Public Health Aspects of Child Well-Being   12

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12.1   Introduction

There is a dramatically increasing body of evidence showing that the pathways to adult disease start in utero and early childhood. The main concerns of those working in public health are the common, chronic, and burdensome adult diseases. While there may still be some residual tension between the "traditional" public health groups, who believe that the most important pathways involve adult lifestyle exposures (traditionally substance abuse, poor diet, and low levels of exercise), there is increasing realization that the opportunities for prevention and public health interventions will be more instrumental the more we understand the early pathways to disease (Lynch and Davey-Smith 2005). Those interested in the social determinants of public health will also realize that a combination of exposures and social circumstances during childhood crucially influences the whole life course (Li et al. 2009).

To effectively improve public health from pregnancy to old age, we need professionals working in child development, maternal child health, and public health to work better together with an understanding of the genetic and environmental interactions during early child development. This chapter initially provides some background to the influence of public health on child health and well-being and then argues for the need for a common instrument to measure and compare child well-being as a fundamental requisite to providing the evidence base to facilitate modern public health approaches.

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12.2 Background: How Public Health Has Contributed to Our Understanding of Child Well-Being

The essence of public health is to prevent disease and to enhance health and quality of life within populations. It uses a range of population measures from legislation (e.g., to put fluoride in water supplies, to mandate folate fortification in food, enforce seat belts, or to increase the costs of unhealthy exposures such as tobacco) to health promotion campaigns (e.g., to increase immunization, avoid harmful exposures, avoid obesity, and to exercise regularly). Primary health care in many countries has also had a significant role in providing individual screening for disease and health promotion.

12.3 The Contemporary/Mainstream Public Health's Relationship to Child Well-Being

Since the mid-twentieth century, biomedical and individual lifestyle theories to disease causation have dominated, influencing attitudes to child public health thinking. Such thinking has been summarized to include three views: (1) that the real causes of disease comprise biophysical agents, genes, and risk factors with exposures largely the consequence of individual characteristics and behaviors; (2) these real causes of disease in individuals are enough to explain population rates of disease; and (3) that theorizing about disease occurrence is equivalent to theorizing about disease causation at the individual and biological level (Kreiger 2011). What such thinking ignores are the considerable pathways that are now being understood around the social and emotional aspects of child development, well-being, and how they relate to overall public health. We need to embrace all this thinking to achieve the best approaches to improving health outcomes.

The following section details some of the most significant biomedical and individual lifestyle public health interventions that continue to shape the health of children across the world.

12.3.1 Hygiene

In children, diarrheal diseases and respiratory infections are the major causes of morbidity and mortality worldwide. Diarrhea has also been implicated as a cause of poor growth (Humphrey 2009). Access to clean water, hand washing with soap, and fresh uncontaminated food all significantly reduce the incidence of diarrheal disease. The Lancet Maternal and Child Under Nutrition Series estimated that sanitation and hygiene interventions implemented with 99 % coverage would reduce diarrhea incidence by approximately 30 % (Bhutta et al. 2008).

A review of recent evaluations of non-vaccine interventions for the prevention of childhood diarrhea in developing countries both confirmed the importance of standard strategies (e.g., breast-feeding, clean water supply, and sanitation

improvements) and suggested refinements in approaches to personal and domestic hygiene, weaning education, and food hygiene (Huttly et al. 1997). Although mainly considered an issue in developing countries, there are population groups such as Australian Aboriginal children living in remote communities that are still experiencing a high burden of common infectious diseases due to poor hygiene and unsanitary living conditions (McDonald et al. 2008).

12.3.2 Immunization

Apart from the provision of clean water and hygiene practices, vaccines have been more effective, than any other public health measure, particularly in children (Pollard 2007). Improved immunization programs and the development of new vaccines continue to provide opportunities to improve and sustain the health of our children. Although immunization has always been considered one of the greatest and most well-known success stories of public health, there are still challenges in communicating the benefits of immunization to all populations and in particular the importance of delivering vaccines to those in greatest need for the benefit of not just those individuals but for the entire population (Pollard 2007). For example, in 1980 only 20 % of children worldwide had received three doses of DTP (diphtheria, tetanus, pertussis) vaccine, but this had risen to 78 % by 2004 (Pollard 2007). While funding for vaccines is unprecedented, particularly now in developing countries, there are, however, concerns over the sustainability of funding. Children in the hardest-to-reach and poorest communities are still dying of preventable diseases such as diphtheria, polio, measles, rotavirus, tetanus, and pertussis (Pollard 2007). Unfortunately measles is still the fifth most common cause of death in children aged 0–14 years of age (Lopez et al. 2006).

12.3.3 Sexual Health

HIV/AIDS is the 6th most common cause of death among children in developing countries (Lopez et al. 2006). In addition to this, there are more than 15 million children in the world who have been orphaned due to the death of their parents from HIV/AIDS. Almost all children with HIV/AIDS have the disease through "vertical" transmission from their mother at birth or immediately afterwards through breast-feeding. This "vertical" transmission can almost be totally eliminated if the mother has access to antiretroviral therapy (Blair et al. 2010). There are however, concerns regarding the increased and mass use of antiretrovirals, including poor implementation in many developing countries, where issues such as interruptions in drug supplies can lead to limited health gains for the individuals and an increased likelihood of transmission. Many programs rely on the cheapest possible drug, leading to toxicity and potentially drug resistance (Jamison et al. 2006). As always, public health prevention via increased use of condoms and education about STDs are still the key methods to reduce HIV transmission.

12.3.4 Nutrition/Obesity

Babies of mothers who have poor nutrition during pregnancy have an increased likelihood that their children will be of low birth weight, have congenital abnormalities, and have higher risk of mortality after birth. Folate has now been added to cereals and breads in many countries as a classic population-wide public health approach to prevent spina bifida and other serious birth defects (Stanley and Maberley 2006). Vitamin D deficiency during pregnancy can lead to low bone density, increased risk of infections, and an increased risk of neonatal convulsions in the child, and there is now a considerable debate about the longer-term negative impact of vitamin D deficiency on children (Wagner et al. 2012). Iodine salts are still provided as nutrient supplements globally to prevent neuro-logical deficits (Pharoah et al. 2012). Of late, this issue seems to be reemerging in subpopulation groups in the UK (Hetzel 2012; Vanderpump 2012). The addition of fluoride to water to prevent dental caries in children and adults is another classic population-wide nutritional intervention, which has had a dramatic impact on child health and well-being.

The extent of the advantages of breast-feeding have been debated; however, in general it is agreed that breast-feeding is associated with reduced respiratory and gastrointestinal infections, a reduced risk of sudden infant death syndrome and asthma, and a reduced risk of childhood obesity and of heart disease later in life (Blair et al. 2010). It is also acknowledged that breast-feeding increases the likelihood of a positive attachment between the mother and child. In developing countries, the promotion of breast-feeding has shown to reduce diarrhea-related morbidity by 8–20 % and to reduce mortality up to 6 months of age by 24–27 % (Huttly et al. 1997). Much of this reduction can be attributed to the prevention of infection due to bad water (used when preparing formula) rather than to specifically the positive properties of breast milk (Huttly et al. 1997). Educational campaigns to improve the weaning practices by mothers have also shown positive results, cutting the mortality rate by 2–12 % for children under 5 years of age (Taylor and Greenough 1989).

Child underweight or stunting causes about 20 % of all mortality of children younger than 5 years of age and leads to long-term cognitive deficits, poorer performance in school, fewer years of completed schooling, and lower adult economic productivity (Victora et al. 2008). Of the 555 million preschool children in developing countries, it is estimated that 32 % are stunted and 20 % are underweight (Black et al. 2008). These data illustrate a clear link between child health, well-being, and total population health in these countries. The challenges for public health services to alleviate poverty and inequalities, are that the sustainable solutions will come from social and economic strategies – and such strategies are outside the usual scope of traditional public health.

In developed countries the concern is primarily the opposite, with steadily increasing prevalence of overweight and obese children. Such an increase in overweight and obesity has implications for future population health and well-being via increases in diabetes, heart disease, and stroke, as well as the more

immediate individual negative consequences for self-esteem and peer relationships during childhood (Blair et al. 2010). Many public health practitioners have suggested that societal influences like the perception of safety for children and the reduction of the "backyard" and safe parks have all lead to children spending more time indoors, with increasing amounts of "screen time" (Hands et al. 2011). Children are less likely to ride their bikes or walk to school, because parents are either frightened to let them go alone or do not have the time to walk or ride with them, so many are now being dropped off at the school's front gate. School health promotion strategies are frequently targeting children to increase their fruit and vegetable consumption and increase physical activity while trying to reduce exposure to saturated fats and high sugar content food through school canteens and educational campaigns (Branca et al. 2007). However, such behavior change interventions cannot operate in isolation from the broader socioeconomic context and the increasingly obesogenic environment (Waters et al. 2011). For example, there is some evidence that the increase in women working is influencing some of the negative dietary trends (Li et al. 2011). The available knowledge base on which to develop appropriate public health interventions to reduce the risk of obesity across the whole populations still remains limited. The impact of interventions on preventing obesity and the extent to which they work equitably remains poorly understood (Waters et al. 2011).

12.3.5 Substance Abuse

Maternal smoking has been shown to have a significant influence on the fetus and is associated with a range of poor outcomes such as low birth weight, preterm birth, and later childhood respiratory disease. Parental smoking after birth has also shown to increase the risk of otitis media and respiratory tract infections (Jacoby et al. 2008; Moore et al. 2010). Antismoking public health interventions have targeted women during pregnancy to quit smoking for the benefit of both themselves and their unborn baby; however, controlled trials have shown that such health promotion programs are mainly ineffective (Whitworth and Dowswell 2009).

The impact of substance abuse (alcohol particularly, but also drug abuse) on the health and well-being of children is profoundly negative. This relates not only to pregnancy-related exposures with resulting fetal alcohol syndrome but to almost all poor childhood outcomes including child abuse and neglect as well as physical conditions (O'Leary et al. 2010). Children born to and raised by parents who abuse substances commence their lives in high-risk environments and the impact can be lifelong. While the data on fetal alcohol spectrum disorder are not complete and data on substance abuse even harder to quantify and study, we believe that these exposures may now be the most important preventable causes of intellectual disability and developmental disorders worldwide (May et al. 2009).

