs early in life. Studies show that exposure to heatwaves or increased high temperature days contribute to preterm birth and stillbirth.³² Dampness from flooding can increase mould, which is linked to impaired respiratory health. At a larger scale, this can affect food availability and access to clean drinking water for certain communities. Infectious diseases may also spread more easily.

5. Sun and UV exposure patterns

Warmer conditions may increase sun exposure by people living in some areas of WA, while decreasing sun exposure in people in other locations. For example, in south west WA, if temperatures increase in currently mild-temperate conditions, then at certain times of the year warmer weather may promote outdoor activities/sun exposure. In hotter sub-tropical locations (e.g. north west WA), then increased temperatures may have the opposite effect, with very hot conditions reducing the time when it will be comfortable for individuals to spend time outdoors. Increased sun exposure elevates the health risk of UV-induced skin/eye damage, and also potential benefits such as vitamin D (with the opposing effects for reduced sun exposure).

Changing atmospheric conditions are predicted to modify UV radiation in various locations:

- The recovery of stratospheric ozone will reduce UV radiation in the southern hemisphere and locations not affected currently by air pollution (e.g. south west WA). This recovery may also reduce global warming as the hole in the ozone layer itself contributes towards global warming and climate change (e.g. warming sea temperatures in southern oceans).
- Reducing rates of air pollution may increase UV radiation in China (with clearer skies).
- Ozone levels may be reduced by water vapour when there are severe storms in some parts of the world (e.g. great plains of USA; potentially cyclones in north west WA), which might increase UV levels, but these effects overall are likely relatively small.

While the effect of climate change on UV exposure among Australians is uncertain³³ climate change has the potential to undermine past reductions in sun exposure and cancer rates, via increased UV radiation intensity and temperature-dependent changes in sun protective behaviours.³⁴ Any increased exposure to UV is likely to have a negative effect on public health in terms of increased morbidity, mortality and costs associated with skin cancers. Exposure to UV radiation during childhood has been identified as an important risk factor for the development of melanoma skin cancer during adulthood, particularly among populations of European origin.³⁵ While research³⁶ and public education campaigns³⁷ have advocated the need for reduced UV exposure, continued advocacy and action highlighting the importance of UV protection, particularly for children, must remain a vital consideration when addressing climate change.

In dry conditions, increased severe weather events (e.g. drought, bush fire) may increase reflected UV radiation, and with increased dust, potentially promote eye conditions such as pterygium.³⁸

Climate change and UV radiation may interact to modify the growing seasons of plants, affecting crop outputs, and potentially extending times for allergen exposure (i.e. promote asthma, hayfever etc). UV radiation may act as a disinfectant (e.g. water supplies) and may affect vector-borne disease (UV may be an insecticide).

6. Skin Health

Climate change impacts on healthy skin are multifactorial. For example, hot, humid conditions are when skin infections become more common. Natural disasters (eg. earthquakes, flooding, cyclones) impact the north of the state much more than the southern areas and can result in displacement of people from their homes temporarily or permanently. This can then result in overcrowding which compounds the risk for skin infections. It also potentially reduces the accessibility of health care providers to provide health care in the remotest of locations where we know burden of disease is highest. So it is an equity issue that once again is borne most significantly by already disadvantaged Aboriginal people in our state.

Opportunities for action to mitigate the health sector's contributions to climate change and/or opportunities for the health sector to advocate/lead/contribute to/promote society wide greenhouse gas emission reductions and other climate change mitigation efforts.

Opportunities to advocate for:

- The adoption of strong climate change policies by federal and state governments, and a rapid and just transition to renewable energy.
- Greening our health systems to minimise our impact on the environment and improve their capacity to cope with climate change.
- Strengthening our health system to cope with a changing climate, in particular supporting the rural and mental health sectors as well as acute care services.
- Investment in renewable energies.

Outline not only what the issues are but how problems can be addressed.

