

ORIGINAL RESEARCH

Children's Environmental Health Indicators in Australia



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Abstract

BACKGROUND Adverse environmental exposures in early life increase the risk of chronic disease but do not attract the attention nor receive the public health priority warranted. A safe and healthy environment is essential for children's health and development, yet absent in many countries. A framework that aids in understanding the link between environmental exposures and adverse health outcomes are environmental health indicators—numerical estimates of hazards and outcomes that can be applied at a population level. The World Health Organization (WHO) has developed a set of children's environmental health indicators (CEHI) for physical injuries, insect-borne disease, diarrheal diseases, perinatal diseases, and respiratory diseases; however, uptake of steps necessary to apply these indicators across the WHO regions has been incomplete. A first indication of such uptake is the management of data required to measure CEHI.

OBJECTIVES The present study was undertaken to determine whether Australia has accurate up-to-date, publicly available, and readily accessible data on each CEHI for indigenous and nonindigenous Australian children.

FINDINGS Data were not readily accessible for many of the exposure indicators, and much of the available data were not child specific or were only available for Australia's indigenous population. Readily accessible data were available for all but one of the outcome indicators and generally for both indigenous and nonindigenous children. Although Australia regularly collects data on key national indicators of child health, development, and well-being in several domains mostly thought to be of more relevance to Australians and Australian policy makers, these differ substantially from the WHO CEHI.

CONCLUSIONS The present study suggests that the majority of these WHO exposure and outcome indicators are relevant and important for monitoring Australian children's environmental health and establishing public health interventions at a local and national level and collection of appropriate data would inform public health policy in Australia.

KEY WORDS physical injuries, insect-borne disease, diarrheal diseases, perinatal diseases, respiratory diseases

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INTRODUCTION

Recent estimates of the major contributors to the global burden of disease in both developing and developed country settings have demonstrated a swing away from communicable to noncommunicable diseases over the past decades.^{1,2} There has been a reduction in early childhood death from the traditional infectious diseases and an increase in the years lived with disability associated with chronic noncommunicable diseases.^{2,3} Adverse environmental exposures in early life increase the risk of chronic disease but do not attract the attention nor receive the public health priority warranted.⁴

A safe and healthy environment is essential for children's health and development, yet is absent in many countries.^{5,6} Children worldwide are continuously exposed to a number of environmental hazards that are known to be associated with adverse short- and long-term health outcomes.⁷ Poor health of a child places an economic burden on the country's public health care system⁸ as well as financial strain on the child's family in terms of medical expenses.⁹

Poor child health results in absences from school and reduces education standards. Parents missing work because of this reduces the productivity of a community, resulting in detrimental effects on the socioeconomic well-being of the country.^{9,10} A clear understanding of, and thus protecting children from, exposure to environmental hazards should be an important regional, country, and community goal. Although some environmental contaminants, conditions, and settings are generally recognized as being hazardous, many others are not. For example, although most would recognize that exposure to high levels of ambient air pollution are likely to have adverse health consequences, the same may not be true for exposure to the endocrine-disrupting activity of plasticizers leaching from containers into foods or beverages. A better understanding of the relationship between environmental hazards and adverse health outcomes is necessary to improve communities' resilience and response toward such hazards. A classical mechanism that helps us understand these relationships is a framework of environmental health indicators specifically for children.

The World Health Organization (WHO) developed such a framework of children's environmental health indicators (CEHI), which were aimed at improving the assessment and reporting of children's environmental health, including monitoring of the effects of environmental interventions

developed to protect and improve children's health.⁵ The WHO CEHIs were based on 5 main groups of disease and affliction that were considered by WHO as the main causes of childhood disease burden in the early 2000s, namely: perinatal, respiratory, diarrheal, and insect-borne diseases, as well as physical injuries. Each group has exposure and outcome indicators (Table 1) that can be measured at both local and national levels.^{5,11} For example, an exposure indicator for perinatal diseases is *the number of women of childbearing age who are malnourished* and an outcome indicator is *the number of children born of low birth weight*.

