report

The case for a new Australian birth cohort study

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ISSR
Institute for Social Science Research

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Primary authors
Professor Mark Western
Professor Michele Haynes
Dr Bernard Baffour
Dr Paco Perales

Contributing authors
Professor Janeen Baxter
Dr Belinda Hewitt
Professor Guyonne Kalb
Professor Bill Martin
Professor Gita Mishra

Editor
Colleen Foelz

Project manager
Emma Earl

Prepared for
Australian Government Department of Social Services

Produced by
Institute for Social Science Research
The University of Queensland
Room 401, Level 4, General Purpose North 3 (Building 39A)
Campbell Road
St Lucia Queensland 4072 Australia
Business: +61 7 3346 7471
Email: issr@uq.edu.au

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INTRODUCTION

Longitudinal birth cohort studies that follow participants from the time they are born (or just before) are among the most compelling data collections for their ability to make sense of the complex multi-dimensional relationships that characterise human lives.

A new birth cohort study would collect vital data on the next generation and achieve cost savings for government

These studies capture important early-life factors that have been shown to predict future life outcomes. They control for contextual characteristics such as policy settings and historical events, which reduces the noise in statistical estimates and improves the reliability of results. When design is based on the widely accepted life course theoretical framework, these studies have the scope to explore open-ended outcomes relating to health, wellbeing, cognitive skills, physical development, psychological and emotional capabilities, and social relationships that have high relevance to policymaking.

Many of Australia's comparator nations invest in longitudinal birth cohort studies for these reasons. The United Kingdom's latest longitudinal birth cohort study, the *Life Study,* started in 2014 and will collect vital data on children before they are even born with the inclusion of important prenatal measures and information on the expectations and experiences of parents who are about to have a child. The *Life Study* is the fifth national birth cohort study undertaken by the British Government, recognising that these data collections are significantly more powerful tools for research and policy development when they occur in sequence and are appropriately spaced.

The optimum interval between birth cohort studies is 12 to 15 years. Studies that are spaced this way provide data on generational groups that can be used to identify between-cohort differences and determine the impacts of social changes, economic conditions and government policy. The data from sequential birth cohort studies can ultimately be used to draw important cross-generational comparisons between corresponding 'parent' and 'child' cohorts. The series of five British birth cohort studies have typically been spaced at 12 year intervals.

In Australia, we have invested in two major longitudinal birth cohort studies to date - *Growing Up in Australia: The Longitudinal Study of Australian Children* (LSAC) and the smaller satellite study *Footprints in Time: The Longitudinal Study of Indigenous Children* (LSIC). The children in LSAC are now aged 10 to 15 years, making the next 1 to 3 years the optimum time to implement a new study.

In this report, we explain the case for a new Australian birth cohort study and identify the design principles required to ensure this data investment by the Australian Government future-proofs policymaking for years to come. Where LSAC collected data on children born early in the new millennium, the *New Australian Birth Cohort Study* would collect data on the next generation of young Australians, which is vital for cross-cohort comparisons and making available the most up-to-date information.

The *New Australian Birth Cohort Study* can achieve important cost savings for government by providing the requisite longitudinal data to design, test and monitor policy solutions, and by leveraging existing data investments (including LSAC, LSIC and administrative records) to maximise the output and value for policymaking. The quantitative science behind longitudinal birth cohort studies has advanced significantly over the past 10 years and the new study would be based on leading edge statistical techniques, using advanced data linkage, modelling and methods (including accelerometry and anthropometrics) to get the best scientific evidence for future public policy in Australia.

CHAPTER 1
Summary of the case

1 SUMMARY OF THE CASE

This report establishes the case for a new Australian birth cohort study that will generate up-to-date and representative data about children growing up in Australia today. Such data would be used to design and test policy solutions to maximise the social and economic participation of all Australians and reduce the cost of disadvantage and ill-health to society and the economy. The new study would enable valuable comparisons with Australia's previous birth cohort studies, as well as with similar studies conducted internationally.

1.1 There are challenges of evidence in social and economic policy making

Social and economic policy in Australia covers a range of important and intersecting life domains, such as employment, education, cognitive development, mental health, family formation, disadvantage, physical health, and lifetime wellbeing. This makes government policy decisions both important and inevitably complex.

An absence of appropriate data is one of the primary challenges faced when making informed policy decisions in this area. It is difficult to find fit-for-purpose data to best understand contemporary social problems and design and test evidence-based solutions; policymakers must often manage with incomplete information. International studies are sometimes used as a proxy for domestic studies and may be inappropriate to the local context. Government reports and academic papers frequently recommend improvements to our national data resources in key areas, most recently deep and persistent disadvantage (McLachlan, Gilfillan, and Gordon 2013) and national childcare services (Australian Government Productivity Commission 2014). These reports underscore the challenge of obtaining good data as an ongoing issue for government.

1.2 Longitudinal birth cohort studies are the gold standard in research design

Longitudinal birth cohort studies are widely recognised as an optimal design for social research due to their ability to contribute to social and economic policy by collecting essential data on people's lives. A longitudinal birth cohort study follows the same individuals from birth, taking repeated measures. The data can be used to reliably assess the impact of individual differences, family circumstances, government policies, community and social contexts, and national and international events on life outcomes for individuals and populations.

A key advantage of longitudinal birth studies is that they are both methodologically robust and broad in scope. The design of these studies is comprehensive and flexible, which means they can address a wide range of policy topics; help determine cause and effect; complement other policy-relevant information, such as administrative data; and contribute to policy and program-related research, development and evaluation.

1.3 Australia's current study children are growing up

Australia currently invests in national longitudinal birth cohort studies that are making an important contribution to policy development. The *Longitudinal Study of Australian Children* (LSAC) has been running since 2004, and the satellite study – the *Longitudinal Study of Indigenous Children* (LSIC) – commenced in 2008. LSAC is Australia's most comprehensive birth cohort study. It follows two cohorts, one with children aged four to five years in 2004 and another of newborns from that year.

When first implemented, these Australian studies were innovative because they linked data collected via surveys with some existing government administrative records. This extended topic coverage and improved data quality. They also collected basic physical and cognitive information, along with activity data in time-use diaries. As Australia's only national longitudinal birth cohort dataset, LSAC is used extensively by researchers, policymakers and service providers for decision-making on family matters

But the children of LSAC and LSIC are growing up; the LSAC children now range in age from 10 to 15 years. LSAC and LSIC continue to be useful sources of information about the impact of social, economic and policy changes on the life outcomes of this cohort as they move through their teenage years and into early adulthood. However, Australia no longer has a national data resource to investigate the effect of early circumstances on later life outcomes for children born in Australia today, or the impact of current and future government policies and social changes on the next generation of young Australians.

Families who experience persistent disadvantage are largely invisible in Australia's existing birth cohort studies

Moreover, there are recognised limitations in the LSAC and LSIC study designs and opportunities for improvement in a new study. Our current birth cohort studies do not enable robust analysis of sub-populations that are now relevant to policy. This refers in particular to families who experience persistent social and economic disadvantage. These subgroups are largely invisible in Australia's current birth cohort studies because of sample size constraints, but are among the most at-risk and in need of help from changes to social policy. In the 2013-14 financial year, the Australian Government allocated $146 billion (or 35% of all its expenses) to social security, and this is projected to grow to $170 billion by the 2017-18 financial year. Australia does not have an appropriate longitudinal data resource that supports evidence-based policy to reduce the economic and social costs of disadvantage.

1.4 Australia risks falling behind international comparators

Other countries have moved ahead of Australia in terms of investing in new birth cohort studies to produce policy-relevant findings in areas such as child health and early childhood education.

The more established studies in the United Kingdom have informed new interventions that target their most at-risk children and achieve cost savings for government. The United Kingdom has repeatedly invested in new birth cohort studies (with at least five major studies funded since 1946), and demonstrated the intrinsic and ongoing value of the resulting evidence. The new studies have extended and enhanced those prior to it. The latest iteration, the *Life Study*, reflects international best practice in this area.

Consistent with other leading contemporary birth cohort studies, the United Kingdom's *Life Study*:

- involves a large sample of respondents
- collects pre-birth information and extensive biophysical data
- supports extensive data linkage with administrative records
- applies a family-impact approach, looking at the consequences of having children on the broader family unit and providing information on the influence of parents and broader social networks on outcomes for children.

We can apply learnings from the United Kingdom birth cohort studies, and others in New Zealand, France, Denmark and Norway, to design a new Australian birth cohort study. Such a study could

capitalise on the advances of science and technology that have occurred since LSAC and LSIC were first developed. The recommended *New Australian Birth Cohort Study* would produce comprehensive data to support Australia's future policymaking.

1.5 Now is the optimum time to introduce a new study

Investing in a new study now has the added value of maximising the value of the government's previous investments in LSAC and LSIC. LSAC, in particular, has ongoing value as a nationally representative study tracking the life outcomes of its respondents (now teenagers) as they move through the life course. It would be a missed opportunity not to invest in a new Australian study that follows on from LSAC and enables cross-cohort comparisons.

One-off national birth cohort studies decrease in value if there are no follow-up studies. If a new Australian study starts soon, the period of time between the beginning of LSAC and the introduction of a new study will facilitate comparisons across cohorts in Australia, as well as cross-national comparisons with relevant studies overseas.

One-off national birth cohort studies decrease in value if there are no follow-up studies

The ideal spacing between study children in a birth cohort is approximately 12 to 15 years. This means that key contextual factors do not change enough to render them too disparate for meaningful cross-cohort comparisons. Using new birth cohort data, we can identify similarities and differences between the LSAC children and the *New Australian Birth Cohort Study* children and pinpoint the impacts of national events, family circumstances, and policy interventions. Britain has the most developed suite of birth cohort studies, and there is approximately a 12-year interval between its recent cohorts.

When multiple cohorts are spaced appropriately, we can build a dataset that also supports cross-generational analysis. When cohort studies are two intervals apart (24–30 years), participants are drawn from a corresponding 'parent' generation and 'child' generation. The adjacent cohorts (12 to 15 years apart) provide important intermediary information in this context, enabling defensible conclusions to be made. The *New Australian Birth Cohort Study* thereby builds the important foundations for future cross-generation comparative studies.

1.6 The design features for a new innovative study are now possible in Australia

In order to achieve the optimum data from the *New Australian Birth Cohort Study*, Australia needs to apply the following seven core design principles.

1. Maintain **continuity** with previous Australian birth cohort studies and where applicable, leading overseas studies, in order to facilitate comparisons over time and across populations.
2. **Oversample** some of the key population subgroups, including the disadvantaged, to produce sound evidence about the life trajectories and life outcomes for groups of most interest to policy.
3. Collect vital **biophysical data** to provide evidence on the social and biological basis of disease and ill-health and inform preventive health measures that will deliver cost savings for government.
4. Facilitate **early-life measurement**, including the collection of prenatal and postnatal information that has been shown to predict future life outcomes.