As noted above, individual lifestyle and biomedical approaches to public health have been common over the last century. The major challenge is how to get people to change their behaviors for the betterment of their future health. Such approaches

are, however, predicated on the basis that behaviors and habits are discrete and independently modifiable and that individuals can voluntarily and independently choose to modify their behavior. As mentioned earlier, such individualistic models ignore the influence of societal, familial, cultural, and wider population and community attributes and contexts. In contrast, modern public health appreciates the complexity of disease causation, as outlined below.

12.4   Modern Public Health's Relationship to Child Well-Being

The two most important new developments in public health which have impacted most on research and thinking in child well-being and public health have been the movements around the social determinants of health and the developmental origins of health and disease.

12.4.1 Life Course Approach: Developmental Origins of Health and Disease (DOHaD) and Epigenetics

DOHaD commenced with studies which showed that low birth weight was associated with coronary heart disease (CHD), type 2 diabetes, and hypertension and that these effects of low birth weight were increased by slow infant growth and rapid weight gain in childhood (Barker et al. 2002). They coined the term "fetal programming" to explain these pathways. Moreover, the relationship between childhood characteristics and later disease was found to persist even when controlling for factors previously thought to mediate the relationship, such as adult smoking and obesity (Fuller-Thomson et al. 2010).

Fundamentally the DOHaD and epigenetic approaches take the view that throughout development there are strong and time-related interactions between biological and genetic characteristics and environmental influences which influence disease status throughout life. This approach, termed epigenetics, moves away from the debate between nature versus nurture, instead strongly suggesting that nature and nurture interact at critical time periods, from conception through to old age to influence all of life disease risks, health, and well-being.

The ability of environments to influence the impact of genes during development is still poorly understood in relation to human disease. Epigenetics is likely to prove of immense importance to our understanding of how fetal and child development occurs, but it will require some healthy scientific debates across disciplines and methodologies (Ebrahim 2012; Waterland and Michels 2007).

12.4.2 Social Determinants of Health

The "social determinants of health" approach takes the view that societal influences have a significant influence on health and health inequalities. That there is a strong

relationship between the way people live in societies and their physical and mental health is logical and crucial for us to appreciate if we are to develop the most effective strategies for sustainable public health interventions. The major contributions to this whole area which strongly make the case for societal interventions come from Marmot (2010) and Hertzman (Hertzman 1994; Hertzman and Boyce 2010). In 2005, the World Health Organization established a Social Determinants of Health Commission which was chaired by Marmot and the "Early Child Development Knowledge Network" set up under this Commission was led by Hertzman (Hertzman et al. 2010; Irwin et al. 2007). The push for greater understanding around the social determinants as a buffer to the prodigious individualistic biomedical paradigms was at its height in the mid- to late 1990s and continues to struggle for appropriate recognition and policy influence today. Consequently, in this chapter, we have spoken about the social determinant approach to child public health as a *modern* public health approach, despite the fact that it has been known for centuries that poverty affects health and development and that systemic interventions are required to address inequality – that is, the blame and responsibility cannot just fall to the individual as a solution. The following quote comes from a series of free public lectures in London that were later published in a book meant for the people and public administrators back in 1881:

> The deaths which occur in this country are fully a third more numerous than they would be if our existing knowledge of the chief causes of disease were reasonably applied throughout the country; that of deaths which, in this sense, may be called preventable . . . then there is the fact that this terrible continuing tax on human life and welfare, falls with immense over-proportion upon the most helpless classes of the community; upon the poor; the ignorant; the subordinate; the immature; upon classes which, in great part through want of knowledge, and in great part because of their dependent position, cannot remonstrate for themselves against the miseries thus brought upon them. And have, in this circumstance, the strongest claim of all claims on a legislature which can justly measure and can abate their sufferings. (Smart 1881)

It is not enough for researchers to just continue to show that social conditions and economic inequality have potent consequences for health, development, and well-being. What is required is a better understanding of how these social and economic influences "get under the skin" and what we can do about them from a population-wide and policy perspective. Understanding the multiple determinants of health and how they interplay, as well as the complexity of mediating factors that may influence the relationships between the causes of ill-health and health status, is the new public health.

For modern epidemiologists, the step away from solely individual causation approaches to a population-level understanding of disease distribution can be attributed to Geoffrey Rose. In 1985, Rose originally published "Sick Individuals and Sick Populations" where he exemplified that the more widespread a cause across a population, the less it explains the distribution of disease, and therefore he argued that a population strategy of prevention is required where the risk is widely diffused through the whole population (Rose 2001). The recent terminology of progressive or proportionate universality takes Rose's work a step further and aims

to support policy makers in their understanding of the requirements for both universal and targeted strategies by addressing the barriers that people face to gain access to the services and supports offered across the whole socioeconomic spectrum in a way that is proportionate to the underlying levels of inequality (Marmot 2010). As will be argued later in this chapter, such insights are only revealed with population-wide monitoring and surveillance data.

Another recent paradigm trying to support policy makers and preventative public/population health strategies is the concept of biological embedding (Hertzman and Wiens 1996), which aims to explain how the social environment gets "under the skin." The hypothesis is explained as "systematic differences in the qualities of emotional, social, intellectual, and physical circumstances are found in different socio-economic, psychosocial, and developmental environments. From the time of conception through the first several years of life and at a diminished pace thereafter, these differences will affect the development of the brain and the central nervous system, and will, in turn have systematic effects on cognitive, social, emotional and behavioural development" (Hertzman and Frank 2006). Biological embedding, as such, brings much of modern public health together – social determinants of health, eco and environmental influences, an understanding of the broader context in which children are raised, and a life-course perspective together.

The various contributors to the social determinant models are outside health services and include such things as working conditions, employment, housing, education, community environments, urban design, public transport, equality of opportunities, and positive cultural environments. The social determinants and DOHaD thinking come together as we realize that many of the ways in which fetal programming embed are a result of the very adverse social environments listed above. It is exciting to think that if all these different areas of public health, child development, and social researchers could work together – including those interested in environmental exposures (such as lead, mercury, iodine deficiency, alcohol, smoking, other drugs) – we could bring holistic, sustainable, and effective solutions to the myriad of problems which damage child health and well-being. In many ways such efforts mirror the United Nations Declaration on the Rights of the Child which was mentioned at the beginning of this chapter.

12.5   Status of Indicators of Child Well-Being in Public Health

Current basic health and education statistics collected to compare the progress of countries commonly include rates of infant, maternal, and child mortality; breast-feeding; immunization; and primary school enrolments and attendance (UNICEF 2010). Notwithstanding the significance of these vital statistics, those in public health should also be seeking indicators that not only determine whether children are surviving, or if children are attending school, but how well populations of children are developing. This is now recognized by organizations such as OECD, the World Bank, and UNICEF who are promoting the use of internationally comparable instruments to measure child development. It is understood that such

instruments should foster global understanding while providing the evidence for local through to international policy development.

The UNICEF report cards written in collaboration with the Innocenti Research Centre attempt to compare measures of child and youth well-being across several domains for the wealthier countries of the world (e.g., countries that are members of the OECD) (UNICEF 2007). They include material well-being, health and safety, educational well-being, family and peer relationships, behaviors and risks, and subjective well-being. The data included come from a range of sources and provide considerable and variable methodological challenges. For example, comparisons across these countries with indicators such as mortality and low birth weight are more robust than those relating to how youth view themselves and their place in society.

The Australian Research Alliance for Children and Youth (ARACY) published a similar set of indicators comparing the best in the world for each indicator with the rates for all Australian children, whether they had improved or worsened over time, and a separate analysis for our Aboriginal children (known to be the most marginalized and impoverished in the nation) (http://www.aracy.org.au/index.cfm?pageName=report_card_overview). The most interesting aspect of such report cards is how much variation there is in many well-being indicators across countries with similar incomes. That is, there is no clear gradient between national wealth as measured by GDP or GDP per capita; in fact the most wealthy countries in the OECD (USA and UK) are ranked the lowest on most measures of child well-being. This suggests that factors other than crude estimations of available financial resources are more powerful for child well-being. In fact, it may well be the policies, practices, or values in countries that account for the variation in child well-being when countries with similar incomes and capacity are contrasted. The implications for guiding public policy are obvious. Measuring child well-being across nations and understanding the major drivers of good outcomes may result in much more effective public health in all countries. Do those countries that invest more in upstream activities, for example, to reduce poverty (such as taxing the wealthy to fund family support and child care for the poor), do better in these rankings than those countries who tend to put more funding into downstream activities? It is of interest that while the USA has the lowest neonatal mortality rates in very preterm infants, it has very high (and increasing) rates of preterm births, with the result that overall infant mortality is higher in the USA than in any other developed country (OECD).

There is some evidence that those working in the development and implementation of public policy in relation to children and young people are influenced by these well-publicized and regularly published international comparisons. Advocacy groups use these data to "shame" their country's responses to child and youth issues by highlighting how poorly they are performing in comparison to, for example, Norway who ranks highly in almost all measures of child well-being.

The measurement of child development is additionally important considering the implications for monitoring that are highlighted by the United Nations Convention on the Rights of the Child (Bernard van Leer Foundation 2006; UNICEF 2009). In 2009, 194 UN members signed up to the Convention, representing all states

except for the United States of America and Somalia. Each of the countries who ratified the convention are responsible for providing children with the opportunities necessary to develop physical, cognitive, social, and emotional capacities in early life (Convention on the Rights of the Child et al. 1989). In August 2010, the United Nations' Secretary General delivered a report on the status of the Convention of the Rights of the Child to the United Nations' General Assembly. At the conclusion of the report, the Secretary General encourages states to

(a) Establish a framework of laws, policies and programmes ensuring that the rights of the child are implemented within a continuum of care (maternal, newborn, child health), education and protection throughout the early years of life, including:
  (i) Developing a plan for the realization of children's rights in early childhood that is comprehensive in scope, is supported by operational strategies with clear goals, timelines and adequate resources, and is aimed at ensuring the development of the child's fullest potential, protecting young children from all forms of violence, abuse and exploitation, and maximizing opportunities for their voice to be heard in all matters that affect them. These strategies should involve all levels of government and include civil society partners;
  (ii) Supporting research, monitoring, and evaluation studies on young children's rights, development and well being, including the identification of indicators that are universally accepted, locally relevant and easily applied;…. (United Nations 2010)

The implications of this report are clear; however, unlike mortality rates, the measurement of child development is influenced by culture, language, and theory, and thus its concept can vary across place, culture, language, and research tradition, making international comparability difficult (Hambleton et al. 2005). The definition of death and birth are more consistent across countries, but progressing towards indicators like breast-feeding requires strict adherence to definitions. Assessments such as psychological, educational, and developmental tests are even more complex and require significant consideration particularly prior to making any cross-country or even within-country comparisons.