Widespread use of these WHO CEHI would enable comprehensive comparisons across countries and regions to allow refinement and improved resolution of each individual indicator. For instance, with no routine collection of CEHI data in a specific region or country, implementation of action and policies to improve children's environmental health in that area becomes challenging.¹¹ When the WHO, in 2003, launched the CEHI initiative with a pilot project, some countries and regions adapted, adopted, and institutionalized a number of indicators as part of regular national indicator sets. However, countries from southeast Asia and the western Pacific region, which includes Australia, did not participate.¹¹

The aim of the present study was to determine, by applying a WHO CEHI measurement approach, whether Australia has accurate up-to-date, publicly available, and readily accessible data on each CEHI for all (indigenous and nonindigenous) Australian children.

Methodology. A comprehensive systematic search of the Australian Bureau of Statistics (ABS), Australian Institute of Health and Welfare (AIHW), Australian Government websites (including state government sites), PubMed, and Google was conducted to find publicly available Australian information in particular data that correspond to WHO CEHI. Reference lists of relevant articles and reports were also examined to see if our search had overlooked any available Australian data.

RESULTS

Physical injuries (unintentional) include drowning, road traffic incidents, falls and burns, accidental poisonings, and injury by natural events such as earthquakes or storms.¹² Modifiable environmental risk factors contributing to physical injuries include: poor housing, lack of adequate and safe play space,

Table 1. World Health Organization Children's Environmental Health Indicators

Condition	Exposure Indicators	Outcome Indicators
Physical injury	People living in informal settlements	Mortality rate of children aged 0-4 y as a result of physical injuries
	Children aged 0-14 y living in disaster-affected areas	Incidence of physical injuries to children aged 0-14 y requiring treatment
	Children aged 0-14 y living in proximity to heavily trafficked roads	
	Children aged 0-14 y involved in routine employment	
	Children aged 0-14 y living in unsafe, unhealthy, or hazardous housing	
	Children aged 0-14 y living in homes lacking access to a piped water supply	
Insect-borne diseases	Total area of insect vector habitats	Mortality rate of children aged 0-4 y as a result of insect-borne diseases
	Children 0-14 y living in households providing suitable conditions for insect-borne disease transmission	Approximate rate of insect-borne diseases in children aged 0-14 y
	Children aged 0-14 y living in areas endemic for insect-borne disease	
Diarrheal diseases	Drinking water supplies failing national microbiological water quality standards	Diarrhea mortality rate in children aged 0-4 y
	People living in informal settlements	Diarrhea morbidity rate in children aged 0-4 y (hospitalizations)
	Children aged 0-14 y living in disaster-affected areas	Recurrence of outbreaks of diarrheal disease among children aged 0-14 y
	Children aged 0-14 y living in households without basic services for water supply, sanitation, and hygiene	
Perinatal disease	Famine risk	Perinatal mortality
	People living in informal settlements	Infant mortality
	Women of childbearing age who are malnourished (underweight)	Intrauterine growth retardation in newborn children (born with low birth weight)
	Women of childbearing age working in unregulated working places	Congenital malformations
Respiratory diseases	Births to mothers living in unsafe or hazardous housing	
	Children aged 0-14 y living in unsafe, unhealthy, or hazardous housing	Mortality rate for children aged 0-4 y as a result of acute respiratory illness
	Overcrowding	Morbidity rate for children aged 0-4 y as a result of acute respiratory illness
	Children aged 0-14 y living in proximity to heavily trafficked roads	Prevalence of chronic respiratory illnesses in children aged 0-14
	Mean annual exposure of children aged 0-4 y to atmospheric particulate pollution	
	Children aged 0-4 y living in households using biomass fuels or coal as the main source of heating and cooking	
	Children aged 0-14 y living in households in which at least 1 adult smokes on a regular basis	
Smoking during pregnancy		
	Intrauterine growth retardation in newborn children (born with low birth weight)	

child labor, and exposures to wastes and chemicals.^{5,12} Specific incidence and mortality data are kept on physical injuries for both indigenous and nonindigenous children (Table 2). Physical injuries were the main causes of hospitalization of Australian children aged 1-14 years in 2009, accounting for 12% of all admissions in this age group.¹³ The most common causes were: falling from a low

height, 1 meter or less (43%); hitting something or being hit by something (14%); or being bitten or stung (13%).¹³

Australian data on exposure CEHI are limited, with data only available on those living in homes lacking access to piped water; again, these data are not child specific. No data were available on children aged 0-14 involved in routine employment.