5. Leverage policy value from existing administrative data through extensive **data linkage** to establish the most comprehensive information about growing up in Australia, and to reduce the burden of research for study participants, particularly for those from conventionally hard-to-reach groups.
6. Take a **family-impact approach** to capture the true complexity of the networks in and around Australian families, and in particular, disadvantaged families.
7. Exploit **new technologies** for data collection and communicating results in order to generate evidence more efficiently, minimise the attrition rate of study participants, and encourage broader engagement.

This report concludes that these seven design principles are viable for Australia and recommends they be included in a new Australian birth cohort study supported by the government.

1.7 A modernised Australian birth cohort study helps future-proof policymaking

Investing in the *New Australian Birth Cohort Study* contributes to future-proofing Australian policymaking. A new birth cohort study for Australia will enable policymakers to better understand the rapidly changing social realities influencing children's day-to-day lives. This will occur either by including new research questions on topics of emerging relevance, or by comparing the prevalence of certain situations with LSAC and other relevant studies.

Using the data from the *New Australian Birth Cohort Study*, Australia can build its capacity to answer critical questions and inform future health, economic and social policy. As examples, this report explains how a new study would provide the tools to make defensible determinations on:

- the nature and availability of income support, and other interventions, to increase economic participation and mitigate social and economic disadvantage
- preventive health measures to address childhood obesity
- the refinement of return-to-work interventions to achieve best effects for new mothers and their children
- standards and availability of childcare services and the role of the childcare rebate.

The possible applications of longitudinal birth cohort data are both extensive and relevant to contemporary policy concerns. By investing in the *New Australian Birth Cohort Study* now, the Australian Government will have a data resource that also has the potential to address a range of unknowns in the nation's future policy environment.

CHAPTER 2
Policy and research value of longitudinal birth cohort studies

2 POLICY AND RESEARCH VALUE OF LONGITUDINAL BIRTH COHORT STUDIES

KEY POINTS

- Birth cohort studies can provide the requisite evidence to evaluate policy and achieve savings for government by reducing the costs of maintaining policies that do not achieve intended effects, are inefficient and/or are no longer appropriate.
- By collecting information from the same individuals and their families on repeated occasions, a longitudinal birth cohort study can help policymakers overcome sensitive and complex policy challenges such as maximising social and economic participation and reducing disadvantage.
- The main advantages of the birth cohort approach are the standardisation effect of recruiting study children at the same point in life and the ability to follow their development over time. It is superior to the snapshots provided by cross-sectional survey design and the Census for understanding intractable social issues and developing policy.
- There are also opportunities to design birth cohort studies with large sample sizes that meaningfully represent critical sub-populations, such as those suffering persistent disadvantage, and link to existing administrative data to create a dataset that is cost-effective, efficient and powerful.
- Advances in large longitudinal birth cohort studies in terms of their design, underlying theory, and the range and rigour of data collected mean they are increasingly effective at providing an evidence base for informing policy. Australia is now poised to take advantage of these developments and position itself to provide effective and practical social policy solutions for the future.

A persistent policy challenge for the Australian Government is how to maximise the lifetime social wellbeing of all Australians by enhancing social and economic participation and reducing disadvantage. This is particularly challenging because there are many interdependencies and multiple causal effects. There is also limited public tolerance of policy solutions that fail in this domain (Head and Alford 2008). A longitudinal birth cohort study is the research approach best suited to tackling this policy challenge.

2.1 Longitudinal study design – an essential option for informing policy

Longitudinal birth cohort studies are widely recognised as the optimal research design for investigating a broad range of intractable social issues and for designing and testing related policy options and solutions. Data for a longitudinal study are collected using repeated observations of the *same* individuals over time and start at (or before) birth. This allows researchers to examine long-term phenomena.

The longitudinal data in a birth cohort help inform policy by:

- identifying change and persistence in people's living circumstances
- informing statistical techniques that unravel issues of cause and effect

- showing how experiences are inter-related over time and across different life domains, such as health, education and employment
- sequencing life events and life outcomes to identify where government investments would be most effective as preventive or remedial measures
- providing an evidence base to test and evaluate ideas, policies and programs, for instance by providing statistically generalisable control groups for comparison in trial interventions (FaHCSIA Research and Analysis Branch 2013).

In contrast to a longitudinal birth cohort study, a cross-sectional study collects only a snapshot of information from participants at one point in time, and if repeated (e.g. annually) uses *different* participants at each time point.

Due to this snapshot effect, cross-sectional surveys cannot:

- quantify changes at the level of the individual
- convincingly demonstrate cause-and-effect processes
- compare within-individual changes across populations and over time
- compare cause-and-effect processes across populations and over time
- quantify change or persistence in individual and population characteristics
- provide a comparative basis or control group for trial policy interventions that require before-and-after comparisons of outcomes.

A birth cohort study puts everybody on the same clock because participants are recruited at the same point in life: at birth

Longitudinal surveys do not have the limitations of cross-sectional surveys listed above. A birth cohort study puts everybody on the same clock because participants are recruited at the same point in their life: at birth. This standardises many aspects of historical and policy context, essentially controlling for them through the research design and ruling out invariant factors as causes of differences in outcomes for individuals and groups.

A large-scale birth cohort study has further advantages. These studies make it possible to incorporate adequate samples of small sub-populations that can then be used to conduct reliable statistical analysis. There is also an option to oversample specific sub-populations to further increase the power of the data for policy interest groups. Even in a large general population sample (such as the national *Household, Income and Labour Dynamics in Australia* survey) it is difficult to find enough respondents in a particular sub-population to address specific policy issues.

Why can this study not be achieved by using Census material?

The Census is an important whole-of-population survey, but its value to policymakers is limited because it is short, has disclosure controls, and its data collection is infrequent.

- The Census is designed to encourage broad participation, so the survey questionnaire supports only basic data collection. A well-designed longitudinal birth cohort study has scope for greater depth and granularity in the data collected.
- The Census has disclosure controls such that data can be reported only in the aggregate. A longitudinal birth cohort study obtains consent from respondents to develop a de-identified profile. This maintains respondent confidentiality but can be used to report at the level of the

individual and show how and why an individual changes over time.

- The Census occurs every five years. A longitudinal birth cohort study can be designed to support data collection at more frequent and flexible intervals. For example, longitudinal birth cohort studies typically have more frequent data collection in the early development years, which have been shown to be strong predictors of later life outcomes.

The new *Australian Census Longitudinal Dataset* brings together a 5% sample from the 2006 Census with corresponding records from the 2011 Census. This creates a research tool for exploring how Australian society is changing over time, but it does not achieve the same data outcomes as a longitudinal birth cohort study.

Why can this study not be solely based on our existing administrative data?

Administrative data sources are useful for collecting information from the population, and can be important in answering key questions. However, such data collections usually have a narrow focus, and the information they make available depends on pre-determined factors based on the purpose of the administrative register. This may not align with the focus of interest. For instance, Centrelink's administrative register will contain information about welfare benefits but not physical or psychological development.

When administrative data are combined with birth cohort data, we create an enriched dataset for research and policy at a relatively low cost and with high efficiency. This is achieved by combining the data regularly collected for administrative purposes and the survey questions from the birth cohort. This not only reduces the response burden of the birth cohort participants, but also creates a linked dataset capable of providing new and powerful information.

2.2 Life course theory – innovative and advanced research design

Longitudinal birth cohort studies are underpinned by life course theory. This approach to human development is widely accepted because it helps explain variations in health and wellbeing within and among populations and over time (Mayer 2009; US Department of Health and Human Services 2010). Life course theory has been used to examine and explain trends and issues in areas such as employment and unemployment, earnings, education, physical and mental health, psychological development, fertility, marriage, cohabitation, divorce, volunteering, social participation, crime, reliance on income support, social disadvantage, smoking, and obesity.

Life course theory is broadly concerned with two questions that relate to understanding how and why human capabilities develop, or fail to develop, in individuals, families and populations over time:

1. What factors influence the capacity of individuals and groups to reach or fail to reach their full potential? (US Department of Health and Human Services 2010)
2. Why do differences in outcomes persist between groups, even when many overall population and group measures suggest that lifetime wellbeing is improving?

The formation of human capability is vital to a successful and productive society. Human capability is a broader concept than human capital, with the latter referring only to the competencies and skills arising from education, training and experience that make individuals productive in the labour market. Human capability includes human capital in conjunction with social, cultural, psychological and

environmental capital as resources that individuals can draw upon in order to participate in and contribute to society (Sen 2003).

Figure 1 illustrates the science of life course theory. It shows the life course of a hypothetical individual and how the phases of their life (infancy, childhood, adolescence, and adulthood) occur within settings and institutions and reflect significant individual, national and global events.

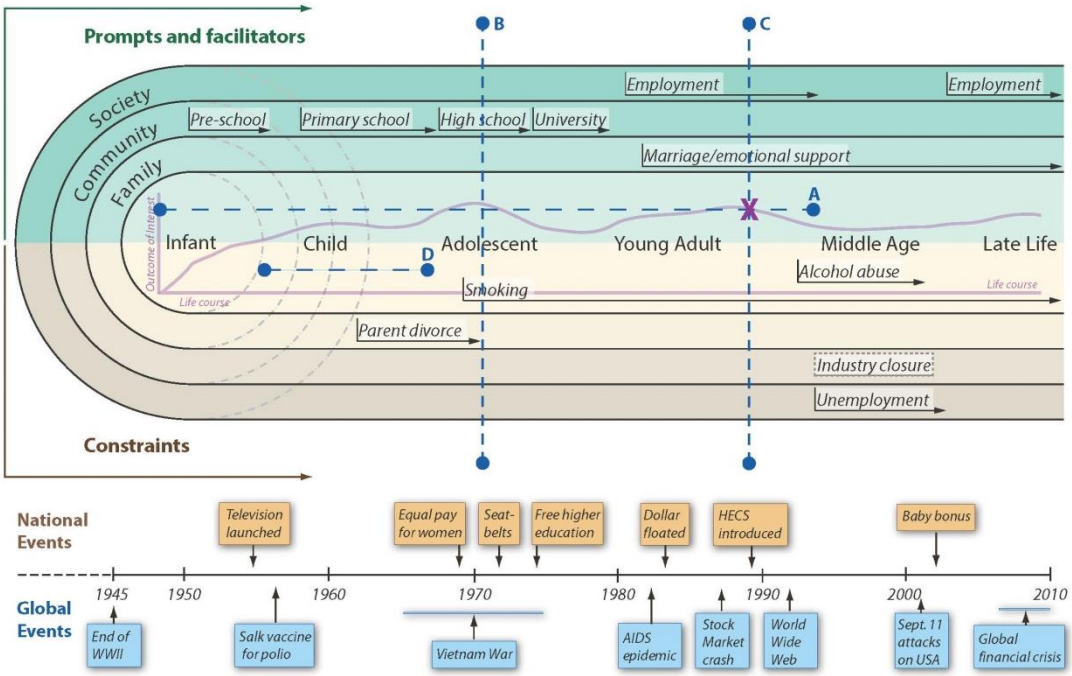


Figure 1: A hypothetical life course (from Zubrick et al. 2009)

The blue dashed lines in Figure 1 represent different research designs. Line A is a study design that starts at birth and tracks the life course of an individual over time (a longitudinal birth cohort study). Lines B and C are snapshots taken during adolescence and adulthood respectively (cross-sectional studies), and line D is a shorter longitudinal study that starts in early childhood and finishes before adolescence. These designs have strengths and weaknesses but only the birth cohort study takes the comprehensive long view of the life course.