Early childhood development (ECD) is generally defined as the holistic development of children from conception. *Development* is defined as the process of change in which the child comes to master increasingly complex levels of moving, thinking, feeling, and interacting with people and objects in their environment. There are various aspects of development, and these are called *developmental domains* such as physical, social, emotional, language, and cognitive development. Epidemiology also uses such domains to measure child well-being.

Children develop at different rates on each of the developmental domains. For example, babies generally begin to crawl from 6 to 10 months of age. This age range is considered within the *normal developmental range* for this ability. Irrespective of when during this entire period a child starts crawling, the child is considered on course for healthy development. The rates and patterns of development during the early years are highly variable, and not all children who are doing well are doing the same thing at the same time. However, the classification of *developmental delay* occurs when children have not reached these *developmental milestones* within the expected time period. For example, if the normal range for

learning to walk is between 9 and 15 months, a 20-month-old child that is not starting to walk would be considered developmentally delayed. The most common instruments in the field of child development are individual diagnostic instruments to identify developmental delay. These instruments are usually unidimensional and have a binary outcome (i.e., pass or fail on that milestone).

The dimension of *child well-being*, as opposed to developmental delay, allows for the measurement of both the positive and negative aspects of how a child is developing and allows for a holistic approach to the child (i.e., social, emotional, cognitive, and physical well-being). Such measures also have the potential to place a child on a *developmental trajectory* rather than simply a bimodal pass/fail outcome. However, there is little agreement in the literature as to how to measure child well-being and many of the current instruments only measure one dimension of child well-being and/or take a deficit approach.

12.6 Why Do We Want to Measure Child Well-Being in Public Health?

There are numerous reasons to measure child well-being and these have been discussed before by others (Young 2007; McCain et al. 2007). We would suggest from a public or population health point of view there are eight main motivations.

1. ***Monitoring the state of early child development at the level of the population***

As now ratified by the Convention on the Rights of the Child, countries are required to monitor how well children are developing within and across their population. Monitoring the state of early child development impacts children and families by (1) raising the profile of the issue, (2) advocating strongly for children and families, and (3) providing a base level of information around which to mobilize action. Public access to the results of monitoring means that civil servants, nongovernment organizations, aid agencies, and the media alike are able to use the results to advocate for children and families. In essence, publication of results promotes recognition of and action to address new policy issues.

2. ***Evaluate and monitor change in child well-being over time***

The monitoring of child development/well-being over time enables communities and populations to determine if they are making any improvements. Only by monitoring over time can policy makers and service providers determine if they are making a difference to the new generations of children born every year. If improvements are made across societies and population groups to help support families, we would hope to see improvements in well-being over successive cohorts of children.

3. ***Identification of resilience in communities that support child well-being***

Population measurement (such as a census) of child development enables the relative comparison of communities. Comparing how communities do in comparison to each other leads to the question why? That is, why are some communities doing better than others and what are the strengths and weaknesses that help support

families and children in some communities better than others? And of particular interest is what are the characteristics that explain why some high-risk communities are doing unexpectedly well in terms of child development? These questions can only be asked and investigated with population-wide data.

4. **Understanding the state of child well-being in special populations**

Within each country there are special population groups, such as Aboriginal, specific migrant population groupings, and maybe populations defined by geography, language background, or economic circumstances. Child development and well-being like most health outcomes tend to vary across such population groupings. Quantification of the relative and absolute difference across these groupings, as well as the variation in results within the special populations of interest, can reveal patterns of child well-being that lead to a better understanding of the determinants of child well-being and inform public policies (health and other) for these groups.

5. **Anchor developmental trajectories to help evaluate early childhood public health policies, interventions, and programs**

Instruments that are able to measure child development or well-being, as opposed to developmental delay, are able to place individual children on a developmental scale. As such it is easier to anchor a child's developmental trajectory making it easier to assess how these children continue to develop over time. Such scales improve our ability to evaluate public health policies, interventions, and programs through traditional research designs such as randomized controlled trials and longitudinal cohort studies. Furthermore, findings from longitudinal studies are able to provide evidence for forecasting models. Thus, a combination of population-wide cross-sectional monitoring linked with longitudinal studies allows policy makers to evaluate their policies, interventions, and programs by forecasting and assessing the implications for future human capital on the basis of child development.

6. **Inform community development strategies and public policy**

It is vitally important that governments and service providers base policy making, service planning, and community development strategies on evidence (i.e., evidence-based). Population monitoring provides evidence, which can help increase the recognition of a policy issue. The extent and nature of the problems can be quantified to inform the policy actions required. A UNICEF report on evidence-based policy stated that "measuring the impact of a policy intervention is more demanding of methodology and of information than is monitoring policy implementation. Incorporating an explicit mechanism for evaluating policy impact into the design of a policy is a key step to ensure its evaluability." (UNICEF 2008).

7. **Understanding culture**

To better understand and unpack the influence of culture, research studies comparing migrant populations to the population of "home origin" are also becoming more common with the use of internationally comparable population measures. Doing so enables better understanding about how cultural practices impact both positively and negatively on child well-being.

8. *International comparison*

Although many people do not necessarily approve of rankings or league tables, as mentioned earlier, international comparisons can act as an advocacy tool and provide a strong catalyst for action. Political leaders do not like to see their countries ranking fall or perform poorly against other "like" countries. International comparison can also lead to a better understanding of how macro-level policies can impact upon families and children. For instance, child care assistance, maternity/paternity leave entitlements, minimum wage standards, and the like, which tend to be nationwide policies, can be better evaluated when internationally comparable measures are utilized over time.

Essentially the reasons for monitoring child development are to increase understanding of the early determinants of children's health and development – an understanding which will, in turn, inform the organizational, structural, and environmental changes that are needed to build better support for children and their families. This knowledge will inform effective preventive strategies to improve population health throughout life. To make such improvements, across and within countries, requires firstly an understanding of the complexity of the patterns of child development across various population groupings and secondly use of that understanding to inform a mix of universal and targeted strategies, interventions, and policy decisions.

The quotes below from UNICEF offer an excellent summary of this section.

> The true measure of a nation's standing is how well it attends to its children - their health and safety, their material security, their education and socialisation, and their sense of being loved, valued, and included in the families and societies into which they are born. (UNICEF 2007)
>
> Measurement serves as the hand-rail of policy, keeping efforts on track towards goals, encourages sustained attention, gives early warning signs of success or failure, fuels advocacy, ensures accountability, and helps decision making in relation to the most effective allocation of resources. (UNICEF 2007)

12.7   The Challenges of Measuring Child Well-Being for Public Health Research

To date, the vast majority of population-based early childhood research has been conducted in a relatively small number of economically affluent nations, leaving vast gaps in knowledge about the state of early child development in more economically marginalized regions. Such child development and well-being data, if it were available, would preferably be consistent and comparable. Consistency would enable comparisons between and within countries across time, gender, age, sociodemographic groups, and rural to urban geographical areas.

Currently, late childhood is the focus of the majority of surveys (European School Survey Project on Alcohol and other Drugs (ESPAD), Health Behavior in School-Aged Children (HBSC), Program for International School Assessment (PISA),

Trends in International Mathematics and Science Study (TIMSS)); beyond traditional health or education data, there is, however, very little survey and time-series data on early childhood (ages 0–5) or middle childhood (ages 6–11). The development of a broader set of indicators on child well-being and development will allow for a more detailed analysis of the well-being of particular groups of children and ultimately stimulate national and international debates and policy responses that are in the best interests of children and enable all children to realize their full potential (UNICEF 2007). Conversely, a present lack of data and the current unequal distribution of data collection pose challenges for increasing the global awareness of the importance of early child development and well-being in shaping future human capital and participation in the economy and in civil society.

Although the need for such instruments and indicators is clear, the challenge to adapt and validate instruments so that country comparisons can be reliably made is not easy. A growing body of literature on the theoretical underpinnings of approaches to cross-cultural adaptations (Herdman et al. 1997, 1998) indicates the complexity of the process. Unfortunately research has not advanced to a stage where there exists a library of instruments, from which people can select an instrument and then apply it locally knowing that the instrument is valid and reliable for their particular country and context and thus be confident in making conclusions on the results observed. The process of validating an instrument requires a series of steps to be taken before a sufficient level of confidence can be placed in the tool and, subsequently, inferences can be made about the children based on the scores or results from the instrument. *What we know depends on how we know it*. Improper validation can lead to measurement errors, such as accepting findings that may not be true or rejecting differences that may indeed be true but do not fit the fashion or modern theoretical understanding.

The methodological challenges to adapt and validate test instruments for country comparison led to the formation of the International Test Commission (ITC). The ITC, although formed for psychological and educational assessment, provides guidelines that can be equally applied to the field of child well-being. The Guidelines (International Test Commission (ITC) (ITC) 2000) stipulate the various steps that should be taken before instruments can be used to reliably compare results across countries and cultures. The most recent version (2010) of the ITC Guidelines for translating and adapting tests can be downloaded freely and covers the following categories: context, test development and adaptation, administration, and documentation/score interpretation. In total there are 22 guidelines that apply whenever moving a test from one cultural setting to another (either within or across countries) (http://www.intestcom.org/upload/sitefiles/40.pdf).

Although this chapter is not long enough to delve completely into culture, it is important to note from a public health approach the aspects of culture that are very important to consider. But firstly what is culture anyway? "Is culture an ineffable emergent quality greater than the sum of its parts, or is culture an aggregation of variables that is equal to their sum? This question is of more than passing interest to developmental scientists. It is a crucial conceptual foundation that informs how culture can or should be measured in cross-cultural developmental science research.

Are cultural similarities and differences somehow intrinsic and unmeasurable, or can they be categorised and quantified? Furthermore, cultures are composed of people. How do the two relate" (Bornstein 2010, p. 37).

Invalid measures can either inflate or hide true differences in child well-being or development that might actually be the result of cultural differences. What may be a reliable measure of well-being in one culture may not work for others. Cross-cultural equivalence is difficult in terms of child well-being as the equivalence of the concepts that define the dimensions of well-being may not be consistent. It may be useful for researchers interested in measuring child well-being to make a distinction between emotional states that vary in intensity and individual differences in well-being from a health perspective that should be more stable over time. Child health researchers can learn from the literature around the development of personality trait indicators to aid the making of such distinctions.