1. Sun Exposure Policy

Consider developing Western Australian location-specific policies for sun protection/exposure recommendations that consider the effects of changing temperature (and other weather conditions) on sun exposure behaviours.

2. Big Data

Big data, machine learning and artificial intelligence are becoming increasingly important as means to generate financially sustainable health systems worldwide. The associated need for super-computing and therefore increased power consumption is adding to the environmental impact of the health sector. Our recommendation is to carefully consider power consumption when deploying new computer systems, and wherever possible use centralised and shared resources. Green computing (as opposed to 'best bang for buck' or 'latest, greatest') must become the major paradigm when constructing future health and research infrastructures.

3. Data Linkage

WA has a wealth of longitudinal birth cohort studies and access to data linkage. There are also many researchers already working in the field of environmental health who have worked to map air pollution across Perth. With access to sampled data and satellite data, we could potentially examine changes in UV levels, temperature and particulate matter over the past few decades, and determine whether there are impaired health outcomes in the population to contribute evidence on effects on health.

Linked data and analytics offer significant potential for informing climate health policy and practice:

- In recent years there has been an increased demand for linked data to inform government planning, particularly around the complex, inter-related health, social and economic problems that face modern societies.

- Linking data across government agencies and services provides information on entire populations, the breadth of which far exceeds data that could be collected via surveys or other means. It provides a powerful tool for understanding complex issues, as well as developing new multi-disciplinary approaches to improve population health and wellbeing.
- Data linkage can provide insights related to ‘whole-of-government’ initiatives, including intervention programs that are working or failing; areas that need greater resources; trends to promote new intervention strategies; and information regarding risk or protective factors.
- Western Australia has been a world leader in data linkage for several decades, especially in relation to datasets contributing to population health research.
- Western Australia’s existing linked datasets cover a broad spectrum of life experiences, including (but not limited to): birth, morbidity, mortality, hospital admissions, housing, education, and justice.
- Western Australia already has valuable linked health and non-health data resources that can be harnessed and linked with climate, weather and other relevant environmental data to inform climate health policy and practice.
- The Bureau of Meteorology provides free access to extensive online collections of meteorological and climate data, and accepts applications for data that are not yet online on a cost-recovery basis.

Existing datasets that offer relevant data for linkage may include:

- Climate data online: daily and monthly statistics, historical weather observations, rainfall, temperature and solar tables, graphs and data.
- Weather Station Directory: additional data types, or data for specific dates and localities (either for free download or on request).
- Australian Climate and Weather Extremes Monitoring System: information about climate and weather extremes of temperature and rainfall.
- Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT): a long-term temperature record to monitor climate variability and change in Australia. It provides a daily record of Australian temperatures since 1910.
- It will also be important to include projections about future climatic conditions in Western Australia, the future distribution and densities of populations, and the development of associated infrastructure to allow for comprehensive assessment of health impacts.
- Data on climate projections may be available from
 - A range of model outputs (for registered users) including climate model data.
 - Australian climate futures: a multi-purpose tool to support advanced users of climate projections data to obtain appropriate climate model data for detailed impact assessments.
- Managing the impacts of climate change on public health will require the involvement of multiple sectors, such as water, planning, building, housing and transport infrastructure. Local government, and other state government departments (e.g. Water and Environmental Regulation, Primary Industries and Regional Development and others), CSIRO, and other state (Indian Ocean Climate Initiative) and national agencies will also have datasets that may provide relevant information.

Describe what you or your organisation would be willing to do or contribute following the Inquiry.

The current situation requires immediate action to protect those who are most vulnerable, especially children. Given our children learn from our values, we have the opportunity and responsibility to instil the ideologies and values of planetary health, through our commitment to address climate change: to show this not just in our words, but through our actions. In addition to its links with good health and wellbeing, there is a critical imperative to nurture the natural environment for numerous personal, social and economic reasons.