Using life course theory for policy requires longitudinal studies that follow individuals and groups over time, map different social domains (such as health, education, employment, and family circumstances), and recognise and measure the individual and collective factors and contexts within which our lives play out. A life course approach can accommodate scientific and theoretical approaches from disciplines such as economics, sociology, psychology, population health and criminology and is compatible with a wide range of research methods. Because of their potential to advance policy and knowledge in a broad range of policy areas, longitudinal life course studies have been described as the gold standard research design (Mayer 2009) and as the most innovative and advanced approach in the social sciences (Butz and Torrey 2006).

2.3 Longitudinal birth cohort studies – the evidence base for policymaking

Large-scale longitudinal birth cohort studies incorporate tens of thousands of lives to enable comparisons across even those relatively small sub-populations that are significant for policy.

Modern birth cohort studies are also increasingly designed to address the needs of policy by incorporating:

- new kinds of information from biological and medical records and readings
- direct assessments of physical activity
- government administrative data in areas such as health, education, social welfare, employment, income and criminal justice.

When combined with detailed longitudinal questionnaire data, birth cohort studies provide a comprehensive evidence base for practical policy development and evaluation.

The design features of longitudinal birth cohort studies vary based on study purpose and conditions of implementation. Table 1 gives an indication of the scope and variation in longitudinal birth cohort studies for policymaking.

Table 1: Variation in longitudinal birth cohort study parameters

Study parameters	Small studies (~100)	Large studies (~100 000)
Sampling of births	probabilistic (random)	random or non-random (e.g. all births occurring during a particular time period at a particular hospital or birthing centre)
Information collected	typically from birth child only	from the birth child and their parents, carers and/or siblings
Focus	narrow (specific health condition or behaviour)	wide (e.g. include information relating to health, physical and psychological development, education, and social factors)
Time frame	usually short-term or discrete duration but occasionally open-ended	indefinite or open-ended life (follow participants from birth to late adulthood)
Data sources	often questionnaires only, or questionnaires with medical, physical and cognitive assessments	combine information from sources such as questionnaires, medical and physical assessments, cognitive assessments, biological collections of materials (e.g. blood, saliva, urine, genetic screening), and government administrative records (e.g. health, education, crime, and/or income support and social welfare)

Internationally, large-scale, broadly focused birth cohort studies are increasingly recognised as critical tools for policy development (Bynner et al. 2007; Bynner and Joshi 2007). Countries invest in birth cohort studies because:

- the economic and social benefits of birth cohort studies exceed the costs, including the costs of maintaining policies that:
    - do not achieve intended effects
    - are not cost-efficient
    - are no longer appropriate given prevailing social and economic circumstances.
- they incorporate a generally accepted conceptual framework for human development and lifetime wellbeing that is based on the life course and is scientifically defensible
- they use life course theory to develop the evidence base for policy in a very wide range of nationally significant areas such as health, lifetime wellbeing, employment and education
- evidence-based policy can lead to success in terms of improved population outcomes and alignment with national priorities

Longitudinal birth cohort studies provide an evidence base for effective and practical policy for a range of reasons that include:

- providing data on prenatal and cross-generational experiences that are known to matter for lifetime wellbeing (exposure in utero, parental health, poverty and family dynamics)
- isolating particular periods in the life course (foetal development, early childhood, adolescence, early adulthood) that are especially sensitive to events and experiences (positive and negative) and to interventions
- identifying the cumulative effects of adverse events and experiences that can indirectly affect other behaviours and life outcomes
- specifying the nature and effect of protective factors that improve life outcomes (such as individual behaviours, appropriate health and social services, supportive family circumstances, economic security, participation in quality employment)
- determining the risk factors that compromise life outcomes (such as food insecurity, homelessness, unsafe communities, domestic violence, poor mental health) (US Department of Health and Human Services 2010).

IMPACT CASE STUDY 1: Birth cohort studies and life course theory for health policy

Recent decades have seen an increasing and international shift away from cross-sectional studies in public health research and towards large-scale birth cohort studies. Findings from birth cohort studies can answer questions beyond simple associations between risk factors and adverse health outcomes. They can identify complex causal pathways for disease and provide the detailed evidence base needed for the development of health policy and preventive health strategies (Ben-Shlomo et al. 2013).

Birth cohort studies adopt an inherently multidisciplinary approach to identify the effects that biological (including genetic), environmental and social exposures during gestation, childhood, adolescence, early adulthood and across generations have on health and health-related outcomes (Kuh and Davey-Smith 1993). They emphasise the role of the timing of exposures and aim to understand how both risk and protective factors act independently, cumulatively and interactively across our lives.

In the early 1980s, several studies related poor prenatal growth – as measured using the proxy of low birth weight – to increased risk of chronic disease in adulthood, including cardiovascular disease and diabetes (Barker 1998). Formulated as the *foetal origins hypothesis*, it accelerated recognition of the first years of life as a critical period for the trajectory of healthy child development and later life outcomes (Power et al. 2013). From further evidence, we now know the importance of the nurturant qualities of the environments where children grow up through to early adulthood. These include the effects of maternal mental and physical health; appropriate child and maternal nutrition; as well as socioeconomic factors such as income, familial stressors, housing conditions, and neighbourhood quality (Irwin et al. 2007; Maggi et al. 2010; Marmot et al. 2010).

Longitudinal birth cohort studies can find evidence to guide the optimal timing, targeting, and type of health policies. In other words, findings can help detect if there is a time window during development, at-risk groups of children, or an ideal context (such as the familial or school environment) where a preventive health intervention is likely to have the most impact. This is vital in achieving cost savings and efficiency for governments and improving population health.

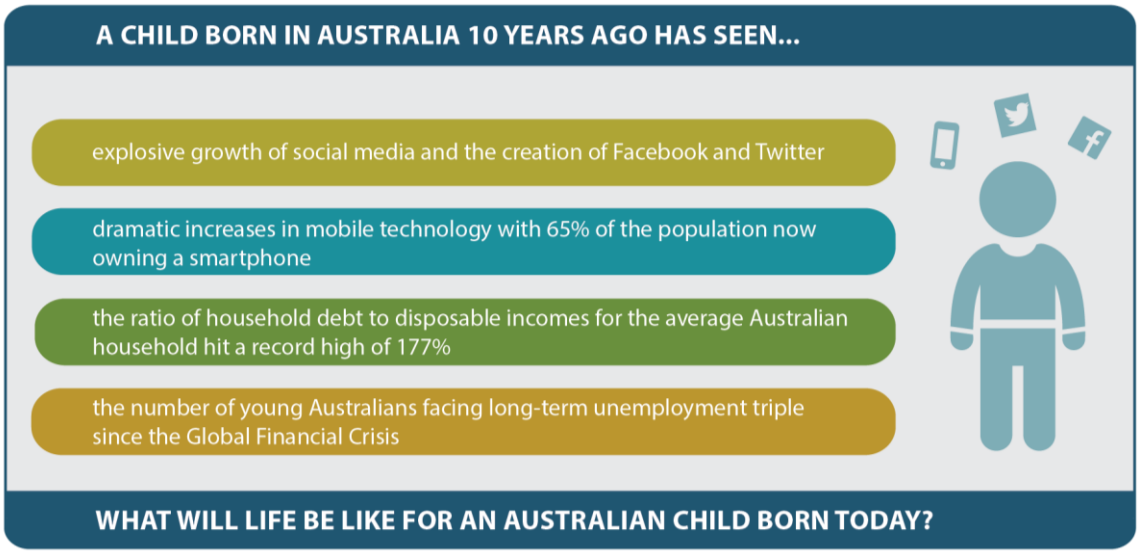
CHAPTER 3
Australia's birth cohort studies

3 AUSTRALIA'S BIRTH COHORT STUDIES

KEY POINTS

- Australia's current national birth cohort studies are *Growing Up in Australia: The Longitudinal Study of Australian Children* (LSAC) and *Footprints in Time: The Longitudinal Study of Indigenous Children* (LSIC). These are relatively small longitudinal birth cohort studies that have nonetheless been useful in informing public policy.
- There is a lot of value in LSAC, as demonstrated by its widely used study data. LSAC was designed to follow contemporary good practice in birth cohort study design 10 years ago. Its innovative features include data linkage with some administrative records and collecting basic physical and cognitive information.
- LSAC has immense worth in tracking the life trajectories of children in its current cohorts aged 10 to 15 years, but it has diminishing relevance for the next generation of Australian children.
- There are methodological limitations in LSAC's study design (small sample size, differing age of entry for study children, limited measurement of early-life factors) and it is now dated by international standards.
- LSIC was intended to be a supplementary data resource on Indigenous Australian children, a subgroup of particular policy interest. However, it cannot be used to compare life pathways and outcomes of Indigenous Australian children with those of other population groups.
- Australia would benefit from a new Australian birth cohort study to provide a robust longitudinal data resource about growing up in Australia today, and a sampling strategy that includes disadvantaged sub-populations within a single study.

LSAC and LSIC generate evidence for policymakers, organisations, service providers and other professionals concerned about children and their wellbeing. The children in LSAC, Australia's most comprehensive birth cohort study, are now aged 10 to 15 years. This makes our current birth cohort studies a valuable resource in understanding children born early in the new millennium but leaves it increasingly dated in relation to the experiences of Australian children born today.



3.1 Growing Up in Australia: The Longitudinal Study of Australian Children

LSAC is Australia's first and current national longitudinal birth cohort study. The study emerged in a rapidly changing demographic, social and economic Australian landscape. It filled the need for robust and representative data that could provide "further understanding of child development, inform social policy debate, and be used to identify opportunities for intervention and prevention strategies in policy areas concerning children and their families" (AIFS 2013).

LSAC was originally funded by the Australian Government via the Department of Social Services (formerly the Department of Families, Housing, Community Services and Indigenous Affairs) in the 2000-01 Budget. The initial allocation was $20.2 million for the first nine years (Sanson et al. 2002), and continuing funding for the study is around $7.8 million per year. Data is collected in biennial waves. These are two-year time points at which respondents are observed and new information is collected. Wave 1 of data collection occurred in 2004; wave 6 of the study is currently in the field (2014).