Essentially the difficulty is to create measures that can reliably show differential child development across countries so that it becomes possible to then investigate how cultural practices and norms may impact on child development; that is, culture should not be part of the measured aspect of development (dependent variable), instead it should be captured in the measured aspect of the independent variables. From a public policy point of view, public health has a significant role in trying to change those prevailing negative dominant structures that prevent or curtail children realizing their developmental potential. With the knowledge that both poverty and inequality are damaging conditions for child well-being, social policy and cultural change is required to redress the power formations, social arrangements, values, and practices that hold children back. Thus, from a public health perspective, it is important to investigate how culture influences behavior and care giving practices and how these may influence child development and well-being in both a positive and negative way.

Additionally public health interventions need to be informed by the attitudes, beliefs, and practices that are influenced by culture. An understanding of culture is important in order to enhance the efficacy with which public health messages are communicated. From a systems public health perspective, culture influences how health-care settings and systems are developed and the paradigms in which health-care professionals are trained. Thus, in a workforce and systems approach, public health has a role in raising the awareness of the importance of culture. For further readings around these points, we suggest Kleinman (1981), Kreuter and McClure (2004).

Indicators of child development and well-being need to be able to help inform understanding about how children's outcomes vary by social and economic conditions. Eckersley (2006) argues that cultural characteristics such as materialism or individualism can have an important impact on a person's self-control and levels of social support. Typically aligned with Western cultures, materialism is associated with dissatisfaction (rather than happiness), depression, anxiety, anger, isolation, and alienation resulting in the human needs for security, safety, and connectedness being unmet in materialistic cultures. Eckersley contends that individualism and materialism affect well-being through their influence on values. Values, being

a core component of culture, provide a framework for deciding what is important, true, right, and good (Eckersley 2006).

Such values bring order and meaning to people's lives and provide a framework to guide child-rearing practices. Culture can clearly have both positive and negative influences on children. Where there exist potentially negative aspects of cultural practices, at times political correctness and the fear of challenging cultural practices may have a deleterious effect on the development of public health interventions. Sutton provides some challenging thoughts on this matter in his book aptly titled the "Politics of Suffering: Indigenous Australia and the end of liberal consensus." Sutton states.

> ... the kind of deep cultural changes that may assist a real move out of profound disadvantage are not well understood, not just in official policy-making circles, but more generally, and in my own grasp of the situation as much as anyone else's. It is easier for an anthropologist to suggest why it is that certain past cultural shifts have been effective in improving a peoples quality of life, than to suggest future shifts that people might consider trying to manipulate so as to have a better existence. One of the obstacles to effective debate is the present context is that so many people are still in denial over the need for cultural change. (Sutton 2009, p. 69)

These insights into the importance of culture and the recognition of the complex interplay between culture and history, religion, politics, economics, and the status of women, children, ethnic, and indigenous groups are fundamental to understanding the health of populations. As such, the development of indicators to measure child well-being and development needs to be robust enough to actually decipher true differences in child development across all of the subpopulation categories. Only then will it be possible to unpack this complex interplay to determine the facilitators and barriers to positive child health and well-being. Those in the field who are aware of the methodological issues will be better able to critically evaluate research findings and in turn may help foster the development of improved methods and thus advances in knowledge.

12.8   Research Designs in Public Health

It would be remiss to write a chapter on public health and not have a section dedicated to research design. Research design is fundamentally linked to the discipline of public health through the field of epidemiology. Often overlooked, however, is that the generalizability of results, no matter what research design is chosen, can be cleverly enhanced through the choice of a common indicator.

In developmental science, longitudinal studies and cross-sectional designs dominate. In traditional developmental science, the task in longitudinal studies is to find meaningful associations between age changes and changes in specific outcome behaviors or abilities of interest. Cross-sectional studies, on the other hand, aim to discover age group differences in particular behaviors or abilities. Put rather crudely developmental scientists aim to understand how children develop.

In contrast, public health, as a discipline, aims to prevent disease and disability. As such, public health is interested in contextual factors that may be modifiable during early childhood to help improve future human well-being. Thus, the interest in the field of developmental science by public health practitioners has a different intent compared to the pure developmental scientist. As such, in the discipline of public health and epidemiology, longitudinal (or cohort) studies are generally utilized to model the impact and influence of contextual factors on human development – contextual factors being those factors outside of the body that potentially affect or are affected by the individual and his/her growth. For example, context clearly includes factors such as family/home environment, physical and chemical exposures, community and social services, schools, and peer groups. Epidemiologists typically analyze the influence of *risk factors* on poor developmental outcomes.

Part of the distinction can also be made by observational or experimental studies. In pure developmental science, observational studies dominate. These are studies where nature is allowed to take its course. The investigator measures but does not intervene in any way. Such studies can be descriptive or analytical. In public heath both observational and experimental studies dominate. Experimental studies involve an active attempt to change an outcome – in our circumstance, an active attempt to improve child development and well-being through either treatment/ intervention, change in behavior, or say exposure to a program.

A particular type of experimental longitudinal research design is the randomized controlled trial (RCT). The RCT is the most advanced/best quality research design and is the type of longitudinal study that provides the greatest potential to infer causation which becomes additionally important when designing impact evaluation studies. RCTs were traditionally designed to determine the efficacy and effectiveness of drugs; however, they are now also used to determine the efficacy and effectiveness of interventions. Of particular relevance to child development is the pragmatic randomized controlled trial where an RCT is designed and implemented in "real life" rather than in an excessively controlled set of situations. Pragmatic trials (Zwarenstein et al. 2008) tend to have higher "generalizability"; that is, the results are applicable to usual settings. For example, in order to evaluate a new schedule of care delivered by child health nurses across various communities, a pragmatic trial design would be the most appropriate. Unfortunately, in the field of early child development, such trials are extremely rare, primarily due to expense and the significant commitment required from service providers and funders to randomize (hence to deny half the study subjects the intervention at least temporarily) and be prepared to wait (in some circumstances many years) for the research findings to show impact.

Cross-sectional studies are generally used in epidemiology/public health to determine the prevalence of disease or disability. They can be used to investigate associations between context and development but are limited in determining causality. Cross-sectional studies tend to be survey samples and are generally useful to investigate or categorize common conditions; they often compare cases and

controls for the risk factors of interest and attempt to control for confounding factors. When a cross-sectional survey is done across an entire population, then this is called a census. Such cross-sectional surveys or censuses that are repeated over time form a system of monitoring or surveillance. Repetition of cross-sectional data collections enables monitoring of change or trends across communities, population subgroups, and populations as a whole. Monitoring and surveillance is a fundamental role of public health.

Determining pathways and the mechanisms of causation are also important for public health. Longitudinal studies are, however, expensive, tend to be burdensome on the families involved, suffer from loss to follow-up, and tend to underrepresent minority groups and those families from the tails of the socioeconomic distribution (i.e., the wealthy and the poor). Cross-sectional surveys, although aiming to be representative, also tend to suffer from failing to recruit families from the tails of the socioeconomic distribution and suffer from recall bias of exposures. Unless the researchers take a strategy of oversampling minority groups, survey results are frequently not generalizable across populations. Census collections benefit from being representative, enable the comparison of subpopulations, and provide the opportunity to explore the patterns and distributions of health. Repeated over time there is the added advantage of being able to monitor trends in health. However, without the longitudinal aspect (i.e., following the same child/person over time), it is not possible to determine the pathways to health/ill-health. The recognition of these problems has led many researchers in public health to use linked population data sets.

Data linkage essentially finds connections between different pieces of information that are thought to belong to the same person or between events that occurred at the same place or happened at or about the same time. Consistent measures of early child development can be linked to other measurements of health, educational, and behavioral outcomes over the life course. It is possible to construct crosswalks between health, early child development, and education databases that integrate population-wide, person-specific data at national, jurisdictional, and community levels. As such it is possible to create a historical perspective of developmental trajectories for an entire population of children. Linking early child development outcome data with education, health, and social service administrative databases is key to shedding new light on the complex interplay of risk and protective factors over the life course. The real value from linkage comes if data on child well-being indicators are available for the total population, which provides the ability to generalize to the whole population, allowing unbiased assessments, and makes possible the study of subpopulations.

For those interested in data linkage, a description of how data linkage is achieved while maintaining the privacy of individuals is explained by the following video link: https://www.santdatalink.org.au/animation. From a research perspective, a good summary of the comparison between longitudinal studies versus population-based linked data systems is provided by Roos et al. (2008). Additionally, Jutte et al. (2011) recently published a review of data linkage as a tool for public health.

The primary centers for establishing population comprehensive linked data systems include the Oxford Record Linkage Study in England, the Scottish

Record Linkage System, Statistics Norway, the MigMed2 database in Sweden, the Manitoba Centre for Health Policy, the Centre for Health Services and Policy Research in British Columbia, and the Institute for Clinical and Evaluative Sciences in Ontario. In Australia, the Western Australian (WA) experience in data linkage commenced in the academic sector in the 1970s.

From the 1980s, the WA Maternal and Child Health Research Database contained linked data on all births (antenatal, intrapartum, and neonatal information on the mother and child) with hospitalizations, birth defects, and other disabilities (from total population registers) (Stanley et al. 1997). By 2002, all health-related data linkage was undertaken within the centralized WA Data Linkage System (WADLS) jointly managed by the academic and public sector, with strong ethical oversight. Since 1995 the WADLS has been able to progressively build linkages between the state's administrative population-wide data collections related to the health and well-being of children, adults, and families. Over the last 10 years, this staged development has also seen the WADLS expand to include links to national and local health and welfare data sets, genealogical links, and spatial references for mapping applications (Holman et al. 2008). Elsewhere we have suggested that such data can influence the joined-up policy responses needed for child well-being, for which this chapter is also advocating (Stanley et al. 2011).

Australia is now progressing towards national data linkage activities with state-based "nodes" (such as the WADLS) working together under a national network (the Population Health Research Network), which will allow researchers to access state and across jurisdictional boundary data that is non-identified. The systems will improve Australia's ability to monitor health and well-being using data already collected by social services including primarily health but also education, and family and community services. The systems are able to identify trends in health and development and provide the evidence to develop proactive health and welfare policy. The Australian Population Health Research Network along with the state-based nodes will provide the world's most comprehensive population health data-base to monitor and study health and well-being.