1. Policy and Practice

Telethon Kids Institute, through its diverse research platforms, and unique data linkage and analytics capabilities, is well positioned to help build the evidence base around climate change and health and assist with informing policy and practice. This research is urgently needed as little is currently known about the contribution of climate change to current health problems in Western Australia and the extent and timescale of the effects of climate change on future child health in this state. This knowledge is essential for planning policies and health services to address present issues and to mitigate or prevent problems before they arise.

2. ORIGINS

The ORIGINS Project strongly supports the need for immediate action and is:

- Facilitating research projects nested within ORIGINS that investigate health and environmental impacts through the Environment & Lifestyle Research Interest Group.
- Championing a Nature Relatedness pilot randomised controlled trial (RCT) that promotes connection to nature, healthy eating and lifestyle for children and parents.
- Promoting the importance and connection of personal and planetary health at a national and international level through our partnership with InVIVO Planetary Health.
- Implementing a range of environmental initiatives through an internal ORIGINS Eco Team. These include: encouraging staff to be paper-lite or printing on recycled paper; electronic consent forms and electronic distribution of Participant Information Booklets; eliminating use of non-recyclable products for catering; and providing collection boxes for 'hard to recycle' products and coffee pods.
- Planning an ORIGINS 2020 Forum (August 2020) that will strive to have minimal environmental impact and that supports environmental initiatives. We intend to use this opportunity to reiterate and promote eco initiatives to researchers and other stakeholders. At the event we will limit our carbon footprint by encouraging attendees to bring personal keep cups and water bottles, 'greening' the venue with plants, and not supplying paper handouts.
- Willing to contribute to broader action on Climate Change in partnership with the Telethon Kids Institute, Joondalup Health Campus and the WA Health Department. We have a unique opportunity in that our reach to stakeholders is local, national and international. "Failure to take prompt substantive action – given our current knowledge - would be an act of injustice to all children." - AAPediatrics.

3. Data Linkage

Policymakers are faced with complex and competing demands related to funding and delivering health services for an ageing society, with an ever-increasing burden of chronic disease, and expectations of access to high-technology, high cost interventions. However, the impacts of future climate change on public health have the potential to generate large healthcare costs if current strategies for healthcare are not updated. The Developmental Pathways and Social Policy Team, as well as a number of other groups within the Institute, have the skills to analyse, interpret and provide policy advice to government, through the use of WA's significant linked datasets.

Data linkage has the capacity to be a powerful tool for:

- identifying gaps in current knowledge.
- predicting and evaluating population health outcomes associated with climate change.
- assessing regional health risks and identifying vulnerable and resilient populations, regions and sectors.
- informing impact, risk and vulnerability assessments.
- contributing to mitigation and adaptation strategies and plans for the health sector.
- identifying actions to strengthen the preparedness and resilience of governments, services and communities.
- evaluating the efficiency and effectiveness of climate health initiatives, plans and actions.

However, there is mounting evidence that WA's capacity to meet the growing demand for linked data, and to retain its position as a leader in data linkage is declining. Limited resourcing, and legislative barriers associated with privacy and data sharing, has compromised timely access to linked data, and in turn reduced opportunities for evidence-informed decision making. Fortunately, current government initiatives at both state and national level promise to transform the way public sector data is managed, accessed and used in order to inform approaches to complex problems; evaluate current or proposed policies and services; and remain competitive in an increasingly digital economy. It is important and timely to be part of this broader conversation, and to recommend that the state capitalise on Western Australia's unique data linkage resources, support their expansion to meet the growing demand and increasing scope of data linkage, and utilise the evidence to inform current and future climate health initiatives.

4. Spatial Epidemiology

Telethon Kids Institute has significant expertise and capacity in the field of spatial epidemiology. Professor Peter Gething, previously based at the Big Data Institute at Oxford University, has recently joined the Institute team. He is director of the Malaria Atlas Project, a World Health Organization Collaborating Centre in Geospatial Disease Modelling and with his leadership, Western Australia will be able to make a valuable contribution to better evaluate the 'spatial' impact of climate change over time on child health outcomes and contribute valuable data for evaluation and monitoring systems.