3.1.1 LSAC uses a range of data collection methods

The LSAC questionnaire was initially designed to answer seven broad research questions:

1. How do Australian children rate on a number of key developmental outcomes?
2. What are the life pathway markers, early indicators, or constellations of behaviours that are related to different child outcomes?
3. How are child outcomes interlinked with their wider circumstances and environment?
4. In what ways do the features of a child's environment (such as families, communities and institutions) impact on the child outcomes?
5. What helps maintain an effective life pathway, or change one that is not promising?
6. How is a child's potential maximised to achieve positive outcomes for children, their families and society?
7. What role can the government play in achieving these outcomes?

These questions were revised in 2008 to ensure that study waves 4 to 7 (2010-16) measured developmental factors and circumstances relevant to study children moving into adolescence. LSAC gathers information on: family demographics; housing; household finances; parental work status; social capital; child health status; parental health status; parenting practices; childcare; home environment; and child development measures including health behaviour, risk factors, and cognitive, social and emotional outcomes (AIFS 2013).

LSAC collects information via survey questionnaire and other modes from several informants: the study child, the study child's parents (Parent 1 and Parent 2 and/or the non-resident parent – referred to as Parent Living Elsewhere), and a teacher or childcare worker (for children who attend a school or day-care centre). Parent 1 is usually the parent with the best knowledge on the study child (most often, the biological mother). Parent 2 is typically Parent 1's partner or another adult living in the home with a parental relationship to the study child (AIFS 2013).

LSAC incorporates direct cognitive and physical assessments of the study child. The cognitive testing used is:

- the Who am I? assessment tool
- the Peabody Picture Vocabulary Test

- the Matrix Reasoning Test from the Wechsler Intelligence Scale for Children
- Executive Functioning (wave 6 only).

During visits to the child's home, LSAC interviewers collect physical measurements of the study child's weight, height, girth, body fat, head circumference and blood pressure. These are basic anthropometric data.

LSAC also uses a time-use diary that documents a child's activities and context based on the 96 x 15-minute intervals occurring on the day before an interview. The diary documents:

- the type of day (weekday, weekend, holiday etc.)
- the domain of each activity (leisure, sleep, personal care, travel etc.)
- the location of each activity (own home, somebody else's home, daycare centre etc.)
- who was caring for the child
- any cost incurred from activities and how it was paid for (see Baxter 2007 and Mullan 2014 for further details).

LSAC was designed to follow good practice in birth cohort study design and drew upon successful international studies (Sanson et al. 2002). Since it started, advances in birth cohort design include more effective ways to link administrative information to survey datasets and collect important health and developmental information (see section 4). This means that many elements of LSAC's design are now 10 years behind best practice.

3.1.2 LSAC's sample size is small

LSAC features an accelerated cross-sequential design involving longitudinal collection of two birth cohorts, adjacent in age. It accelerates data capture for a given age span by combining information from the two cohorts. In LSAC, the first cohort comprises children aged 0 to 1 year in 2004 (cohort B for baby) and the second cohort includes children aged 4 to 5 years in 2004 (cohort K for kindergarten). The age spacing of the cohorts means that after the first five years of study, a full dataset was available on Australian children ranging in age from birth to 10 years. Despite this, there are also clear methodological limitations to this approach, including the small sample sizes that occur as a result.

LSAC features are not conducive to robust analyses of children who experience persistent disadvantage

The analytical sample size for LSAC was 10 090 children in the first wave of the survey (5107 from cohort B and 4983 from cohort K) (AIFS 2013). This is a relatively small sample size and restricts analyses of sub-populations of interest. Contemporary studies include up to 100 000 respondents. The already small sample is further reduced by the two-cohort approach, resulting in each cohort having around 5000 respondents only.

Of most concern is that the study features are not conducive to robust analyses of children who experience deep and/or persistent social and economic disadvantage, as they constitute a very small fraction of the Australian population (McLachlan et al. 2013) and a negligible share of LSAC respondents. The same issue applies to children from Aboriginal and Torres Strait Islander backgrounds. This is an important limitation, as these subgroups comprise some of the most vulnerable Australians, and those who are in most need of attention from policymakers.

3.1.3 LSAC's sampling strategy leads to some data limitations

The study also has some limitations with regard to its sampling strategy. LSAC's sample was designed to represent Australian children born between March 2003 and February 2004 (cohort B) and between March 1999 and February 2000 (cohort K), with the exception of children living in some remote areas. The Medicare Australia enrolment administrative database was used as the sampling frame for selecting children to participate in LSAC. There are inherent challenges in using Medicare records as a sampling frame. One challenge is that it excludes a number of permanent and non-permanent Australian residents who do not qualify or do not use Medicare, but who are nevertheless of interest to policymakers. Moreover enrolment in Medicare can potentially be delayed because it requires a valid birth registration. Evidence from the Childhood Immunisation Register points to a lag-time in registration, with around 80% of children registered on Medicare by 2 months of age, and 98% enrolled by 12 months of age (Hull et al. 2001). Excluding non-qualifying or inactive Australian residents and those who delay registering the birth undermines the representativeness of the study if these groups are of specific policy interest.

The study used a two-stage clustered sampling strategy, which first randomly selected postcodes and then randomly selected children in these postcodes using Medicare records. LSAC used complex stratification techniques to try to maximise geographical representation. All postcodes were first grouped by state and by number of eligible children, and 311 postcodes were then randomly selected from these strata. Children from cohorts B and K were randomly selected from the same 311 postcodes and had approximately 1 in 25 probability of selection.

This strategy had practical advantages. It reduced the cost of data collection as study respondents were clustered geographically and therefore required fewer interviewers and less travel time. In addition, the clustered sampling design meant that community effects could be examined because the respondents lived in concentrated areas.

The disadvantages of any clustered sampling strategy are that geographical clustering may diminish the representativeness of the sample if some regions are not included. LSAC's usefulness for policy is weakened if the clustering systematically excludes geographical areas that are related to variables of interest (such as remote areas which may also be highly disadvantaged). In the case of LSAC, those postcodes that had fewer than 20 children registered for Medicare at wave 1 were excluded from selection into the study, as were some remote postcodes. Although these exclusions do not substantially compromise the quality of the LSAC sample, clustered sampling carries a risk of unrepresentativeness. Clustered sampling also assumes that the geographical unit (postcodes in the case of LSAC) is internally heterogeneous on key variables such as socio-demographics. Postcodes will vary in this regard.

3.1.4 LSAC misses important early life data

LSAC lacks several informative and important prenatal, postnatal and early-life measurements which are recognised as important drivers of subsequent life outcomes (Lynch and Smith 2005) (see also sections 5.3 and 5.4). Furthermore, data collection every two years equates to a long period in an infant's life during which no data are collected; this misses developmental and circumstantial changes.

Ultimately, each LSAC cohort also includes children with age differences of several months to more than one year. Some age variability within a cohort is desirable to ensure all birth months are included, but age differences greater than one year introduce new sources of variation (e.g. physical and psychological maturation and development), which make it harder to identify causal effects. Large age differences are particularly consequential at certain periods in the life course when

children are developing very rapidly, such as infancy. Here differences of a few months or a year in the ages of the children can be associated with pronounced developmental differences. In addition, larger age differences mean that children are exposed to different contexts and policies which can also confound causal analyses. For example, different family policies may have been operating at the time of the birth or conception of children.

Age differences can be controlled using statistical methods but it is better to control them through the research design by having only limited age differences within the cohort. Controlling age variation through the research design eliminates at the study outset age-related individual and contextual factors which could confound causal analyses. This makes it easier to detect causal effects and minimises the risk that researchers and policy makers will misattribute age-related differences to other factors.

LSAC is recognised for its pioneering use of data linkage

3.1.5 LSAC has good respondent retention

Respondent retention is essential to ensuring the value of longitudinal studies because no new individuals enter the study when others stop participating, and it is even more important in a small longitudinal study such as LSAC. Respondent retention in LSAC has been relatively good. In 2004, 10 090 of the 18 800 invited families agreed to participate. This constitutes a response rate of 54% for wave 1 (AIFS 2013), which is low but consistent with expectations of 40 to 60% based on other longitudinal birth cohort studies. Analyses of the patterns of non-response lead to adjustments to the survey weights, so that non-response bias could be managed to some extent (see AIFS 2013). Since then, respondent retention rates for LSAC have been relatively good compared with international cohort studies: 89.9% of wave 1 respondents were retained in wave 2 of which 86.4% were retained by wave 3. By wave 4 the figure was 83.3%, and this remained relatively high at 79.7% by wave 5 (AIFS 2013).

3.1.6 Innovative use of data linkage has improved analytical opportunities

LSAC is recognised as innovative for its pioneering use of data linkage in birth cohort studies in Australia. To broaden the scope of the study and enhance its analytical opportunities, the LSAC data file has been linked to several administrative databases, and includes data from:

- the National Assessment Program – Literacy and Numeracy (NAPLAN) (NAPLAN test scores, test absences and whether the study child repeated a year level)
- Medicare Australia (medical and pharmaceutical benefit claims and immunisation records)
- the National Childcare Accreditation Council (the accreditation and quality of the day-care centre attended by the study child)
- the Australian Bureau of Statistics (ABS) Census of Population and Housing (derived information on neighbourhood characteristics, such as the Socio-Economic Index for Areas or percentages of people or households with certain characteristics).

These linkages have greatly improved the opportunities to analyse LSAC data (Edwards 2012). For example, linking Medicare Australia data to the LSAC database has been used to estimate the cost of special healthcare needs by Australian children, at both the individual and population level (Quach et al. 2014). Linking NAPLAN numeracy scores of LSAC children to LSAC data of their parental occupation shows a gradient in children's test scores that relates to the quality and status of their parents' occupations (Edwards 2012). It follows that additional data linkage (including links to Department of Human Services' welfare data) would further enhance the scope and value of LSAC to policymaking.

3.1.7 Uptake by policymakers and other end users has been extensive

LSAC study data have been used extensively. At the end of the 2011–12 financial year, there were over 600 LSAC registered data users (DSS 2013) and 107 institutions had obtained an organisational licence for data access. Over the past two years, LSAC data were used in 17 government reports, 104 academic articles, and 94 conference presentations (DSS 2013 and DSS 2014a). To date, the study name has been mentioned in 984 academic publications within the Google Scholar repository, and in 267 articles from Australian news providers in the Factiva database (excluding duplicates, and searched on 26 June 2014). This is likely to be an underestimate as many publications may not mention the study name.