Integration from each approach (longitudinal, pragmatic randomized controlled trials, cross-sectional, and population census monitoring added to population-wide data linkage systems) can significantly enhance our ability to understand child development and inform public health strategies to improve future human capital. This understanding is further enhanced when consistent indicators are used in both longitudinal studies and cross-sectional and/administrative data collections. For example, data from longitudinal studies can be used to then extrapolate by the use of forecasting models to the entire population if the same instrument is used. If the same indicator is used over time to monitor trends or across populations, then further comparisons and knowledge are uncovered. Linking cohort studies and cross-sectional surveys to population-linked data where each is using the same indicator of child well-being enables more complete follow-up and generalizability.

Despite the knowledge of the benefits of a consistent and standardized measure, there is currently no single internationally recognized measure of early child

development. However, the report of the United Nations' Secretary General in late 2010 names three examples of child development/well-being indicators that are currently rising to the fore:

> In order to better monitor children's right to develop to their full potential, an internationally agreed set of core indicators needs to be established and reported upon regularly. Several instruments have been promoted to close this information gap. They include Save the Children's Child Development Index and the Early Development Instrument promoted by the World Bank. UNICEF has developed an Early Childhood Development Index to be used as part of the multiple indicator cluster survey and other household surveys. The Early Childhood Development Index will further enhance effective data collection to monitor the full implementation of the Convention on the Rights of the Child, as well as any other internationally agreed instruments, to ensure full realization of child rights in early childhood. (United Nations 2010, Sect. 22)

Due to the experience of the present authors, this chapter will concentrate on two of these three indicators as examples of ways to move forward – the UNICEF Multiple Indicator Cluster Survey (MICS) Early Child Development Module (which includes the Early Child Development Index) and the Early Development Index (EDI).

12.9   The MICS Early Child Development Module

In a bid to improve international comparability of child well-being, UNICEF took the lead to fund and coordinate the development of an Early Childhood Module that now forms part of the Multiple Indicator Cluster Household Survey (MICS). MICS is conducted across the world and as such the results of this work now serve as one potential for an international comparative measure for early child development.

In 2007, UNICEF commissioned a review of tests, measures, and items used to establish the developmental status of children aged 0–6 years, with specific focus on those instruments tested cross-culturally (Zill and Ziv 2007). This review recommended five, equally weighted developmental domains (motor, language, cognitive, social-emotional, and approaches to learning) to form the basis for the module. In early 2008, a validation study of the items recommended by Zill and Ziv was commissioned, with the goal of producing a reliable and feasible set of items to be used in the MICS; however, the age under consideration was truncated to cover ages 3–6 years: the preschool years.

The validation study was conducted in two countries: Jordan and the Philippines, in close collaboration with local UNICEF offices (Janus et al. 2008b). The design of the study involved collecting base data on approximately 900 children in each of the two countries. The sample was evenly distributed to equally represent boys and girls between 3 and 6 in yearly interval groups. Urban and rural regions of each country were also represented. A subsample of the total sample was used to allow for additional validity testing: test-retest (repeated application of the questions after a short time interval), and inter-rater components (two parents, if possible, or parent and preschool teacher).

A variety of data collection methods were used to assess content and concurrent validity. Several questionnaires and parent interviews with established international validity or validity in the studied countries were reviewed to enable addition of items. These were later used for comparison and item reliability assessments. It was believed that the finalized module could include a combination of parent reports and direct observations, and therefore a number of simple gross and fine motor tasks were added, as well as a direct, gamelike, assessment of executive functioning. All items used in the study were translated into the appropriate languages. In the preparatory phases of the study, initial content validity assessments with local early childhood educators and experts were conducted. Recommended changes and/or modifications were back translated into English for review by the project team. The differences were discussed to consensus, and all finalized items were incorporated into the standard MICS format.

The finalized instrumentation to be tested included the set of questions recommended by Zill and Ziv (2007), along with the Early Development Instrument (Janus and Offord 2007), the Strengths and Difficulties Questionnaire (Goodman 2001), and selected questions from a questionnaire developed for the Philippines (King, n.d.). In addition to these parental interview questions, a couple of task-based child assessments were utilized including items like "draw a circle," "can you stand on one foot?" and a direct test of executive cognitive functioning (Zelazo 2006). The sociodemographic and contextual information was collected with items from selected modules from the standard MICS inventory.

A series of psychometric, reliability, and validity testing along with factor analyses were applied to the collected data to detect the underlying factors and item integrity. This series of analytical techniques successfully identified a small number of factors that explained most of the variance observed. Each of the resultant factors was then tested for internal consistency and the findings establish a set of indicators for each developmental domain and within these a series of sub-domains. A long (48-item) and a short (18-item) version covering six developmental domains – language, cognitive, physical, social, emotional, and approaches to learning – were developed (Janus et al. 2008b). While the resulting sets of items were validated against the direct assessment measures, it was clear that using such assessment on a wide-scale basis in the MICS would not be feasible. Information on the implementation challenges contributed to the writing of an associated field guide now associated with the MICS module (Janus et al. 2008a).

The 48-item and 18-item versions were proposed to the UNICEF Early Childhood Development Unit and discussed with a broad group of experts, who brought forward concerns over the length of administration and difficulty of some items, especially in the 48-item version. The 18-item draft of the Early Child Development Index (ECDI) was, therefore, chosen to be tested in 2009 in Mombasa, Kenya. Following this, further revisions were undertaken with simplicity and non-ambiguity in mind. Items which elicited the most negative feedback because of the difficulty of underlying concept were eliminated. The number of items contributing to the ECD Index was then reduced to 10. All questions allow only for binary responses, yes or no. The original language and cognitive domains have been

collapsed into one, now consisting of three items, and the social and emotional domains have been collapsed into one, now consisting of three items. Two remaining domains – physical and approaches to learning – consist of two items each (Janus et al. 2008b).

The resulting Early Child Development Index (ECDI) is a holistic simple indicator, within the framework of a MICS module, with adequate sensitivity to external variables, the basic reliability and sensitivity, as well as capacity to inform. The index is calculated for the whole set of items as well as for each domain, indicating the percentage of children aged 3 and 4 years who are developmentally on target in language-cognitive, physical, socio-emotional, and approaches to learning domains, as well as overall development. The ECDI now functions as a part of the Under-5 Child Development MICS Module, which includes questions on breast-feeding, availability and child's access to toys and reading materials, participation in preschool programs, parent–child interactions, and child being left alone. All the aspects measured in the module contribute to a better understanding of the context of the lives of young children. As more countries implement the MICS Early Child Development Module, a comparative picture of developmental outcomes (children "on target") in the context of other variables, including maternal health, family wealth, and dwelling charac- teristics, will emerge and assist in better understanding of the early years in the developing countries, going beyond the statistics of survival and disease (Janus et al. 2008b).

12.10 The Early Development Index (EDI)

Transition to school is seen as one of the best stages in a child's life to measure their development and well-being. Research has established that high-risk children can be prepared for initial success at school through early childhood education, family support, pediatric and allied health-care interventions, and child health programs. When children come to school with the skills, competencies, and developmental capacity to take advantage of the education system, coupled with a high quality education system, the initial positive effects persist into adolescence and adulthood.

The Early Development Index (EDI) is a population measure of children's development. The index is a holistic measure covering five developmental domains: physical health and well-being, social competence, emotional maturity, language and cognitive skills, and communication skills and general knowledge (Janus and Offord 2007). In general teachers complete the instrument for all children in their class on the basis of their own observations and reflections of the children. It is generally used across the population of children attending their first year of full-time schooling. The purpose of the EDI is not to identify individual children for treatment but is a population measure to provide an evidence base to inform and evaluate both universal prevention strategies and interventions targeted to specific geographic or population groups. As such, the EDI data is made publically available via community maps, community profiles, and jurisdiction or

national reports, with the information intended to inform strategies that can be applied to improve child well-being.

As mentioned in the introduction, the measurement properties of instruments are rarely comprehensively assessed across countries and generally lack strong evidence of international validity and reliability. The particular suitability of an instrument like the EDI to measure holistic child development presents an opportunity for international organizations to build a comparative international indicator (Janus et al. 2011). To aid the international comparability of the EDI, a set of minimum guidelines outlining the steps to be undertaken prior to claiming that the EDI is a valid instrument within a country has been developed by the author of the EDI (Janus and Offord 2007). These guidelines are consistent with the International Test Commission Guidelines for Test Adaptation (Hambleton et al. 2005) and adhere to a universalist approach (Herdman et al. 1998), making no a priori assumptions about comparability. In concordance with these various guidelines, the EDI needs to be validated and tested for reliability within each country prior to being able to compare across countries.

With its continued success, the EDI is now being adapted for use around the world with 20 countries (both developed and undeveloped) utilizing the instrument. The instrument's use is being supported by governments and the World Bank, UNICEF, and the Bernard van Leer Foundation. As each country undertakes the adaptation process, the reliability and validity of the instrument continues to build. With this, the research potential to investigate the complexities of child development across cultures, populations, and societies also continues to grow. Although it is very early days, the following graph has been compiled as an example of our aspirations for the EDI (Fig. 12.1).

The results in this graph may well be difficult to compare. For instance, the data have been collected in different ways. In the Philippines, Jordan, and Indonesia, the parents were asked the questions by an interviewer (i.e., within a household survey). In all other countries the teachers were the respondents completing the instrument for each child in their class. In Australia the data represent an entire population cross section (a census). In Canada the information presented is the Canadian normative sample representative of Canada as a whole. The information collected in Mexico is a population census across a region within the country. In both the Philippines and Jordan, the sample was a representative survey. In all other circumstances, the sample collection was to evaluate early childhood interventions and cannot be considered representative. As such, although the instrument is essentially the same, the modes of data collection and design of the study collecting the information jeopardize the comparability. In each country, we have undertaken, as reasonably practical within budget constraints and local capacity, the required steps to validate the instrument to the local settings.