Table 2. Publicly Available Data on Physical Injuries for Children in Australia

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Exposure Indicator			
People living in informal settlements ¹³	16/1000	87/1000	12/1000
Children aged 0-14 y living in disaster-affected areas ¹⁴	Not available	Not available	Not available
Children aged 0-14 y living in proximity to heavily trafficked roads ¹⁵	Not available	Not available	Not available
Children aged 0-14 y involved in routine employment ¹⁶	Laws regulate children <13 y from working and those >13 y are regulated by the amount of hours they are allowed to work per shift and per week (this varies slightly between states)		
Children aged 0-14 y living in unsafe, unhealthy, or hazardous housing ^{13,17,18}	Not available	Data not child specific Housing: <ul style="list-style-type: none"> ● 26% with major structural problems ● 89% not electrically safe ● 50% no tub or bath ● 65% no functioning shower ● 94% inadequate facilities to store, prepare, and cook meals 	Not available
Children aged 0-14 y living in homes lacking access to a piped water supply ^{13,17,19-23}	Data not child specific <ul style="list-style-type: none"> ● Western Australia <5% ● Melbourne <1% ● Regional Victoria 14% ● Queensland 10% ● Brisbane <1% ● South Australia <4% ● New South Wales <1% 	Data not child specific Drinking water: <ul style="list-style-type: none"> ● 18% from nearby town systems ● 58% ground water (bores) ● 9% no organized water supply 	Not available
Outcome Indicator			
Mortality rate of children aged 0-14 y as a result of physical injuries ²⁴	5/100,000* (1-4 y, 8/100,000; 5-9 y, 3/100,000; 10-14 y, 4/100,000) Road transport: 1.4/100,000 Accidental drowning: 1.0/100,000 Assault (homicide): 0.6/100,000	15/100,000* Road transport mortality 7/100,000	5/100,000* Road transport mortality 2/100,000
Incidence of physical injuries to children aged 0-14 y requiring treatment ²⁴	Injury hospitalization rate for children aged 0-14 y: 1,381/100,000 Assault hospitalization rate for children aged 0-14 y: 15/100,000 Intentional self-harm hospitalization rate for children aged 10-14 y: 39/100,000		
* Age-standardized death rates.			

Australia has strict regulations regarding the employment of children younger than 13 years,¹⁶ which may explain the lack of data available on this exposure indicator.

Insect-borne diseases are dependent on the availability and extent of suitable habitats for their vectors.⁵ Thus, insect-borne diseases vary globally in

prevalence and incidence. Human-induced impacts on the environment, such as land use change, irrigation, drainage, water development, road development, and forest clearance, create increased habitats for insect vectors, particularly mosquitos.⁵ In Australia, the main mosquito-borne diseases are Ross River fever, Dengue fever, and Barmah Forest

virus, with Rickettsia being another common insect-borne disease in Australia.^{25,26} Mosquito-borne diseases are notifiable in Australia,²⁵ and accurate and up-to-date data are kept on outcome indicators for both mortality and cases attributable to the diseases. Exposure indicator data are also up-to-date because these are kept by monitoring and surveillance systems in the main regions where the insect-borne diseases occur. However, readily accessible data were not found that were specific for the other 2 other exposure CEHI (ie, children 0–14 years living in households providing suitable conditions for insect borne transmission and children aged 0–14

years living in endemic areas for insect borne diseases) (Table 3). Nevertheless, the 2013 Australian census data can be used to generate a rough estimate for both. Compared with the other 4 disease categories, the insect-borne diseases category in Australia provides the most widely available and up-to-date data for WHO CEHI.