IMPACT CASE STUDY 2: LSAC data informing government policy in Australia

In the government-commissioned report on paid parental leave (Productivity Commission 2009), the analytical opportunities of LSAC enabled the Productivity Commission to make very specific recommendations to the Australian Government on how to efficiently and cost-effectively improve support for parents with newborn children. Recommendations included developing a parental leave scheme that was taxpayer-funded and provided postnatal leave for 18 weeks to be shared by eligible parents at the adult federal minimum wage.

These inferences were possible due to LSAC's uniqueness as a source of longitudinal data on:

- the availability and use of parental leave at the time of a child's birth
- breastfeeding practices
- parental employment patterns as a child grows older
- reasons why women return to work earlier than preferred
- work-life balance.

The richness of LSAC data also enabled the Productivity Commission to produce counterfactuals on the costs and returns of potential courses of action for the new parental leave scheme.

3.1.8 LSAC has important strengths and some design limitations

LSAC is the first significant national birth cohort study in Australia and was innovative for its time. It filled an important data shortfall on child development in Australia and will continue to produce vital longitudinal data on a generation of Australian children born 10 to 15 years ago.

LSAC's key strengths:

- Basic cognitive and physical measures and activity data from time-use diaries are integrated.
- Data linkage is being pioneered in birth cohort studies in Australia by merging the dataset to several administrative data sources at the individual and aggregate level.
- Data are being prolifically used by researchers and policymakers and in public commentary.

Australia's national capacity in longitudinal research has improved over the past 10 years since the introduction of LSAC, due in part to Australian Government investment in longitudinal data as well as methodological and analytical advances in research practice. This means we better understand the limitations of LSAC and can identify opportunities for study improvement.

LSAC's main limitations

- Medicare records are used as a single sampling frame which excludes some policy groups of interest and creates a variable lag-time between birth and involvement in the study.
- There is significant variation in the ages of children within each birth cohort, especially cohort B (aged between 3 and 17 months at wave 1). The ideal is to collect data on children born in every month in a 12-month period. The age variation in LSAC means that the study's design does not sufficiently control for contextual factors or age-related individual differences, and this can compromise causal analyses.
- Children enter the survey at a relatively late age, including the youngest cohort. This reduces the amount of early-life data which is a foundation for informing later life outcomes.
- The sample size is sub-optimal at 5000 in each cohort. This means that key sub-populations of policy interest are largely invisible in Australia's current major national birth cohort study.

3.2 Footprints in Time: The Longitudinal Study of Indigenous Children

LSIC is a supplementary birth cohort study to LSAC. It commenced in 2008 in recognition of LSAC's limited data collection from Indigenous Australian children. LSAC contains information from only 417 children from an Indigenous background, and this sample is too small for robust analysis of this sub-population (Dodson et al. 2012).

LSIC was the first longitudinal survey to indefinitely track Indigenous children and their families

Given that Indigenous Australians are more likely than non-Indigenous Australians to live in remote areas and that LSAC did not cover such areas, the Indigenous subsample of LSAC is less representative of Indigenous than non-Indigenous children. There are also important differences in the cultural and social circumstances of Indigenous Australians. These differences can hamper data quality if culturally inappropriate data collection instruments are used, which in turn would limit the study's potential to inform evidence-based policy planning. Consequently, LSIC uses tailored data collection tools and methods to engage respondents.

LSIC is also funded by the Australian Government via the Department of Social Services. Funding for the initial phases of the project was granted in the 2003-04 Budget, and for its first four annual waves in the 2007-08 Budget (DSS 2014b). This amounts to about $3 million per year. Ongoing funding for the study is secured until it is no longer viable due to sample attrition (DSS 2014b).

3.2.1 LSIC is innovative for its focus on Indigenous children

LSIC was the first longitudinal survey to indefinitely track Indigenous children and their families, and constituted a timely addition to the Australian data library.

Unlike LSAC's biennial data collection practices, LSIC has collected data annually for five years, commencing in 2008. Fieldwork for data wave 6 (2013) has been completed and is being prepared for public release. Data are currently being collected for wave 7. This process uses a combination of face-to-face interviews, telephone interviews and self-complete questionnaires (DSS 2014b).

LSIC uses an accelerated cross-sequential design following two child cohorts, similar to that described for LSAC. The first cohort comprised children aged 6 to 18 months in 2008 (cohort B); and the second, children aged 3½ years to 5 years in 2008 (cohort K). As a result, we have data on Indigenous child development and life outcomes from age 6 months to 11 years, but the study suffers

from the same methodological shortcomings as LSAC in this regard: large variation in the ages of cohort K children and limited early-life data.

3.2.2 LSIC's design has been tailored to Indigenous children

The content of LSIC is designed to answer five key research questions of specific relevance to Indigenous children and their families (DSS 2014b). These are:

1. What do Aboriginal and Torres Strait Islander children need to have the best start in life?
2. What helps Aboriginal and Torres Strait Islander children stay on track or become healthier, more positive and strong?
3. How are Aboriginal and Torres Strait Islander children raised?
4. What is the importance of family, extended family and community in the early years of life and when growing up?
5. How can services and other types of support make a difference to the lives of Aboriginal and Torres Strait Islander children?

To answer these questions, the LSIC questionnaire gathers information on: household composition; the health of the study children and their parents; how the child and family function; and relevant socio-demographic characteristics (DSS 2014b).

Similar to LSAC, LSIC collects information provided by several different informants: the study child, the study child's parents (Parent 1 and Parent 2), and a teacher or childcare worker. Due to low response rates, information from Parent 2 was not collected in wave 3. In wave 4, Parent 2 information was collected only from 'Dads', defined as biological fathers or other men performing a father-like role in the study child's life (DSS 2014b).

LSIC also incorporates direct cognitive and physical assessments of the study child. Cognitive testing in LSIC used the:

- Who am I? Assessment Tool
- Renfrew Word Finding Vocabulary Test
- PAT-R Progressive Achievement Tests in Reading
- Matrix Reasoning Test from the Wechsler Intelligence Scale for Children.

LSIC also collected physical measurements of the study child's weight and height, but fewer anthropometric data were collected than for LSAC.

Collecting qualitative data via free-text responses to open-ended questions is an innovative, though relatively unused, feature of LSIC. These questions relate to diverse topics such as recent major life events; parental views on fatherhood, racism and discrimination; Indigenous culture, values and community life; as well as the study child's use of time, bed-time routine or experience of school bullying. Additionally, LSIC children completed a task asking them to draw pictures of their house and family. The resulting data are important in terms of the worldviews and perceptions of Indigenous children and their families.

3.2.3 The practical sampling strategy is non-representative

A key difference between LSIC and LSAC is that LSIC features a non-random sampling design. Its purposive sampling design is not probabilistic; that is, the probability of selection into the sample for each child is unknown. This sampling design was implemented because a representative sample of

the Indigenous Australian child population would be too costly as they comprise only a small fraction of the total Australian child population (around 5%, FaHCSIA 2009) and the remote and widely dispersed area across which many live. Purposive sampling enables broad coverage at a reasonable cost.

LSIC data are collected from 11 sites within urban, regional and remote areas that reflect the range of environments where Aboriginal and Torres Strait Islander Australians live. Medicare and Centrelink records were used as a sampling frame to locate houses with eligible children within these sites. Children were also recruited through word-of-mouth and by recommendation from local families and key informants (DSS 2014b).

The final analytical sample size was 1687 children in wave 1 (960 from Cohort B and 727 from Cohort K) (FaHCSIA 2009). This is a fairly large share (between 5% and 10%) of the total population of Indigenous Australian children at the relevant ages (Dodson et al. 2012). Nonetheless, with about 800 children per age cohort, the sample size is much lower than other national and international studies with similar goals and scope.

This non-representativeness of the Aboriginal and Torres Strait Islander population in LSIC and the small size of the sample mean that its findings need to be used with caution if informing evidence-based policy planning. LSIC data say a lot about the developmental pathways of Indigenous Australian children, but cannot be used to explain gaps between Indigenous and non-Indigenous children and how they have developed over time.

Significant efforts went into designing LSIC to ensure that survey practices and content were culturally appropriate

3.2.4 Data collection is sensitive to Indigenous cultural practices but has attrition

Significant efforts went into designing LSIC to ensure that survey practices and content were applicable, relevant and user-friendly for different Indigenous sub-populations. Although this is culturally appropriate, it limits the possibility of comparing outcomes of Indigenous children with non-Indigenous children in the Australian population.

There were anticipated difficulties in retaining study respondents, given evidence suggesting that Indigenous Australians:

- have high rates of residential mobility
- have low average socio-economic status
- display symptoms of survey fatigue due to intensive research in their communities
- are more likely to mistrust survey research (Perales et al. 2014).

LSIC's initial retention rate was reasonably high with 86.6% of the total respondents participating in wave 1 being retained in wave 2. This is higher than most previous social surveys of Indigenous populations and more than originally anticipated. However, participants began dropping out of the study at a faster rate thereafter: 79.8% of the total respondents participating in wave 1 were retained by wave 3, and just 73% were retained by wave 4 (Kneebone et al. 2012). These retention rates are higher than those for the Indigenous subsample of LSAC (Biddle 2014), but much lower than for the whole of the LSAC study. This was despite face-to-face contact with study respondents being more frequent in LSIC (yearly) than in LSAC (biennially). In a small study such as LSIC, respondent drop-out can quickly lead to a sample size that is no longer of value to policymakers. This is a real risk to the ongoing viability of LSIC over time.

3.2.5 Linking broadens the scope and value of the data

LSIC has some in-built added-value features, such as linkage to information on the Australian Early Development Census, a 2009 nationwide assessment of children's development on physical health and wellbeing, social competence, emotional maturity, language and cognitive skills, communication skills and general knowledge.

Linkage at the aggregate level was done by postcode of residence, and is projected for the individual level. At the aggregate level, linked variables contain information on, for example, the average neighbourhood Australian Early Development Census scores and the proportion of 'developmentally vulnerable' children in the neighbourhood. At the individual level, linked variables will contain information on the study child's overall and domain scores (DSS 2014b).

The regions in which LSIC respondents live are also linked to an index of remoteness according to their Level of Relative Isolation (De Maio et al. 2005) and to an Index of Relative Indigenous Socio-Economic Outcomes (Biddle 2011). A linkage of LSIC to NAPLAN data is projected.

3.2.6 Uptake by policymakers and other end users has been limited

LSIC has been used relatively little. By 2014, there were 190 LSIC-registered data users, with 28 institutions having signed for an organisational licence. By 30 June 2014, LSIC data had been used in 9 academic articles, 17 conference presentations, and 13 discussion papers. To date, the study name has been mentioned in 113 academic publications within the Google Scholar repository, and in 14 news articles from Australian news providers in the Factiva database (excluding duplicates, and searched on 26 June 2014).

3.2.7 LSIC is an important resource with limitations that need to be taken in context

LSIC is unique as a targeted longitudinal data resource for collecting information on Aboriginal and Torres Strait Islander children in Australia.