However, given the limitations it is still interesting to note the large differences in results across countries and just such a graph mobilizes people to start to ask the question about why there are such differences. No doubt some variation will be measurement error; some will be due to lack of representative country samples. However, given that children from the poorest communities across Indonesia
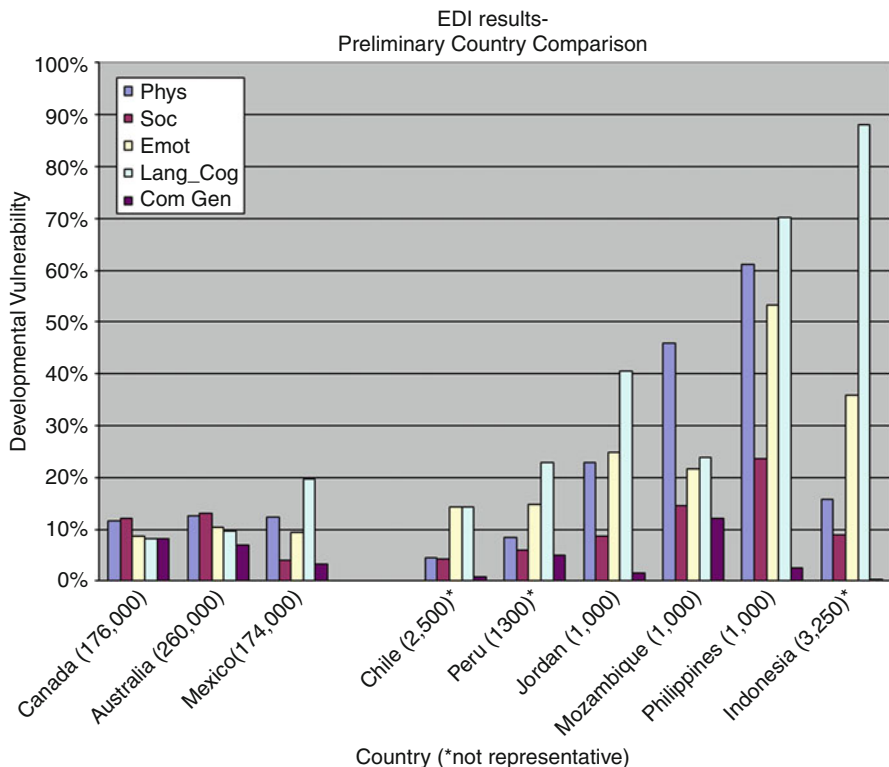
Fig. 12.1 EDI results – preliminary country comparison

appear to be doing considerably better than children in Australia and Canada on the communication skills and general knowledge domain as well as the social competence domain begs us to ask why. What are the social and cultural aspects that support children in these villages (a community raises a child?) versus communities across Australia and Canada? The explanation of the differential between language and cognitive development may be more easily explained. The questions that comprise this domain include aspects of formal reading and writing skills which considering the literacy levels of caregivers and access to books and pens in some of the villages in Indonesia contrast significantly with the experiences and resources of children in Australia and Canada. A question may well be raised – but what is most important for future health and well-being, maybe in Indonesia such skills are not as important. These are questions riddled with culture, political correctness, and complex social and cultural, historical, and economic interplays. Our personal views aside, it is likely that children with good skills and development across the domains of child development will be more likely to succeed than children who at entry to school are already struggling.

12.11 The Australian Story with the Early Development Index (AEDI)

The Australian Early Development Index (AEDI) is based on the Canadian Early Development Instrument (EDI) (Janus and Offord 2007), which was developed by the Offord Centre for Child Studies at McMaster University in Ontario. Although the EDI was developed in Canada, Australia is the first country in the world to measure the development of their entire population of children. After extensive piloting from 2002–2008, in 2009, as a federal government election commitment, the AEDI was collected for almost every child across Australia in their first year of full-time schooling. In what was essentially a "child development census," information was collected for over 261,000 children representing 98 % of the population. Nearly 16,000 teachers from 7,420 government and nongovernment schools completed the checklist based on their knowledge and observations of the child. The data collection occurred within a 3-month window.

Although the 2009 National AEDI data set provides the first Australia-wide population baseline to which future data collections will be compared, the instrument has been used in Australia since 2002 and has been the subject of various reliability and validity studies. It should be noted that the Canadian EDI has also been the subject of numerous validation and reliability studies. The checklist was first utilized in Perth in 2002 (Brinkman and Blackmore 2003) and then again in 2003 (Hart et al. 2003) where the process of adaptation initially included testing its content validity and utility as a community-level measure of early child development in Australia. In 2004 federal government funding enabled further instrument validation and communities from across Australia to become involved (Goldfeld et al. 2009). From a technical point of view, Rasch analyses were conducted to confirm adequate psychometric properties of the instrument (Andrich and Styles 2004). From a community point of view, the use of the instrument was evaluated in terms of its utility as a community mobilizer around early childhood (Sayers et al. 2007).

In a separate study, the AEDI was embedded in a nested sample within the Longitudinal Study of Australian Children (LSAC) (Sanson et al. 2002). To date this has enabled the assessment of the AEDI's concurrent and construct validity, with predictive validity analyses now underway. The results indicate that the AEDI performs as well as expected and in some cases better than individual assessment tools that are more time-consuming and expensive to administer (Brinkman et al. 2007).

The AEDI Indigenous Adaptation Study further developed the AEDI to ensure it is relevant and sensitive to the needs of Australia's Indigenous children (Silburn et al. 2009). Additionally, the Language Background Other Than English (LBOTE) Study reviewed the AEDI implementation process, results, and data usage for culturally and linguistically diverse populations. These two studies have resulted in significant improvements to the AEDI Teacher Guidelines to further explain the intent of each question with the provision of culturally inclusive examples and prompt to support teachers completing the checklist.

The 2009 National AEDI results were released by Prime Minister Julia Gillard and the former Minister for Early Childhood Education, Child Care and Youth, Kate Ellis, in December 2009. The results are available in the form of a national report and online community maps and profiles. Highlights from the National AEDI report (Centre for Community Child Health and Telethon Institute for Child Health Research 2009) show that:

- The majority of children are doing well on each of the developmental domains.
- However, 23.5 % of Australian children are developmentally vulnerable on one or more of the five domains.
- Children living in the most socioeconomically disadvantaged communities are more likely to be developmentally vulnerable on each of the AEDI domains; however, vulnerable children are found across the entire socioeconomic spectrum.
- Similarly the majority of Australian Indigenous children are doing well on the AEDI domains; however, Indigenous children show disproportionly higher developmental vulnerability rates when compared to non-Indigenous children.
- Interestingly the figures show different patterns when reviewing the different aspects of child development, where Indigenous children are showing extremely good skills in terms of physical independence but significantly poorer results in terms of language and cognitive development.
- Children who are proficient in English and speak another language at home are less likely to be developmentally vulnerable on all the AEDI domains.
- However, children who only speak English, but are reported as not proficient in English, are more likely to be developmentally vulnerable across all five AEDI domains.

The AEDI results are available online via a designated website www.aedi.org. au. To help community members understand and interpret the results, there is an interactive results guide. This guide provides information about how to engage with your community and helps develop plans for community action to support children and families. The AEDI website also provides community case studies, videos, FAQs, publications, fact sheets, and links to other relevant websites.

Colloquially, the AEDI results are referred to as a measure of how well the community has raised their children to school age, and thus, the results are primarily seen as an outcome indicator, although the data is also interpreted as an indicator of future human capital. The AEDI aims to determine whether children are starting school with the developmental capacity to take advantage of the school learning environment. When accessing and interpreting the AEDI results, it is important to recognize that although the data is collected through the school system the information is always reported on the basis of a child's suburb or geographic area of residence and not the school location, so the AEDI results are not a reflection of the school.

The interactive mapping platform allows users to see how a suburb/ neighborhood is going in comparison to (or relative to) neighboring suburbs across the region. Different "data layers" are available including each of the AEDI domains as well as socioeconomic and demographic data sourced from the

Australian Bureau of Statistics. Data legends on the side of the maps allow users to see both the number of children vulnerable on each of the developmental domains as well as the percentage of children vulnerable in each of the suburbs.

Along with a range of other community indicators and information, the AEDI can be used by communities to plan and evaluate place-based initiatives for children and families. The AEDI data acts as a community catalyst for conversations across agencies and provides communities with the opportunity to strengthen collaborations between schools, early childhood services, and local agencies (Sayers et al. 2007). In 2006, the Centre for Community Child Health undertook an evaluation of how communities utilized their AEDI results. The findings showed that the community implementation process and AEDI results facilitated the development of community partnerships and coalitions, particularly between early childhood settings and schools, raised awareness of the importance of early childhood development, assisted communities to map and understand their assets, identified priorities for action, and provided data to support local grant applications. The results from the evaluation also highlighted the need for local champions and strong support from the education and health sectors to successfully implement and then act upon the AEDI results (Sayers et al. 2007).

Governments are becoming increasingly interested in the early determinants of children's health, development, and well-being in order to inform changes needed to better support children and their families (Young 2007). To make such improvements across and within countries, however, requires an understanding of the complexities of the patterns of child development across various population groupings to inform the mix of universal and targeted strategies. Getting this mix right has significant service and policy ramifications.

The AEDI population data mapped across regions helps inform policy makers on where, what, and how to scale up early child development programs. Such data enables governments to (1) judge the resilience of communities and understand where early child development programs are most needed; (2) monitor the state of child development and assess change in outcomes over time, for example, identifying trends in child outcomes as a result of policies and programs; and (3) anchor developmental trajectories to identify groups of vulnerable populations which will require additional support.

With the national Australian infrastructure development for population data linkage (as mentioned earlier in this chapter), the linking of various administrative data sets to the AEDI provides a potentially powerful person-specific longitudinal total population-based data set. Such a data set significantly increases our ability to investigate the complexities of developmental trajectories. In addition, program and policy evaluation and economic models can also be investigated with such data sets such as the effectiveness of preventive interventions which are traditionally hard to quantify.

The AEDI has significant scope as an independent data source used in context with other geographically available social and demographic information along with local community knowledge. When the AEDI is repeated in successive cohorts, this then enables us to monitor early child development across populations and time and

to examine trends for geographic areas. However, the investigation of risk and protective patterns in child development is generally undertaken using individual-level information. Further to that, the importance of examining individual-level data is reflected by the fact that while the AEDI clearly shows a significant socioeconomic gradient in developmental vulnerability, there are still many children in middle-class and upper-class Australia that are developmentally vulnerable. So although socioeconomics explains some of the variation in child development, there is still a significant amount of variation that needs further unpacking for us to better understand the complexities of child development (Centre for Community Child Health and Telethon Institute for Child Health Research 2009; Lynch et al. 2010; Brinkman et al. 2012).