Diarrheal diseases have complex environmental origins and transmission routes. These are linked to poor domestic sanitation and hygiene, including poor management of solid wastes, as well as lack of safe drinking water.²⁸ Australia uses the Australian Drinking Water Guidelines²⁹ for the management

Table 3. Publicly Available Data on Insect-borne Diseases for Children in Australia

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Exposure Indicator			
Total area of insect vector habitats ^{25,26}	<ul style="list-style-type: none"> ● Ross River fever: Australia wide ● Dengue fever: Nth Queensland ● Barmah Forest virus: Australia ● Tick-borne infections/rickettsia: more common on east coast, including Tasmania 	As for total population	As for total population
Children 0–14 y living in households providing suitable conditions for insect-borne disease transmission ¹⁴	<ul style="list-style-type: none"> ● 100% (4.00% of Australia population is <14 y; n = 4,299,878) 	As for total population	As for total population
Children aged 0–14 y living in areas endemic for insect-borne disease ¹⁴	<ul style="list-style-type: none"> ● Ross River fever: 4.00% (n = 4,299,878)* ● Dengue fever: 0–4 y, 12; 5–9 y, 22; 10–14 y, 45† ● Barmah Forest virus: 4.00% (n = 4,299,878)* ● Tick-borne infections/rickettsia: 15.3% (n = 3,485,151)* 	Not available	Not available
Outcome Indicator			
Mortality rate of children aged 0–4 y as a result of insect-borne diseases ²⁵	0 deaths per year	Not available	Not available
Approximate rate of insect-borne diseases in children aged 0–14 y ^{25,26}	<i>Ross River fever:</i> 0–4 y: 0/100,000 5–9 y: 3/100,000 10–14 y: 7/100,000 <i>Dengue fever:</i> 0–4 y: 0/100,000 5–9 y: 0/100,000 10–14 y: 1/100,000 <i>Barmah Forest virus</i> 0–4 y: 0/100,000 5–9 y: 0/100,000 10–14 y: 2/100,000 <i>Rickettsia</i> 0–14 y: 3.9/100,000	Not available	Not available
* Estimate from census data.			
† Standardized incident rate per 100,000—Queensland only. ²⁷			

of safe drinking water. These guidelines provide a risk management framework for drinking water supply systems, which includes a multiple-barrier “catchment-to-tap” approach. Although compliance with these guidelines is excellent for most of Australia, there are exceptions, most notably in New South Wales and Tasmania. A recent review found that in regional New South Wales almost 40% of drinking water supply systems failed to meet the guidelines, with 25.39% of regional drinking water systems registering rates of *Escherichia coli* detection of more than twice the guideline value.²⁰ This equated to 1.4% of the population of regional New South Wales receiving water that did not comply with the Australian Drinking Water Guidelines. Similarly 2.4% of Tasmania’s population received water that did not comply with the Australian Drinking Water Guidelines in 2011–2012.³⁰

Australian data on outcome indicators such as mortality and morbidity from diarrhea for children aged 0–4 years are available for both indigenous and nonindigenous children. Data on the recurrence of outbreaks of diarrheal disease among children aged 0–14 years were not publicly accessible. With respect to the risk factors related to the exposure indicators for diarrheal diseases, Australia has data available on health-related microbiological water quality standards for both indigenous and nonindigenous populations by region as well as by state. Data are also available on people living in informal settings and people living in households without basic services for water supply, sanitation, and hygiene (Table 4). These data, however, are combined with adult data and are therefore not child specific—that is, exclusively for 0–14 years of age—as the CEHI suggest. Australian data on the number of children aged 0–14 years living in disaster-affected areas are not readily accessible. This can, however, be deduced from data about Australia’s entire population at risk of living in a disaster-affected area. For instance, 2013 census data for this risk factor can be used as a rough estimate of those 0–14 years at risk of living in disaster-affected areas.