5. Evaluation

We have considerable experience in health promotion program and policy evaluation. This expertise can be used to evaluate the impact of climate change-related programs and policies on different health-related outcomes across the life course.

6. Lung Health

The Children's Lung Health team would be willing to explore the effects of air pollution and climate change on health in children using data from existing cohort studies and data linkage. We will consider how we can incorporate climate health into our current research, which includes research into asthma, Aboriginal lung health, children born premature, cystic fibrosis, and neuromuscular disease. We will also work closely with the Respiratory Environmental Health team to validate potential mechanisms of disease in human populations using his pre-clinical models.

7. Health Economics

The CoLab Health Economics Working Group is looking at the idea of adding climate health to its project which is using an economic model to rank early childhood interventions based on their return on investment.

8. Carbon Dioxide Exposure

Telethon Kids Institute is the lead collaborator on a project focused on the health risks associated with chronic carbon dioxide exposure. This project is exploring the direct effects of lifetime exposure to slightly increased levels of atmospheric CO₂ on developmental biology and health. The rationale is that atmospheric CO₂ is predicted to increase to ~900ppm by the end of the century, and while we know that short-term high dose exposure to CO₂ can be lethal, lower-dose, chronic exposure leads to impaired cognitive function and a range of other potential adverse effects on the lungs, kidneys and bones.

As it is not logistically possible to study the effects of lifetime exposure to the increased levels of CO₂ in humans, we have developed a mouse model to address this question. We have conducted preliminary studies which show that lifetime exposure to even slightly increased levels of CO₂ can have significant impacts on respiratory function and behaviour/cognition in mice. The greatest effects are seen when exposure starts in early-life/in utero, suggesting that protection from increased CO₂ during this critical period may be a potential mitigation strategy. To the best of our knowledge there are no other groups working in this area, so that is the key strength of this research. We have multiple grant applications under review for this project and intend to keep working on it.

9. Heat Waves

The impact of heatwaves on Perinatal Mortality is also a focus of work at the Telethon Kids Institute. Epidemiological studies have shown that heatwaves caused more deaths in Australia than any other natural hazards in the last 200 years. It is estimated that the global trends of heatwaves have been increasing in frequency, intensity and duration, and will lead to a doubling of heatwave-related deaths in Australia over the next 40 years. However, there has been a dearth of studies focused on perinatal death. A previous project the Institute was involved in examined the effects of elevated environmental/ambient temperature on survival/stillbirth by combining an observational study (retrospective cohort study in humans) with an experimental study (in vivo study in mice). The observational study showed that unadjusted hazard ratios for stillbirth indicated an adverse effect of elevated daily maximum temperature, most notably around 37 °C, however there was no observed unadjusted association between heatwaves and stillbirth. The in vivo study showed that exposure to a short heat-wave during pregnancy altered physiological and behavioural adaptations to pregnancy, in addition to impairing placental function. This study was the first of its kind in the world, and the findings suggest that further research is warranted.

10. Natural Environment and Intellectual Disability

Effects of the natural environment on children with intellectual disability have not been formally assessed, but our data suggest that these experiences are an important contributor to their quality of life. The childhood Disability Group would be willing to promote awareness that climate change matters to the quality of life of all members of our society including children with disability; investigate how the natural environment can contribute to quality of life in children with disability overcoming other disadvantages; and develop integrated suites of strategies in our natural and social environments and test how they could build the capacity of children with disability to thrive.