LSIC's key strengths

- The survey design is tailored to the Aboriginal and Torres Strait Islander sub-population.
- Linkages to administrative records (both completed and projected) add value to the survey data.
- Annual data collection enables more precise and timely assessments of persistence and change in the characteristics and circumstances of the study children and their families.

LSAC and LSIC data were collected separately and direct comparisons cannot be made between them

Most of LSIC's limitations must be taken in context, given the limited funding available and the extra challenges involved in conducting this type of satellite study. For instance, relative to non-Indigenous Australians, Indigenous Australians are more geographically mobile, tend to live across households, and display more democratic practices concerning parenting and childrearing (De Vaus 2004). They are also more likely to experience socio-economic deprivation and are substantially less proficient in written and verbal English language (Gray 2006). These traits make longitudinal, household-based survey data collection difficult (Lynn 2009). Additionally, distinctive cultural norms and values operate in Aboriginal and Torres Strait Islander communities in Australia. This means that applying the same data collection instruments to Indigenous and non-Indigenous Australians is problematic and can hamper data quality (Perales et al. 2014).

In light of the above, having a separate study for Indigenous Australian children enables analyses of outcomes for this population. However, LSIC and LSAC data were collected separately using different approaches, and this prevents direct comparisons between Indigenous and non-Indigenous children.

LSIC's key limitations

- Non-probabilistic methods are used to gather the study sample and so LSIC respondents are not representative of the broader Aboriginal and Torres Strait Islander population.
- The sample size is comparatively small and there is a relatively high attrition rate.
- There is diversity in the ages of children within birth cohorts, and this is even more problematic for LSIC than LSAC given the wider age ranges included in both its cohorts.
- Compared to LSAC, administrative data linkages and direct cognitive and physical study child assessments are fewer and sometimes less detailed.

CHAPTER 4
Leading international birth cohort studies

4 LEADING INTERNATIONAL BIRTH COHORT STUDIES

KEY POINTS

- In Australia, LSAC follows two cohorts of approximately 5000 children and their families, and LSIC collects data from two cohorts of 800 Aboriginal and Torres Strait Islander children.
- Leading international birth cohort studies are typically greater than 15 000 respondents per cohort and oversample subgroups of interest. This results in enhanced capacity to produce valid findings on special interest groups, study rare outcomes, and take advantage of new methodologies and designs that require larger sample sizes.
- International birth cohort studies have made significant advances in the breadth of data collected (medical and biological assessments, physical activity monitoring, genetic screening, cognitive and psychological assessment, and multiple forms of linked administrative data). These studies can inform policymaking in a broader range of areas and with greater depth and clarity.
- There is also value in an integrated national system of sequential cohort studies, as shown in the United Kingdom. It has a national longitudinal databank dating back to 1946 and supports national cross-generational comparisons across five birth cohorts.

Since the emergence of the Australian birth cohort studies, several new birth cohort studies with state-of-the-art design features have been launched (or are about to be launched) in a number of developed countries. Design features that were not implemented in LSAC and/or LSIC have proven successful in new or existing birth cohort studies in other countries. Features of key recent birth cohort studies from countries with institutional frameworks similar to those in Australia demonstrate the possibilities for a new study here.

4.1 International birth cohort studies provide new insights

The United Kingdom has arguably the most developed suite of large-scale national longitudinal birth cohort studies that follow representative samples from birth through adulthood. The first of these ongoing studies started in 1946; new ones began in 1958, 1970, 2000 and 2014. New Zealand, Canada, France, the United States and some Scandinavian and European countries have similar studies (Bynner and Joshi 2007) that started later than in the United Kingdom. The value of birth cohort studies is reflected in this breadth of use by developed nations but some studies are more important for their scientific merit and relevance to the Australian policy context.

Sequential large-scale birth cohort studies create opportunities to map social change using cross-cohort comparisons

For the purpose of assessing the case for a new Australian birth cohort study, we conducted an audit of all longitudinal birth cohort studies with the following parameters:

- greater than 10 000 participants for sufficient statistical power
- recent commencement (since 2000)

- relevant scope
- unlimited duration
- undertaken in countries that are relevant comparators for Australia.

The audit included relevant longitudinal birth cohort studies that:

- use either probabilistic or non-random selection processes
- collect information from the birth children only or the birth children and their parents, carers and/or siblings
- use questionnaires only or combine information from multiple data sources.

Information on the studies was largely sourced from two birth cohort inventories: birthcohorts.net and *Cohort and Longitudinal Studies Enhancement Resources* (CLOSER).

We identified the United Kingdom's *Millennium Cohort Study* and *Life Study*, and the *French Longitudinal Study of Children* as best practice and most relevant to consideration about the case for a new Australian birth cohort study, as they met all specified audit criteria. These studies extend and enhance the design features of LSAC and provide important lessons in the design and implementation of a new Australian birth cohort study.

New Zealand's longitudinal birth cohort study, *Growing Up in New Zealand,* was also reviewed in detail. The sample size is less than 10 000, but this is appropriate in the context of New Zealand's relatively small population and the study is particularly relevant because of existing trans-Tasman relations between New Zealand and Australia.

Table 2: Longitudinal birth cohort studies audited (>10 000 respondents)

Study name	Sample size	Recent commencement	Relevant scope	Unlimited duration	Context relevance
Aarhus Birth Cohort	100 000	No - 1990	No	Yes	Low - Denmark
All Babies in South Eastern Sweden	17 000	No - 1997	No	Yes	Low - Sweden
Avon Longitudinal Study of Parents and Children	14 000	No - 1991	Yes	Yes	High - United Kingdom
Born in Bradford	14 000	Yes - 2007	No	Yes	High - United Kingdom
British Cohort Study	17 000	No - 1970	Yes	Yes	High - United Kingdom
British Cohort Study – National Child Development Study	17 000	No - 1958	Yes	Yes	High - United Kingdom
Children of the National Longitudinal Survey of Youth	11 500	No - 1986	No	Yes	Moderate - United States
Danish National Birth Cohort	95 000	No - 1996	Yes	Yes	Low - Denmark

Study name	Sample size	Recent commencement	Relevant scope	Unlimited duration	Context relevance
Europreval – Prevalence of Allergies across Europe	12 049	Yes - 2005	No	Yes	Variable – 9 countries
French Longitudinal Study of Children	**20 000**	**Yes - 2011**	**Yes**	**Yes**	**Moderate - France**
Generation R	10 000	Yes - 2002	No	Yes	Low - The Netherlands
Growing Up in Ireland	20 000	Yes - 2007	Yes	No	Moderate - Ireland
Growing Up in New Zealand	**7000**	**Yes - 2009**	**Yes**	**Yes**	**High - New Zealand**
Growing Up in Scotland	14 000	Yes - 2005	Yes	No	Moderate - Scotland
Healthy Habits for Two	11 144	No - 1984	No	Yes	Low - Denmark
Leicester Respiratory Cohort Study	20 000	No - 1985	No	No	High - United Kingdom
Life Study	**100 000**	**Yes - 2014**	**Yes**	**Yes**	**High - United Kingdom**
Millennium Cohort Study	**19 000**	**Yes - 2000**	**Yes**	**Yes**	**High - United Kingdom**
Norwegian Mother and Child Cohort Study	108 500	No - 1999	Yes	Yes	Low - Norway
Southampton Women's Survey	12 583	No - 1998	Yes	Yes	High - United Kingdom
Understanding Society (British Household Panel Survey)	40 000 households	No - 1991	No	Yes	High - United Kingdom

The studies highlighted in red/bold above have been reviewed in detail, and Table 3 provides a direct comparison of LSAC to each of the studies, based on key design features.

Table 3: Comparison of selected birth cohort studies by design features

	LSAC (Australia)	*Millennium Cohort Study* (UK)	*Life Study* (UK)	*Growing Up in New Zealand* (NZ)	*French Longitudinal Study of Children* (France)
Starting year	2004	2000	2014	2009	2011
Cohorts	2	1	1	1	1
Age at entry	0/1 year & 4/5 years	9 months	Pre-birth	Pre-birth	Pre-birth
Per cohort sample size	≈5000	≈19 000	≈90 000	≈7000	≈20 000
Sampling design	Geographically clustered	Geographically clustered, with ethnic and disadvantage oversampling	Two survey components: (i) sample of pregnant mothers and partners recruited through maternity units; (ii) nationally representative probability sample of live births through the birth register	Geographically clustered, non-probability	All children born on 16 days (from one year) in 344 selected maternity units
Sampling frame	Medical records (Medicare)	Child benefit records	Recruitment at hospitals and GPs (component 1) and birth register (component 2)	None, medical informants (chiefly lead maternity carers and media-based promotion)	Not applicable (see above)
Data collection	0–1 years, 2–3 years, 4–5 years, 8–9 years, 10–11 years…	9 months, 3 years, 5 years, 11 years…	Prenatal, 6 months, 12 months…	Prenatal, 6 weeks, 9 months, 12 months, 16 months, 32 months, 45 months, 54 months…	Prenatal, 2 months, 3–10 months, 1 year, 2 years, 3 years, 4 years, 7 years, 8 years, 11 years…
Data linkages	Health system, school, census, childcare	Health system, school, census, childcare, maternity and birth	Health system, school, census, childcare, environment, social security, maternity and birth, mobile phone data	Health system, school, census, childcare, maternity and birth	Health system, school, census, childcare, environment, social security, maternity and birth
Physical and biological assessments (timing: various)	By interviewer Include: weight, height, girth, body fat, head circumference, blood pressure, *Child Health CheckPoint* biomarkers (projected for B cohort children in wave 5)	By interviewer/respondent Include: weight, height, body fat, head circumference, waist circumference, physical activity monitoring (accelerometry), oral fluid samples, shed milk teeth	Collector undefined Include: vision test; height; weight; body composition; head and waist circumference; placenta, umbilical cord, blood, urine and saliva samples; dried blood spot used for newborn screening, genetic biomarkers	By trained interviewers Includes: weight, height, head circumference (birth), waist circumference, throat, nose and skin swabs for asymptomatic carriage, cord blood (subset), saliva, blood spots	By medical professionals Include: height, weight, urine and blood samples (subsample), mothers' blood and urine, umbilical cord sample, mothers hair, breast milk, baby's first stool, home dust (subsample)

4.2 Child of the New Century: Millennium Cohort Study (UK)

The United Kingdom has a long-running history of successful birth cohort studies, including the 1946 *National Birth Cohort*, the 1958 *National Child Development Study*, the 1970 *British Cohort Study*, and the more recent and ambitious 2000 *Millennium Cohort Study*.

Integrating large-scale birth cohort studies creates opportunities to map social change using cross-cohort comparisons**.** The *Millennium Cohort Study* arose out of a renewed interest in child wellbeing in the United Kingdom in the late 1990s. Thirty years had passed since the *British Cohort Study* of the 1970s started and the social and economic environment was markedly different from that. Ideally a new cohort would have commenced in the 1980s. By 2000 there was an acute need for a new study to show how early family life affected child development and outcomes throughout childhood, adolescence and adulthood in a more recent context.