There are currently plans to link the AEDI to the whole infant cohort of the Longitudinal Study of Australian Children and the Longitudinal Study of Indigenous Children once they reach school age. In addition, children entering the Longitudinal Study of Youth will be consented to link back to their AEDI results when they were in school.

There are few places in the world with the infrastructure developed to conduct such research taking advantage of linked administrative data and longitudinal studies; however, of those that have the capacity in Australia and Canada, all are using (or have funded projects to use) the A/EDI. Scotland also has data linkage facilities and is currently piloting the EDI with the aim to develop a population EDI data set for linked research.

International collaborations with the use of standardized instruments like the EDI provides scope for international and jurisdictional policy evaluation and unique opportunities for investigating social and cultural factors that influence developmental trajectories of children never before possible.

12.12 Summary

Public health researchers and policy makers should primarily be concerned with the availability of quality data on the relationship between exposures and outcomes and adequate evidence of the effectiveness of public health policies to improve those outcomes (Stanley and Daube 2009). With the knowledge that child development and well-being makes a difference to life-course health and civil participation coupled with the knowledge that we can positively influence child development and well-being through a variety of interventions and programs, we need to move towards more refined and pragmatic questions that investigate the relative influence of different types of programs – questions such as age of onset, duration and intensity of treatment (dose), quality required, and the most effective content mix (i.e., are language-specific programs, more holistic programs requiring a multidisciplinary approach, or child-specific or family partnership approaches more effective). To address such questions requires multidisciplinary partnerships and the use of consistent measures of development. For example, if the evaluation

of an intervention in Bangladesh utilizes the EDI as its outcome measure as does the evaluation of either the same or a different intervention in the Philippines, the results are far more likely to be comparable than if the evaluations utilized outcome measures that were different.

More and more governments in developing countries are coming to understand that sound systems for monitoring and evaluation can help them improve their performance. There are a small but growing number of governments that have succeeded in building monitoring and evaluation systems in support of evidence-based policy making, evidence-based management, and evidence-based accountability. The World Bank and other international donors view this as a priority area and stand ready to help developing countries strengthen their work in this area (UNICEF 2008).

An emphasis on only the deficits of child development (i.e., identifying developmental delay) leads research and interventions targeted to efforts towards children's deficits. The measurement of well-being allows the identification and thus the promotion of child strengths. The authors of this chapter prefer to rise above the arguments around the merits of indicators that are deficit based or strength based. We understand the merits of both and the need to be able to measure both the strengths and weaknesses in children. Our argument would be that a holistic instrument that is able to place a child on a developmental spectrum allows us to do both. An internationally comparable measure such as the EDI or the MICS ECDI allows for such applications. Such a measure utilized widely for both population monitoring and longitudinal research studies will significantly enhance the advancement of child well-being and public health.

The importance of the early environments influencing child development or well-being, however defined, is crucial in the challenges we face to improve public health in the twenty-first century, in all nations. Many countries still battle poverty and its associated infectious diseases and malnutrition which contribute significantly to unhealthy child development, child well-being, and, through these, to the public health of the whole population. The more developed world is facing a myriad of other "modern" negative influences on child development such as parental mental health problems, substance abuse, domestic violence, inequalities, and poor educational outcomes – all of which are profoundly important for public health in those nations. And of course, as countries develop and become urbanized, they seem to also take on these risks.

We strongly believe that a focus on improving maternal and child health, early childhood experiences, and youth health and well-being (the parents of the next generation) is key to improving public health globally. A healthy start to life is the major building block for adult health and well-being and for both the present and the next generation. The best ways to measure child well-being across and between nations are still being trialed, but in this respect many countries are taking a lead, including Canada and Australia along with developing nations.

References

Andrich, D., & Styles, I. (2004). *Final report on the psychometric analyses of the Early Development Instrument (EDI) using the Rasch Model: A technical paper commissioned for the development of the Australian Early Development Index (AEDI)*. Western Australia: Murdoch University. Retrieved April 2012 from http://ww2.rch.org.au/aedi/studies/index.cfm?doc_id=14792

Barker, D., Eriksson, J., Forsén, T., & Osmond, C. (2002). Fetal origins of adult disease: Strength of effects and biological basis. *International Journal of Epidemiology, 31*(6), 1235–1239. doi:10.1093/ije/31.6.1235.

Bernard van Leer Foundation. (2006). *United Nations Committee on the Rights of the Child, UNICEF, and the Bernard van Leer Foundation. A guide to general comment 7: Implementing child rights in early childhood*. The Hague: Bernard van Leer Foundation.

Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K., Giugliani, E., & Shekar, M. (2008). What works? Interventions for maternal and child undernutrition and survival. *The Lancet, 371*(9610), 417–440.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., & Rivera, J. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *The Lancet, 371*(9608), 243–260.

Blair, M., Stewart-Brown, S., Waterson, T., & Crowther, R. (2010). *Child public health* (2nd ed.). New York: Oxford University Press.

Bornstein, M. (2010). From measurement to meaning in caregiving and culture, current challenges and future prospects. In C. Wortham, P. M. Plotsky, D. S. Schechter, & C. A. Cummings (Eds.), *Formative experiences. The interaction of caregiving, culture and developmental psychobiology* (Vol. 1, pp. 36–50). New York: Cambridge University Press.

Branca, F., Nikogosian, H., & Lobstein, T. (2007). *The challenge of obesity in the WHO European Region and the strategies for response summary*. Denmark: World Health Organisation.

Brinkman, S., & Blackmore, S. (2003, March). *Pilot study results of the Early Development Instrument: A population based measure for communities and community mobilisation tool*. Paper presented at the Beyond the Rhetoric in Early Intervention, Adelaide, Australia.

Brinkman, S., Silburn, S., Lawrence, D., Goldfeld, S., Sayers, M., & Oberklaid, F. (2007). Investigating the validity of the Australian Early Development Index. *Early Education and Development, 18*(3), 427–451.

Brinkman, S.A., Gialamas, A., Rahman, A., Mittinty, M., Gregory, T., Zubrick, S.R., Carr, V., Silburn, S., Goldfeld, S., Janus, M., Hertzman, C., & Lynch, J. W. (2012). Jurisdictional, socioeconomic, demographic and gender inequality in child health and development across Australia. *BMJ Open*. 2012;2:e001075. doi:10.1136/bmjopen-2012-001075.

Centre for Community Child Health and Telethon Institute for Child Health Research. (2009). *A snapshot of early childhood development in Australia. Australian Early Development Index (AEDI) National Report 2009*. Canberra: Australian Government.

Convention on the Rights of the Child, Resolution 45/25, Office of the United Nations High Commissioner for Human Rights (1989 2nd Sept 1990).

Ebrahim, S. (2012). Epigenetics: The next big thing. *International Journal of Epidemiology, 41*(1), 1–3. doi:10.1093/ije/dys015.

Eckersley, R. (2006). Is modern Western culture a health hazard? *International Journal of Epidemiology, 35*, 252–258.

Fuller-Thomson, E., Brennenstuhl, S., & Frank, J. (2010). The association between childhood physical abuse and heart disease in adulthood: Findings from a representative community sample. *Child Abuse and Neglect, 34*(9), 689–698. doi:10.1016/j.chiabu.2010.02.005.

Goldfeld, S., Sayers, M., Brinkman, S., Silburn, S., & Oberklaid, F. (2009). The process and policy challenges of adapting and implementing the Early Development Instrument in Australia. *Early Education and Development, 20*(6), 978–991.

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of American Academy of Child and Adolescent Psychiatry, 40*, 1337–1345.

Hambleton, R. K., Merenda, P. F., & Speilberger, C. D. (2005). *Adapting educational and psychological tests for cross cultural assessment*. Mahwah: Lawrence Erlbaum.

Hands, B. P., Chivers, P. T., Parker, H. E., Beilin, L., Kendall, G., & Larkin, D. (2011). The associations between physical activity, screen time and weight from 6 to 14 yrs: The Raine Study. *Journal of Science and Medicine in Sport/Sports Medicine Australia, 14*(5), 397–403.

Hart, B., Brinkman, S., & Blackmore, S. (2003). *How well are raising our children in the North Metropolitan Area: The Early Development Index*. Perth: North Metropolitan Heath Service.

Herdman, M., Fox-Rushby, J., & Badia, X. (1997). Equivalence and the translation and adaptation of health-related quality of life questionnaires. *Quality of Life Research, 6*, 237–247.

Herdman, M., Fox-Rushby, J., & Badia, X. (1998). A model of equivalence in the culture adaptation of HRQoL instruments: The universalist approach. *Quality of Life Research, 7*, 323–335.

Hertzman, C. (1994). The lifelong impact of childhood experiences: A population health perspective. *Deadalus, 123*(4), 167–180.

Hertzman, C., & Boyce, T. (2010). How experience gets under the skin to create gradients in developmental health. *Annual Review of Public Health, 31*, 329–347. doi:10.1146/annurev.publhealth.012809.103538.

Hertzman, C., & Frank, J. (2006). Biological pathways linking the social environment, development and health. In J. Heymann, C. Hertzman, M. L. Barer, & R. G. Evans (Eds.), *Healthier societies. From analysis to action* (pp. 35–57). New York: Oxford University Press.

Hertzman, C., Siddiqi, A., Hertzman, E., Irwin, L. G., Vaghri, Z., Houweling, T. A. J., & Marmot, M. (2010). Bucking the inequality gradient through early child development. *British Medical Journal, 340*. doi:10.1136/bmj.c468.

Hertzman, C., & Wiens, M. (1996). Child development and long term outcomes: A population health perspective and summary of successful interventions. *Social Science and Medicine, 43*(7), 1083–1093.

Hetzel, B. S. (2012). Commentary: A new dimension – studies in schoolchildren. *International Journal of Epidemiology*. doi:10.1093/ije/dys060.

Holman, C., Bass, A., Rosman, D., Smith, M., Semmens, J., Glasson, E., & Watson, C. (2008). A decade of data linkage in Western Australia: Strategic design, applications and benefits of the WA data linkage system. *Australian Health Review, 32*, 766–777.

Humphrey, J. H. (2009). Child undernutrition, tropical enteropathy, toilets, and handwashing. *The Lancet, 374*(9694), 1032–1035.

Huttly, S. R., Morris, S. S., & Pisani, V. (1997). Prevention of diarrhoea in young children in developing countries. *Bull World Health Organ, 75*(2), 163–174.