REFERENCES

1. Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. *The Lancet* 2009;373(9676):1693-733. doi: 10.1016/S0140-6736(09)60935-1
2. Majeed H, Lee J. The impact of climate change on youth depression and mental health. *The Lancet Planetary Health* 2017;1(3):e94-e95. doi: 10.1016/S2542-5196(17)30045-1
3. Sheffield PE, Landrigan PJ. Global climate change and children's health: threats and strategies for prevention. *Environ Health Perspect* 2011;119(3):291-8. doi: 10.1289/ehp.1002233 [published Online First: 2010/10/16]
4. Gergis J. The terrible truth of climate change. *The Monthly* 2019. <https://www.themonthly.com.au/issue/2019/august/1566136800/jo-ile-gergis/terrible-truth-climate-change>.
5. The_Scotsman. Climate change: Too hot to handle. *The Scotsman* 2009. <https://www.scotsman.com/news-2-15012/climate-change-too-hot-to-handle-1-1363112>.
6. Kanter J. Scientist: Warming Could Cut Population to 1 Billion. *The New York Times* 2009. <https://dotearth.blogs.nytimes.com/2009/03/13/scientist-warming-could-cut-population-to-1-billion> (accessed 21 August 2019).
7. Vince G. The heat is on over the climate crisis. Only radical measures will work. *The Guardian* 2019. <https://www.theguardian.com/environment/2019/may/18/climate-crisis-heat-is-on-global-heating-four-degrees-2100-change-way-we-live>.
8. Henson R. Warming world: Impacts by degree: The National Academies, 2011.
9. IPCC. Climate Change 2014: Impacts, Adaptation, and Vulnerability.: Intergovernmental Panel on Climate Change., 2014.
10. Smith KR, Woodward A, Campbell-Lendrum D, et al. Human health: impacts, adaptation, and co-benefits. In: Field CB, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White, ed. Climate Change 2014: Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press 2014:709-54.
11. Hansen J, Kharecha P, Sato M, et al. Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. *PLOS ONE* 2013;8(12):e81648. doi: 10.1371/journal.pone.0081648
12. School_Strike_for_Climate. School Strike for Climate Wikipedia; 2019 [Available from: https://en.wikipedia.org/wiki/School_strike_for_climate accessed 21 August 2019.
13. Malik A, Lenzen M, McAlister S, et al. The carbon footprint of Australian health care. *The Lancet Planetary health* 2018;2(1):e27-e35. doi: 10.1016/s2542-5196(17)30180-8 [published Online First: 2018/04/05]
14. Sustainable_Development_Unit. Carbon reduction strategy 2019 [Available from: <https://www.sduhealth.org.uk/policy-strategy/engagement-resources/nhs-carbon-reduction-strategy-2009.aspx> accessed 21 August 2019.
15. Pencheon D. Developing a sustainable health care system: the United Kingdom experience. *The Medical journal of Australia* 2018;208(7):284-85. [published Online First: 2018/04/13]
16. Sustainable_Development_Unit. Health Check 2018 Report: NHS; 2019 [Available from: <https://www.sduhealth.org.uk/policy-strategy/reporting/sustainable-development-in-health-and-care-report-2018.aspx> accessed 22 August 2019.
17. Rogelj J, Shindell D, Jiang K, et al. Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Masson-Delmotte V, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, ed. Global Warming of 15°C An IPCC Special Report on the impacts of global warming of 15°C above pre-industrial levels and related global

- greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty²⁰¹⁸.
18. Eastin J, Grundmann R, Prakash A. The two limits debates: "Limits to Growth" and climate change. *Futures* 2011;43(1):16-26. doi: <https://doi.org/10.1016/j.futures.2010.03.001>
 19. Burke M, Heft-Neal S, Bendavid E. Sources of variation in under-5 mortality across sub-Saharan Africa: a spatial analysis. *The Lancet Global health* 2016;4(12):e936-e45. doi: 10.1016/s2214-109x(16)30212-1 [published Online First: 2016/10/30]
 20. Xu Z, Etzel RA, Su H, et al. Impact of ambient temperature on children's health: a systematic review. *Environmental research* 2012;117:120-31. doi: 10.1016/j.envres.2012.07.002 [published Online First: 2012/07/27]
 21. Heft-Neal S, Burney J, Bendavid E, et al. Robust relationship between air quality and infant mortality in Africa. *Nature* 2018;559(7713):254-58. doi: 10.1038/s41586-018-0263-3 [published Online First: 2018/06/29]
 22. Bernstein AS, Myers SS. Climate change and children's health. *Curr Opin Pediatr* 2011;23(2):221-6. doi: <http://dx.doi.org/10.1097/MOP.0b013e3283444c89>
 23. Bernstein AS, Rice MB. Lungs in a warming world: climate change and respiratory health. *Chest* 2013;143(5):1455-59. doi: 10.1378/chest.12-2384 [published Online First: 2013/05/08]
 24. Sly PD, Holt PG. Pollution, climate change, and childhood asthma in Australia. *The Medical journal of Australia* 2018;208(7):297-98. [published Online First: 2018/04/13]
 25. Lloyd SJ, Kovats RS, Chalabi Z. Climate change, crop yields, and undernutrition: development of a model to quantify the impact of climate scenarios on child undernutrition. *Environ Health Perspect* 2011;119(12):1817-23. doi: 10.1289/ehp.1003311 [published Online First: 2011/08/17]
 26. Ahdoot S, Pacheco SE. Global Climate Change and Children's Health. *Pediatrics* 2015;136(5):e1468. doi: 10.1542/peds.2015-3233
 27. Levy BS, Sidel VW, Patz JA. Climate Change and Collective Violence. *Annu Rev Public Health* 2017;38:241-57. doi: 10.1146/annurev-publhealth-031816-044232 [published Online First: 2017/01/11]
 28. Prescott SL, Logan AC, Albrecht G, et al. The Canmore Declaration: Statement of Principles for Planetary Health. *Challenges* 2018;9(2):31.
 29. Willett W, Rockstrom J, Loken B, et al. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet* 2019;393(10170):447-92. doi: 10.1016/s0140-6736(18)31788-4 [published Online First: 2019/01/21]
 30. Prescott SL, Logan AC. Transforming Life: A Broad View of the Developmental Origins of Health and Disease Concept from an Ecological Justice Perspective. *International journal of environmental research and public health* 2016;13(11) doi: 10.3390/ijerph13111075 [published Online First: 2016/11/10]
 31. Dean A, Green D. Climate Change, Air Pollution and Health in Australia. Sydney, Australia: UNSW Sydney, 2017.
 32. Strand LB, Barnett AG, Tong S. Maternal exposure to ambient temperature and the risks of preterm birth and stillbirth in Brisbane, Australia. *Am J Epidemiol* 2012;175(2):99-107. doi: 10.1093/aje/kwr404 [published Online First: 2011/12/15]
 33. Andradý A, Aucamp P, Austin A, et al. Environmental effects of ozone depletion and its interactions with climate change: 2010 assessment. Executive summary. *Photochemical & Photobiological Sciences* 2011;10(2):178-81.
 34. Makin J. Implications of climate change for skin cancer prevention in Australia. *Health promotion journal of Australia : official journal of Australian Association of Health Promotion Professionals* 2011;22 Spec No:S39-41. [published Online First: 2012/04/24]
 35. Armstrong B, English D. Cutaneous malignant melanoma. In: Schottenfeld D, Fraumeni JJ, eds. *Cancer epidemiology and prevention*. 2nd ed ed. New York, NY: Oxford University Press 1996:1282-312.
 36. Milne E, English DR, Cross D, et al. Evaluation of an intervention to reduce sun exposure in children: design and baseline results. *Am J Epidemiol* 1999;150(2):164-73. doi: 10.1093/oxfordjournals.aje.a009976 [published Online First: 1999/07/21]

37. Cancer_Council_of_Western_Australia. Campaigns and events 2019 [Available from: <https://www.cancer.org.au/preventing-cancer/sun-protection/campaigns-and-events/> accessed 20th August 2019.
38. Lucas RM, Yazar S, Young AR, et al. Human health in relation to exposure to solar ultraviolet radiation under changing stratospheric ozone and climate. *Photochemical & photobiological sciences : Official journal of the European Photochemistry Association and the European Society for Photobiology* 2019;18(3):641-80. doi: 10.1039/c8pp90060d [published Online First: 2019/02/28]