In the context of this paper, *perinatal diseases* are defined as those that occur between the 22nd week of gestation and the end of the first week after birth.⁵ The main environmental contributors to risk factors for perinatal diseases were those found to be maternal exposures, care practices, and nutrition during the prenatal period, as well as conditions in the home in the days immediately after childbirth. Examples of these are famine, poor housing, and poverty.^{6,7} Our search on perinatal disease

indicators revealed that Australia kept accurate and relatively up-to-date data on all outcome indicators for perinatal diseases for both indigenous and non-indigenous children. However, data for exposure indicators for perinatal diseases were less available, with some of the data being not child specific (Table 5). No data were found on the CEHI for famine risk, women of childbearing age working in unregulated workplaces, and births to mothers living in unsafe or hazardous housing for either indigenous or nonindigenous children (Table 5).

The absence of specific data on exposure CEHI for perinatal disease could be due to these factors being deemed not relevant in an Australian context. An example is unregulated workplaces, which WHO⁴⁶ defines as a workplace that is not subject to effective regulation or control. One plausible explanation for why no record of Australian women of childbearing age working in unregulated workplaces is kept in Australia is that it is assumed that all workplaces in Australia are controlled by regulation.⁴⁷ However, according to WHO,⁴⁶ unregulated workplaces typically include small, family-managed manufacturing or retail establishments. Such workplaces exist within Australia and will be regulated to some extent. How well regulation is applied to the family farming environment is questionable.

An important environmental risk factor for children’s *respiratory diseases* is indoor exposure to air pollution because they spend a lot of time in the home.⁵ In developing countries, poor ventilation in the home combined with the burning of biomass fuel^{48,49} and environmental tobacco smoke⁵⁰ are often the main environmental risk factors. Poor housing, overcrowding, inadequate waste management and poor regulation of emissions from industry and road traffic are more generally reported to be important environmental risk factors.^{5,7}

Although our search revealed up-to-date data for the outcome indicators for respiratory diseases, particularly asthma, in Australia for both indigenous and nonindigenous children, Australia lacks child-relevant data on the exposure indicators for respiratory diseases (Table 6). For instance, there are various studies reporting adverse health outcomes of traffic-related air pollution,^{55–58} including showing that homes surrounding heavily trafficked areas are subjected to increased air pollution and consequently reduced health-related air quality.^{16,59} No data, however, were found for the exposure CEHI *children aged 0–14 years living in close proximity to heavily trafficked roads*. No specific data are available

Table 4. Publicly Available Data on Diarrheal Disease for Children in Australia

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Exposure Indicator			
Drinking water supplies failing national microbiological water quality standards ²⁹⁻³⁸	Data are not child specific 0% Western Australia (regional and metropolitan Queensland (southeast), South Australia (metropolitan and country): 0.06% South Australia country 0.2% for Newcastle and 0.02% Sydney (New South Wales) <5% Alice Springs, Darwin, Katherine, Tennant Creek, Yulara (Northern Territory) <15% Elliot, Daly Waters (Northern Territory) 31% Tasmania 39.93% of regional drinking water supply systems in New South Wales	Data are not child specific 17% of indigenous communities that were not connected to a nearby town water supply failed testing of drinking water 34% of those communities that were connected to a town water supply failed testing on at least 1 occasion <i>In Northern Territory only, 5 out of 52 indigenous communities (9.62%) did not comply with the Australian Drinking Water Guidelines</i>	Not separately available
People living in informal settlements ¹³	16/1000	87/1000	12/1000
Children aged 0-14 y living in disaster-affected areas ¹⁴	Not available	Not available	Not available
Children aged 0-14 y living in households without basic services for water supply, sanitation and hygiene ^{18-23,31}	Western Australia: No water access <5% No toilet 0% No shower 0% No access to electricity 0% No air conditioning 21% No refrigerator 0.7% No washing machine 2% Queensland: No water access: Queensland 10%, Brisbane <1% No toilet 0% No shower 0% No access to electricity 0.1% No air conditioning 32.8% No refrigerator 0.4% No washing machine 1.5% New South Wales: No water access <1% No toilet 0% No shower 0% No access to electricity 0% No air conditioning 50.5% No washing machine 5.1% South Australia: No water access <4% No toilet 0% No shower 0% No access to electricity 0% No air conditioning 18% Victoria: No water access: Melbourne <1%, regional Victoria 14% No toilet 0% No shower 0% No access to electricity 0% No air conditioning 32.6% No refrigerator 0.3% No washing machine 3.7%	89% of houses not electrically safe 50% of houses did not have a tub or bath in which a child could be washed 65% did not have a functioning shower 94% had inadequate facilities to store, prepare, and cook meals	Not separately available