The *Millennium Cohort Study* began to collect data in year 2000. It follows 19 517 children selected using child benefit records and who were born in the United Kingdom between September 2000 and January 2002. Participating children and their parents have so far been interviewed when the child was 9 months, 3 years, 5 years, 7 years and 11 years, with the study projected to follow them into adulthood. The study collects diverse information including parenting practices, childcare arrangements, school choice, child behaviour and cognitive development, child and parental health, parents' employment and education, socio-economic status, housing, neighbourhood and residential mobility, social capital and ethnicity (Hansen 2014).

The *Millennium Cohort Study* has three significant, innovative features that are instructive for a new Australian birth cohort study. First, the *Millennium Cohort Study* oversampled children from deprived backgrounds and from areas of relatively high ethnic minority concentration (Hansen 2014). This enabled robust and cost-effective analyses of the effects of disadvantage and ethnicity on children's development pathways. It generated large sample sizes for these subgroups, which is especially important because disadvantaged and minority groups are likely to be under-represented at baseline and have lower retention rates. Given that disadvantaged and ethnic minority children are often the focus of policies aimed at equalising life opportunities and outcomes, this survey data can be an extremely useful source of evidence.

Second, the *Millennium Cohort Study* pioneered the collection of biological samples from study respondents in large-scale, nationally representative birth cohort studies. At three years, study children provided samples of oral fluids collected through simple mouth swabs administered by their parents. The samples were sent to a specialised laboratory and catalogued. The resulting biological information was used to explore whether common infections in early childhood protect against later allergies. At age seven years, study children provided shed milk teeth (later returned to them) to examine the degree of exposure to environmental lead. At age 11 years, saliva samples were collected from some of the study children and both of their biological parents, as a pilot for the feasibility of DNA data collection in this sort of study (Calderwood et al. 2014). This data collection strategy generated information that could make a substantial contribution to reducing government expenses in preventive healthcare.

In a third innovation, the *Millennium Cohort Study* piloted accelerometer-derived measures of physical activity and sedentary behaviour. Children surveyed at age seven years were invited to wear an activity monitor for seven consecutive days during waking hours. This captured data such as daily steps and time spent in sedentary and moderate-to-vigorous intensity physical activity. These objective measures contrast with the self-reported physical activity levels that are often used in

surveys. The study found that only half of seven-year-old children in the United Kingdom achieve recommended levels of physical activity. Using accelerometry in longitudinal birth cohort studies is a relatively cheap way to collect objective data that can inform policy interventions that are aimed at boosting physical activity and achieving related physical and mental health benefits.

Internationally, the *Millennium Cohort Study* is considered a landmark in the implementation of birth cohort studies and its impact record is a testament to this.

IMPACT CASE STUDY 3: *Millennium Cohort Study* data informing government policy in the United Kingdom

The findings from the *Millennium Cohort Study* have been nationally and internationally important. The study has been used extensively by academics, referred to in the media, and taken as a model for new birth cohort studies (IoE 2011).

An independent evaluation showed that there is evidence of awareness and uptake of *Millennium Cohort Study* findings by the United Kingdom's most senior politicians. For example, the Deputy Prime Minister and the Minister for Universities and Science stated that it was 'helping us assess what works when it comes to early-years interventions' (IoE 2011). As a result, research using *Millennium Cohort Study* data has been applied by the United Kingdom Government to:

- improve Sure Start Children's Centres in the most disadvantaged parts of England
- raise awareness of the importance of early intervention to palliate social disadvantage in Scotland
- reconsider the national strategy to tackle child poverty in Northern Ireland
- change policies relating to the immunisation of children from deprived areas by Primary Care Trusts.

Research using the *Millennium Cohort Study* demonstrated that if all infants in the United Kingdom were exclusively breastfed, the number of children hospitalised each month due to diarrhoea would halve and the number hospitalised due to respiratory infections would drop by 25%. These findings have the potential to bring about substantial economic savings to the government and have been widely cited in reports by health agencies affiliated to the United Kingdom Government, the World Health Organization, and third sector organisations such as UNICEF.

4.3 Life Study (UK)

The *Life Study* started data collection in 2014 and is the latest instalment in the United Kingdom's long tradition of national birth cohort studies. The project is particularly timely because it emerged immediately after the recession that resulted from the global financial crisis which had a profound and detrimental impact on the United Kingdom's society and economy.

The *Life Study* has five core research themes:

1. Inequalities, diversity, and social mobility.
2. Early life antecedents of school readiness and later educational performance.
3. Developmental origins of health and ill-health in childhood.
4. The interplay between infant and parent in the child's social, emotional and behavioural development.

5. The effects of neighbourhoods and environment on study children and their families (Dezateux et al. 2013).

This study is a strong exemplar of international best practice, even though it is only in the early stages of data collection. The study design is unique and has two components to facilitate collecting pre-birth information and data on sub-populations of interest, whilst maintaining the representativeness of the study. The first component is a larger sample of mothers and their partners recruited during pregnancy by participating maternity units, and includes oversampling of individuals from ethnic minorities. This enables processes which occur prior to or immediately after the birth of the child to be examined. The second component is a nationally representative probability sample of live births recruited using the birth register as the sampling frame. This component is useful for "increasing the precision of estimates for nationally representative measures" (Dezateux et al. 2013). Using two components in this way is a great methodological innovation, but is only possible with a very large sample size. The *Life Study* birth cohort is approximately 90 000.

The *Life Study* also incorporates other state-of-the-art and unprecedented design features, namely:

- more detailed and numerous measures of children's and parents' physical and biological markers (including placenta, umbilical cord, blood, urine and saliva samples, and a sample of the dried blood spot used for newborn screenings) that can be used to construct a genetic databank
- a very large sample size that provides sufficient statistical power for robust analyses within and between sub-populations of interest (including children born in profoundly disadvantaged families and children from ethnic minorities), and that facilitates investigations into the interplay between environmental and genetic factors influencing children's life outcomes
- better linkages to a more encompassing range of administrative data sources than previously accomplished, including health-related prenatal and postnatal information and mobile phone data.

IMPACT CASE STUDY 4: *Life Study* data to inform government policy in the United Kingdom

The ambitious features of the *Life Study* lead to high expectations of its potential impact on policy planning and socio-economic change. For example, its large sample size has the potential to generate evidence on the behaviours and outcomes of very specific population subgroups that might be of particular policy interest, such as ethnic minorities, deeply and persistently disadvantaged families, recent arrivals, same-sex families and children born with specific disabilities or health conditions. This will facilitate the development of specific, targeted and tailored policies aimed at preventing and/or alleviating negative circumstances known to be disproportionately experienced by such sub-populations. As a result, local and national governments in social services, welfare payments and the health system can be guided on how to use funding more efficiently.

Coupled with the collection of biological information, the large sample size of the *Life Stud*y will enable the development of a genetic databank of children in the United Kingdom. This information can be used to accelerate medical projects that improve health by identifying the genetic bases of widespread health conditions such as obesity, intellectual disabilities, hypertension, cardiovascular disease, diabetes or cancer (Rabbani et al. 2013). These advances have obvious potential to increase human longevity and quality of life, and will reduce government healthcare costs through more personalised medicine.

4.4 Growing Up in New Zealand (NZ)

Growing Up in New Zealand is the first large-scale national birth cohort study in New Zealand. The study emerged to fill a need for robust information that could be used to draw a picture of "what it is like to be a child growing up in New Zealand in the 21st Century" (Morton et al. 2014).

Since 2009, *Growing Up in New Zealand* has followed a cohort of 6846 children. Strictly defined it does not qualify as a large longitudinal birth cohort study, but the sample size is appropriate given New Zealand's relatively small population.

***Growing Up in New Zealand* is one of the first longitudinal studies to collect prenatal information from parents**

Growing Up in New Zealand placed major emphasis on prenatal and postnatal circumstances, and so it recruited its respondents prior to birth using non-random sampling techniques. Purposive recruitment targeted pregnant mothers and the sample included all children expected to be born between 25 April 2009 and 25 March 2010 in selected regions in the Upper North Island of New Zealand.

Two significant features of *Growing Up in New Zealand* are highlighted here. First, *Growing Up in New Zealand* is one of the first longitudinal studies to collect prenatal information from mothers and their partners (Morton et al. 2010). This includes important information on parental resources, behaviour and expectations during pregnancy. This enables more detailed analyses of epigenetics (how an individual's life outcomes are affected by their biology), the environment into which a study child is born, and the intersections between the two. It also provides information on in utero exposures that can have an impact during a critical period of foetal development. The children were followed up extensively over the first two years of life (a time when developmental change is particularly fast), with three face-to-face interviews and two telephone interviews.

Second, the study includes approximately 1700 children with a Māori background, 1200 children with a Pacific Island background and 1000 children with an Asian background. Unlike LSAC, *Growing Up in New Zealand* ensures sufficient explanatory power to make in-survey comparisons of ethnic inequalities in children's developmental and wellbeing.

Through proactive teamwork between researchers and policymakers, *Growing Up in New Zealand* is having important impacts on the lives of children in New Zealand.

IMPACT CASE STUDY 5: *Growing Up in New Zealand* informing government policy

Growing Up in New Zealand aimed to have a clear policy dimension from the outset. The survey instruments were devised in consultation with key agents in policy planning and aimed to gather evidence on the performance of existing government policies, and evidence that could inform the development of new, better targeted strategies to address entrenched problems.

Topics of policy relevance in the survey include: access to health services; immunisation; breastfeeding intentions and practices; maternal nutrition and physical activity during pregnancy; the effectiveness of support to stop smoking during pregnancy; the formal and informal childcare environment; the child's learning environment at home; and the accessibility of paid parental leave.

As a result, early in the study life, there had already been a sizeable number of policy submissions using *Growing Up in New Zealand* data. These included submissions to the Early Childhood Education Taskforce (January 2011), Green Paper for Vulnerable Children (February 2011), White

Paper for Vulnerable Children (February 2012), Child Health Improvement Plan (September 2011), Auckland City Plan (September 2012), Inquiry into Determinants of Wellbeing for Māori Children (March 2012), The Future of Folic Acid Fortification in New Zealand (July 2012), Parental Leave & Employment Protection Amendment Bill (October 2012), Solutions to Child Poverty (October 2012) and Parental Leave and Employment Protection Amendment Bill (April 2013).

Additionally, *Growing Up in New Zealand* data can be and has been used to fast-track information to policy planners. For example, information on infant sleep locations (September 2011), folic acid supplementation (August 2012), and parental leave and child outcomes (May 2013) was delivered to the New Zealand Minister of Health, and information on sole parenting (December 2010) to the New Zealand Minister of Social Development.