International Test Commission (ITC). (2000). *International guidelines for test use*. Retrieved November 8, 2010, from http://www.intestcom.org/guidelines/index.php

Irwin, L. G., Siddiqi, A., & Hertzman, C. (2007). *Early child development: A powerful equalizer. Final report for the World Health Organization's commission of the social determinants of health*. Vancouver: Human Early Learning Partnership.

Jacoby, P. A., Coates, H. L., Arumugaswamy, A., Elsbury, D., Stokes, A., Monck, R., & Lehmann, D. (2008). The effect of passive smoking on the risk of otitis media in Aboriginal and non-Aboriginal children in the Kalgoorlie-Boulder region of Western Australia. *Medical Journal of Australia, 188*(10), 599–603.

Jamison, D. T., Breman, J. G., Measham, A. R., Alleyne, G., Claeson, M., Evans, D. B., et al. (2006). *Disease control priorities in developing countries* (2nd ed.). Washington, DC: World Bank.

Janus, M., Brinkman, S., & Duku, E. (2008a). *Fieldwork guidelines for the MICS ECD Module. Second interim recommendations report Part II*. Hamilton: McMaster University.

Janus, M., Brinkman, S., & Duku, E. (2008b). *Pilot test results: Child development outcome instrument to be included in UNICEF's MICS Household Survey. Final report*. Hamilton: McMaster University.

Janus, M., Brinkman, S. A., & Duku, E. (2011). Validity and psychometric properties of the Early Development Instrument in Canada, Australia, United States and Jamaica. *Social Indicators Research, 103*(2), 283–297.

Janus, M., & Offord, D. (2007). Development and psychometric properties of the Early Development Instrument (EDI): A measure of children's school readiness. *Canadian Journal of Behavioural Science, 39*, 1–22.

Jutte, D. P., Roos, L. L., & Brownell, M. D. (2011). Administrative record linkage as a tool for public health research. *Annual Review of Public Health, 32*, 91–108.

King, E. (n.d.). Philippines questionnaire. Appendix F. In *A study for the effects of early childhood intervention on children's physiological, cognitive and social development. Baseline Indicators Study*. Cebu: Office of Population Studies, University of San Carlos.

Kleinman, A. (1981). *Patients and healers in the context of culture, an exploration of the borderland between anthropology, medicine and psychiatry*. Berkeley: University of California Press.

Kreiger, N. (2011). *Epidemiology and the people's health, theory and context*. New York: Oxford University Press.

Kreuter, M. W., & McClure, S. M. (2004). The role of culture in health communication. *Annual Review of Public Health, 25*(1), 439–455. doi:10.1146/annurev.publhealth.25.101802.123000.

Li, J., Mattes, E., Stanley, F., McMurray, A., & Hertzman, C. (2009). Social determinants of child health and well-being. *Health Sociology Review, 18*(1), 3–11.

Li, J., O'Sullivan, T., Johnson, S., Stanley, F., & Oddy, W. (2011). Maternal work hours in early to middle childhood link to later adolescent diet quality. *Public Health Nutrition, 15*(1–10), 1861–1870.

Lopez, A. D., Mathers, C., Ezzati, M., Jamison, D., & Murray, C. (2006). *Global burden of disease and risk factors, disease control priorities project*. Washington, DC: World Bank.

Lynch, J. W., & Davey-Smith, G. (2005). A life course approach to chronic disease epidemiology. *Annual Review of Public Health, 26*(1), 1–35. doi:doi:10.1146/annurev.publhealth.26.021304.144505.

Lynch, J. W., Law, C., Brinkman, S., Chittleborough, C., & Sawyer, M. (2010). Inequalities in child healthy development: Some challenges for effective implementation. *Social Science and Medicine, 71*(7), 1219–1374.

Marmot, M. (2010). *Fair society, healthy lives: The Marmot review*. Retrieved January 2012 from http://www.marmotreview.org/AssetLibrary/pdfs/Reports/FairSocietyHealthyLives.pdf

May, P. A., Gossage, J. P., Kalberg, W. O., Robinson, L. K., Buckley, D., Manning, M., & Hoyme, H. E. (2009). Prevalence and epidemiologic characteristics of FASD from various research methods with an emphasis on recent in-school studies. *Developmental Disabilities Research Reviews, 15*(3), 176–192.

McCain, M., Mustard, J. F., et al. (2007). *Early years study 2 – putting science into action, council of early childhood development*. Toronto, Canada.

McDonald, E., Bailie, R., Brewster, D., & Morris, P. (2008). Are hygiene and public health interventions likely to improve outcomes for Australian Aboriginal children living in remote communities? A systematic review of the literature. *BMC Public Health, 8*(1), 153.

Moore, H. C., de Klerk, N., Richmond, P., & Lehmann, D. (2010). A retrospective population-based cohort study identifying target areas for prevention of acute lower respiratory infections in children. *BMC Public Health, 10*(757).

O'Leary, C. M., Nassar, N., Zubrick, S., Kurinczuck, J., Stanley, F., & Bower, C. (2010). Evidence of a complex association between dose, pattern and timing of prenatal alcohol exposure and child behaviour problems. *Addiction, 105*(1), 74–86.

Pharoah, P., Buttfield, I., & Hetzel, B. (2012). Neurological damage to the fetus resulting from severe iodine deficiency during pregnancy. *International Journal of Epidemiology*. doi:10.1093/ije/dys070.

Pollard, A. J. (2007). Childhood immunisation: What is the future? *Archives of Disease in Childhood, 92*(5), 426–433. doi:10.1136/adc.2006.095760.

Roos, L. L., Brownell, M., Lix, L., Roos, N. P., Wald, R., & MacWilliam, L. (2008). From health research to social research: Privacy, methods, approaches. *Social Science and Medicine, 66*, 117–129.

Rose, G. (2001). Sick individuals and sick populations. *International Journal of Epidemiology, 30*(3), 427–432. doi:10.1093/ije/30.3.427.

Sanson, A., Nicholson, J., Ungerer, J., Zubrick, S., Wilson, K., & Ainley, J. (2002). *Introducing the longitudinal study of Australian children*. Canberra: Australian Institute of Family Studies.

Sayers, M., Coutts, M., Goldfeld, S., Oberklaid, F., Brinkman, S., & Silburn, S. (2007). Building better communities for children; community implementation and evaluation of the Australian Early Development Index. *Early Education and Development, 18*(3), 519–534.

Silburn, S., Brinkman, S., Ferguson-Hill, S., Styles, I., Walker, R., & Sheppard, C. (2009). *The Australian Early Development Index (AEDI) indigenous adaptation study*. Perth: Telethon Institute for Child Health Research.

Smart, A. (1881). Preventable diseases and their causes. In *Health lectures for the people. Delivered in Edinburgh during the winter of 1880–81* (p. 208). Edinburgh: Maciven and Wallace.

Stanley, F., & Daube, M. (2009). Should industry care for children? Public health advocacy and law in Australia. *Public Health, 123*(3), 283–286.

Stanley, F., Glauert, R., McKenzie, A., & O'Donnell, M. (2011). Can joined up data lead to joined up thinking? The Western Australian Developmental Pathways Project. *Healthcare Policy, 6*, 63–73.

Stanley, F., & Maberley, G. F. (2006). Mandatory fortification of flour with folic acid: An overdue public health opportunity. *Medical Journal of Australia, 184*(4), 199–200.

Stanley, F., Read, A. W., Kurinczuk, J. J., Croft, M. L., & Bower, C. (1997). A population maternal and child health research database for research and policy evaluation in Western Australia. *Seminars in Neonatology, 2*, 195–201.

Sutton, P. (2009). *The politics of suffering. Indigenous Australia and the end of the liberal consensus*. Melbourne: Melbourne University Press.

Taylor, C. E., & Greenough, W. B. (1989). Control of diarrheal diseases. *Annual Review of Public Health, 10*(1), 221–244. doi:10.1146/annurev.pu.10.050189.001253.

UNICEF. (2007). *Child poverty in perspective: An overview of child well-being in rich countries, Innocenti Report Card 7*. Florence: UNICEF Innocenti Research Centre.

UNICEF. (2009). *The State of the World's Children Special Edition: Celebrating 20 years of the convention on the rights of the child*. New York: United Nations Children Fund.

UNICEF. (2010). *The State of The World's Children: Downloadable statistical tables*. Retrieved November 8, 2010, from http://www.unicef.org/rightsite/sowc/statistics.php

UNICEF (Ed.). (2008). *Bridging the gap. The role of monitoring and evaluation in evidence-based policy making*. Geneva: UNICEF.

United Nations. (2010). *Status of the convention on the rights of the child. Report of the Secretary-General*. United Nations, Sixty-fifth session Sess. 18.

Vanderpump, M. P. (2012). Commentary: Iodine deficiency as a new challenge for industrialized countries: A UK perspective. *International Journal of Epidemiology*. doi:10.1093/ije/dys059.

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *The Lancet, 371*(9609), 340–357.

Wagner, C. L., Taylor, S. N., Johnson, D. D., & Hollis, B. W. (2012). The role of vitamin D in pregnancy and lactation: Emerging concepts. *Women's Health, 8*(3), 323–340. doi:10.2217/whe.12.17.

Waterland, R. A., & Michels, K. B. (2007). Epigenetic epidemiology of the developmental origins hypothesis. *Annual Review of Nutrition, 27*(1), 363–388. doi:10.1146/annurev.nutr.27.061406.093705.

Waters, E., de Silva-Sanigorski, A., Hall, B. J., Brown, T., Campbell, K. J., Gao, Y., et al. (2011). Interventions for preventing obesity in children. *Cochrane Database of Systematic Reviews* (12).

Whitworth, M., & Dowswell, T. (2009). Routine pre-pregnancy health promotion for improving pregnancy outcomes. *Cochrane Database of Systematic Reviews*.

Young, M. E. (2007). *Early child development: From measurement to action*. Washington, DC: The World Bank.

Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols, 1*(1), 297–301.

Zill, N., & Ziv, Y. (2007). *Toward a global indicator of early child development: Final report to the UNICEF*. New York: ECD Unit.

Zwarenstein, M., Treweek, S., Gagnier, J. J., Altman, D. G., Tunis, S., Haynes, B., & Moher, D. (2008). Improving the reporting of pragmatic trials: An extension of the CONSORT statement. *British Medical Journal, 337*, a2390.