(continued on next page)

Table 4. continued

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Outcome Indicator			
Diarrhea mortality rate in children aged 0-4 y ³⁹	Approximately <1 death per year	Not available	Not available
Diarrhea morbidity rate in children aged 0-4 y (hospitalizations) ^{40,41}	Date recorded by ethnicity	<i>Rotavirus</i> 0-1 y: 1045/100,000 1-4 y: 257/100,000 <i>Acute gastroenteritis hospitalizations</i> 0-1 y: 5761/100,000 1-4 y: 2134/100,000	<i>Rotavirus</i> 0-1 y: 135.3/100,000 1 y: 66.59/100,000 2 y: 74.8/100,000 3 y: 65.1/100,000 4 y: 32.2/100,000 <i>Acute gastroenteritis hospitalizations</i> 0-1 y: 1607.9/100,000 1 y: 1146.5/100,000 2 y: 721.8/100,000 3 y: 536.3/100,000 4 y: 365.6/100,000
Recurrence of outbreaks of diarrheal disease among children aged 0-14 y	Not available	Not available	Not available

for biomass fuel use; however, all countries with a gross national income greater than US\$10,500 per capita and for which no survey data are available are assumed to have made a complete transition to using nonsolid fuels as the primary source of domestic energy for cooking and heating. This is likely to be the case in Australia; however, families living in remote indigenous communities may use biomass fuel for cooking and heating. Another example is the exposure indicator *children aged 0-14 years living in unsafe, unhealthy, or hazardous housing*. The only Australian data available were for the indigenous population, and these were not child specific. It is unclear and surprising as to why no data on these 2 exposure indicators were to be found, because both are clearly applicable to children living in Australia. With the growth in traffic volumes and populations living in near proximity of main roads in Australia,⁶⁰ it is important that data on this exposure indicator be collected also in Australia.

DISCUSSION

From our overview of the availability of Australian data for WHO CEHI, a consistent pattern arises; data were not readily accessible for a substantial part of the exposure indicators. Much of these data were not child specific or were only available for Australia's indigenous population. On the other

hand, Australia has data on all but 1 of the outcome indicators and generally for both indigenous and nonindigenous children. Although it was outside the scope of this paper to assess the Australian outcome data for the extent of the children's burden of disease, it would not be possible to do accurate assessment of the Australian children's environmental health, a critically important aspect of managing the children's burden of disease. The childhood conditions making major contributions to burden of disease in Australia include mental illness (23%), chronic respiratory disorders (18%), and perinatal conditions (16%); the rank order changes with the age of the child (Table 7). All of these conditions have clear and major environmental risk factors.

In line with Butterfield's⁶¹ concept of upstream thinking, it has been suggested that the availability and accuracy of data on exposure indicators is perhaps key for enabling the implementation of primary prevention strategies to reduce environmental hazards as well as prevent/limit the child's exposure to the environmental hazard, thus reducing the likelihood of adverse health outcome.⁶² It is, therefore, important for the health of Australian children that appropriate data on exposure indicators are routinely collected for both indigenous and nonindigenous children. The present study also suggests that other countries not involved in the routine measuring of

Table 5. Publicly Available Data on Perinatal Disease for Children in Australia

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Exposure Indicator			
Famine risk	Not available	Not available	Not available
People living in informal settlements ¹³	16/1000	87/1000	12/1000
Women of childbearing age who are malnourished (underweight) ⁴²	18-24 y 7.1% 25-34 y 2.2% 35-44 y 0.6%*	Not available	Not available
Women of childbearing age working in unregulated working places	Not available	Not available	Not available
Births to mothers living in unsafe or hazardous housing	Not available	Not available	Not available
Outcome Indicator			
Perinatal mortality ^{32,43-45}		Queensland: 12.5/1000 South Australia: 9.8/1000 Western Australia: 9.8/1000 Northern Territory: 18.3/1000	
Infant mortality ²⁴	4.1/1000	7.2/1000	
Intrauterine growth retardation in newborn children (born with low birth weight) ²⁴	6%	12%	
Congenital malformations ¹³	Neural tube defects 4.5/10,000 [†]	Neural tube defects 11/10,000 [†]	Neural tube defects 4.3/10,000 [†]
	Down syndrome 11/10,000	Down syndrome 11/10,000	Down syndrome 11/10,000 [†]
	Abdominal wall defects 4.4/10,000 [†]	Abdominal wall defects 7/10,000 [†]	Abdominal wall defects 4.3/10,000 [†]
	Orofacial clefts 17/10,000 [†]	Orofacial clefts 25/10,000 [†]	Orofacial clefts 17/10,000 [†]
* Estimate has a relative standard error of 25%-50% and should be used with caution.			
† Malformations requiring surgical correction in children <1 year of age.			

WHO CEHI should be encouraged to participate. This would provide a much wider foundation for comparing regional progress in reducing environmental exposures and improving children's health over time, especially against countries with similar developmental indices. Integrating CEHI into existing surveys and reporting tools that exist within local, national, or regional levels (ie, censuses) is a challenge faced not only in Australia but globally.⁶³ There is then the added challenge of providing people with an incentive to complete these surveys and report accurately. Furthermore, the gaps that exist in indicator data vary depending on the country/region; whereas one country might keep accurate data on physical injury but not on respiratory diseases, another might do the reverse. The difference in the approaches taken by the countries and the limited availability of data on a number of the indicators makes cross-country/region comparisons very difficult. Because a limited number of indicators are applicable to all regions, it was suggested that each

region could develop complementary indicators specific to its own circumstances.⁶³ This approach, however, detracts from the idea of having a broad set CEHI that are applicable to each country or region. In light of this, it is proposed that the current set of WHO CEHI be reevaluated to ensure that the broad range of CEHI is applicable to all countries. Additionally, each country or region needs to be assisted in ways to improve data collection as well as incorporate CEHI into existing local or national level surveys. However, whether the CEHI proposed by WHO in 2003 remain the most relevant as we move from the 2015 Millennium Development Goals era into the Sustainable Development Goals 2030 era remains to be determined. The CEHI deal with "traditional" environmental threats to children's health and do not take into account the major shift toward chronic noncommunicable diseases seen over the past 20+ years.^{1,2}

Australia does regularly collect data on key national indicators of child health, development,

Table 6. Publicly Available Data on Respiratory Diseases for Children in Australia

Indicator	Total Population	Indigenous Children	Nonindigenous Children
Exposure Indicator			
Children aged 0-14 y living in unsafe, unhealthy, or hazardous housing ^{13,18,51}	Not available	Data not child specific 26% with major structural problems 89% not electrically safe 50% without a tub or bath 65% without a functioning shower 94% with inadequate facilities to store, prepare, and cook meals	
Overcrowding ¹⁷	Not available	Data not child specific Overall 25%; 58% of those living in <i>very remote</i> areas and 13% in <i>major cities</i>	Data not child specific 4%
Children aged 0-14 y living in proximity to heavily trafficked roads ¹⁵	Not available	Not available	
Mean annual exposure of children aged 0-4 y to atmospheric particulate pollution ⁵²	Data not child specific Australian capital cities' highest daily average PM _{2.5/10} concentrations PM10: 30 µg/m ³ PM2.5: 38 µg/m ³	Not separately available	
Children aged 0-4 y living in households using biomass fuels or coal as the main source of heating and cooking ³⁹	Not available	Not available	
Children aged 0-14 y living in households in which at least 1 adult smokes on a regular basis ²⁴	6% 14%	22% 48%	7% 13%
Smoking during pregnancy²⁴			
Intrauterine growth retardation in newborn children (born with low birth weight) ²⁴	6%	12%	6%
Outcome Indicator			
Mortality rate for children aged 0-4 y as a result of acute respiratory illness ^{53,54}	Asthma: 0-4 y <0.2 per 100,000 0-1 y total deaths in Queensland as a result of any respiratory disease: 0.77% 1-4 y total deaths in Queensland as a result of any respiratory disease: 2.94%		
Morbidity rate for children aged 0-4 y as a result of acute respiratory illness (hospitalization) ^{13,53}	Asthma: 0-4 y: 1320/100,000 (males) 0-4 y: 790/100,000 (females)	Asthma: 0-1 y: 1100/100,000 2-4 y: 1150/100,000	Asthma: 0-1 y: 950/100,000 2-4 y: 1200/100,000
Prevalence of chronic respiratory illnesses in children aged 0-14 y ^{13,44}	Total respiratory disease: 18.8% Asthma: 9.3%-12% Chronic lung disease: 0.8% Hay fever/allergic rhinitis: 9.5% Chronic sinusitis: 2.9% Other respiratory diseases: 0.7%	Asthma: 14%	Asthma: 11%

Table 7. Top Causes of Burden Disease, Expressed as Years Lived with Disability (YLD), for Australian Children

Rank	Condition	YLD (Average Rate/100,000)
≤5 years		
1	Nutritional deficiencies	959.72
2	Diarrhea, lower respiratory infections, meningitis, and other common infectious diseases	706.92
3	Other noncommunicable diseases	369.20
4	Skin and subcutaneous diseases	292.15
5	Diabetes, urogenital, blood, and endocrine diseases	213.56
5-9 years		
1	Chronic respiratory diseases	1059.93
2	Asthma	1037.15
3	Mental and behavioral disorders	913.52
4	Other noncommunicable diseases	585.44
5	Nutritional deficiencies	488.89
10-14 years		
1	Mental and behavioral disorders	1763.38
2	Chronic respiratory diseases	1412.09
3	Asthma	1291.85
4	Musculoskeletal disorders	996.53
5	Other noncommunicable diseases	808.52

Data are presented by age group as average rate per 100,000.
Data sourced from <http://www.healthdata.org/australia>. Accessed April 25, 2015.

and well-being in several domains, titled “How healthy are Australia’s children?” incorporating mortality, morbidity, and disability; “How well are we promoting healthy child development?” incorporating breastfeeding, dental health, and early learning; “How well are Australia’s children learning and developing?” incorporating transition to primary school, attendance at primary school, and literacy and

numeracy; “What factors can affect children adversely?” incorporating teenage births, smoking in pregnancy, alcohol use in pregnancy, birthweight, overweight and obesity, environmental tobacco smoke, and alcohol misuse; “What kind of families and communities do Australia’s children live in?” incorporating family economic situation, children in nonparental care, parental health status, neighborhood safety, and social capital; “How safe and secure are Australia’s children?” incorporating injuries, child abuse and neglect, children as victims of violence, homelessness and children, and crime; and “How well is the system performing in delivering quality health, development and wellbeing actions to Australia’s children?” incorporating childhood immunization, survival for leukemia, and child protection resubstantiations.²⁴ These indicators were developed to have relevance for Australians and Australian policy makers and do not map to the WHO CEHI. However, as pointed out by the present study, the WHO CEHI are relevant to Australian children in that they provide the framework for exposure and outcome indicators that can be readily compared between countries and across regions, which the Australian key national indicators for child health do not.

Although it is important to question the appropriateness or completeness of the current WHO CEHI for developed countries such as Australia, our findings suggest that majority of these exposure and outcome indicators are relevant and important for monitoring Australian children’s environmental health as well as for establishing public health interventions at a local and national level. This paper has highlighted important gaps in data collection of WHO CEHI in Australia and provides information for improvements in data collection.

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