4.5 French Longitudinal Study of Children (France)

The *French Longitudinal Study of Children* (*Etude Longitudinale Française Depuis L'Enfance*) is the biggest birth cohort study to date in France. After an extensive piloting process in 2007, the data collection phase started in 2011. The study follows a sample of children born in 344 maternity wards, randomly selected in 2011 from the country's 540 maternity wards, with recruitment into the study occurring over 16 days in one year.

The *French Longitudinal Study of Children* places a lot of emphasis on the prenatal and postnatal biological traits, experiences and circumstances of the study children and their parents. After an interview with the parents in the hospital, tracking of the children started in the maternity ward when they were just a few days old. Biological samples of the mother's blood and urine (pre-delivery) and hair and breast milk (post-delivery), the umbilical cord and its blood, and the baby's first stools were obtained from the hospitals. This enabled infectious agents to be detected and interactions between the environment and the genome to be examined.

This study focuses on the impacts of environmental factors on the child's health and development and this continues in subsequent data collection points. For example, when the child is two months old, a random sample of participating families are given dust traps to place at several locations within their homes to measure the presence of substances known to trigger allergic reactions. When the study children are around eight years old, medical practitioners will collect additional biological samples for assessing the child's metabolism, allergies, breathing and exposure to pollutants.

IMPACT CASE STUDY 6: *French Longitudinal Study of Children* data to inform policymaking

As the data only became available for research in 2013, the impact of this study on government policies is not yet available. It is expected to help gauge the health consequences (e.g. allergies, asthma and obesity) on the child resulting from factors such as premature birth, infections contracted by a mother during pregnancy, and early exposure to various pollutants. Establishing such links would assist the French Government to develop strategies for moving from palliative to preventive and early interventions, even prior to the child's birth, and is aimed at reducing human, social and economic costs of ill-health over the life course.

4.6 Other international birth cohort studies

Other major relevant birth cohort studies have been released shortly before or after LSAC and LSIC were conceived but did not meet the study audit criteria. These include the:

- 1991 Avon Longitudinal Study of Parents and Children (South East England)
- 1994 National Longitudinal Survey of Children and Youth (Canada)
- 1996 Danish National Birth Cohort (Denmark)
- 1999 Norwegian Mother and Child Cohort Study (Norway)
- 2002 Generation R study (the Netherlands)
- 2005 Growing Up in Scotland (Scotland)
- 2007 Growing Up in Ireland (Ireland).

A number of these studies also include methodological innovations with specific relevance to a new Australian birth cohort study. The *Avon Longitudinal Study of Parents and Children* (see Impact Case Study 7), the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study* are particularly instructive in their use of data linkage, biological information, and early-life measurements, and we have referred to them where applicable in drawing learnings from leading international birth cohort studies in Section 5.

IMPACT CASE STUDY 7: *Avon Longitudinal Study of Parents and Children*

The *Avon Longitudinal Study of Parents and Children* is a large-scale birth cohort of children born in the area around Bristol (South East England) that began in 1991. A key contribution of this study is the emphasis on prenatal, perinatal and early-life health measurements and exposure to substances. This resulted in a large body of research (over 1000 academic papers) that had enormous policy impacts and contributed to improving the lives of millions of children (Boyd et al. 2012).

This study's most celebrated contribution is perhaps the evidence it produced to support the *Back-to-Sleep* campaign, which featured a government-endorsed recommendation that babies sleep on their backs to reduce the risk of Sudden Infant Death Syndrome, also known as cot death. The campaign is said to have saved the lives of thousands of babies in the United Kingdom and other countries.

Other study findings with relevance to policy show that:

- mothers who eat fish during pregnancy have children with better eyesight and IQ
- using air fresheners and aerosols is associated with poor health outcomes for babies and mothers
- exposure of a baby to chemical agents is linked to the development of asthma and wheeze
- 15 minutes of physical activity each day halves the risk of becoming obese
- peanut allergies can result from certain baby oils and lotions (prompting the use of warning labels)
- a girl being underweight in her teenage years is associated with bone density risks later in life.

CHAPTER 5
Learning from existing birth cohort designs

5 LEARNING FROM EXISTING BIRTH COHORT DESIGNS

KEY POINTS

- Small birth cohort studies drawn from general populations of births do not enable robust analyses of policy-relevant social subgroups, including Indigenous children and children who experience deep and persistent disadvantage. A large sample size and oversampling sub-populations of interest can address this.
- Routinely collected administrative data are becoming progressively more accessible. For birth cohort studies, these provide previously unavailable information, help reduce data collection costs, and increase data quality.
- Direct physical and biological assessments of children within birth cohort studies help establish the social and genetic bases of disease and ill-health. Using them to build databanks can accelerate medical projects that aim to improve human health.
- The physical, psychological and social circumstances of parents and children prior to, during and immediately after the birth of a child have been demonstrated to have long-lasting consequences on children's life outcomes, and information on these can be incorporated via direct collection or administrative data linkages.
- The value of national cohort studies is greatly enhanced if follow-up studies are released. There is inherent value in developing a national system of sequential cohort studies that allow for national comparisons over time and synchronic international comparisons.

The *New Australian Birth Cohort Study* is an opportunity to modernise birth cohort studies in Australia and align them with international standards, to overcome the limitations and enhance the value of LSAC and LSIC, and to future-proof the data for prospective policy needs and technological advances. There are a number of important lessons from existing international birth cohort studies that should be applied in the design of a new Australian birth cohort study.

5.1 Effective sampling strategies are essential to a powerful cohort study

5.1.1 Large sample sizes produce more robust studies

In a longitudinal birth cohort study of the general population, a survey design that incorporates a large sample of respondents is of key importance because it:

- provides the statistical power to make robust inferences for informing policymaking
- allows detailed examinations within and between potentially small sub-populations of interest
- lessens the impact of attrition by ensuring that even when participants drop out of the study prior to follow-up surveys, a sufficient number of respondents remain to ensure the research value of the study.

National birth cohort studies implemented by our international policy comparators have at least 20 000 children in the cohort and up to 100 000, compared to fewer than 5000 for LSAC.

5.1.2 Samples need to represent the vulnerable and disadvantaged

Social and economic policy in Australia aims to improve the life opportunities and wellbeing of children and families, with a special focus on those who belong to vulnerable groups and experience deep forms of disadvantage. Some of these groups form a small part of the Australian population. For example, according to the 2011 Census, only around 3% of Australians are from an Aboriginal or Torres Strait Islander background. Similarly, a 2013 Productivity Commission report found that around 5% of the Australian population are deeply and persistently disadvantaged (McLachlan, Gilfillan and Gordon 2013). A new birth cohort study the size of LSAC would capture too few of these individuals; this constitutes a major shortcoming.

Oversampling ensures that large numbers of respondents with characteristics of interest to policy are included in the study

To prevent this, recent international birth cohort studies have followed two strategies. One strategy is for studies to use very large samples so that many children from disadvantaged families are included. The *Life Study*, the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study* each followed approximately 100 000 children. This is a powerful but expensive strategy. The proposed *National Children's Study* in the United States is also expected to follow about the same number over 21 years but has been postponed due to implementation issues relating to the magnitude of the study.

A second and less costly strategy that Australia could adopt, and which has been used in recent national birth cohort studies overseas, is to oversample minorities of interest in the study design, and use moderately large sample sizes. For example, the *Millennium Cohort Study* followed nearly 20 000 children but oversampled children from deprived backgrounds and from areas of relatively high ethnic minority concentration. This was achieved by stratifying geographical areas (by ethnicity and disadvantage status) before randomly selecting study children. The sample of pregnant mothers in the *Life Study* is also geographically clustered to over-represent births from mothers from minority ethnic groups. The same approach was also taken by large household-based panel studies, such as the *United Kingdom's Household Longitudinal Study* (also known as Understanding Society) that started in 2009.

Oversampling has the advantage of ensuring that large numbers of respondents with characteristics of interest are included in the study. This minimises the impact of the typically higher attrition rates of hard-to-reach subgroups. For the strategy to be executed correctly, prior knowledge is required on the relevant sub-populations and their geographic distribution.

5.2 Data linking builds more insightful, efficient and detailed studies

5.2.1 Administrative data are the basis for data linking

Administrative data are routinely collected by governments and official institutions. Administrative data can be of analytical interest, but often lack the detail and depth to be used in isolation.
A particularly powerful option is merging or linking administrative data to social surveys. This not only adds new information to that in the social survey data, but also reduces the time it takes respondents to complete the survey. For example, instead of asking respondents about their medical history, this information can be imported from medical records. As well as speeding up data collection and

reducing interviewing costs, this also increases the quality and accuracy of the information as it is not affected by recall error or desirability bias. Furthermore, it can generate important insights about the timing and effectiveness of medical treatments (e.g. if a health condition is reported in a survey, before or after the treatment period).

Australia's existing birth cohort studies have made good use of data linkages to enhance their power to inform academic and policy research. As discussed in section 3, LSAC has been linked or will be linked to NAPLAN, the Census, Medicare, National Childcare Accreditation Council and Australian Early Development Index data, and the opportunities emerging from these linkages are well documented (Edwards 2012).

5.2.2 Opportunities for health and schooling data linkage in Australia are expanding

The Australian birth cohort studies do not capitalise on administrative data linkages to the extent achieved by several key recent international birth cohort studies, including recent studies in France, Denmark, Norway, the United Kingdom and the United States. This is reasonable given the Australian studies were not designed with data linkage in mind, partly because the data were not available or were difficult to access in Australia when the studies were conceived.

A new birth cohort study would capitalise on exciting opportunities for advanced data linkage in Australia

Since LSAC started, administrative data libraries and the data linking environment in Australia have developed rapidly (Boyd et al. 2012). This presents opportunities for more extensive and better use of data linkage in a new study. Relevant changes in the Australian data linkage environment include:

- widespread recognition of the importance and benefits of integrating data
- improvements in the requisite skillset and computing power
- the emergence of facilities that enable confidential access and manipulation of datasets
- increases in the information that is stored by government departments and other organisations
- increased acceptability of data linking by respondents as reflected in consent rates.

These factors, among others, open up new opportunities for data linkage in Australia, particularly with respect to health and education. For instance, NAPLAN test scores, to which LSAC is linked, give a longitudinal picture of students' reading, writing and numeracy skills in Years 3, 5, 7 and 9, and offer major opportunities for analysis. However, they are only biennial and do not capture other dimensions of school performance and schooling at the state level that are of interest to policymakers (such as school attendance, numbers of students and teachers, extent of curriculum). The *Millennium Cohort Study* in the United Kingdom linked education records from the National Pupil Database that contained information not only on national test performance, but also on term-on-term school performance, school attendance, absences, pupil censuses and participation in free school meal programs.

In terms of health, LSAC data were linked to immunisation, medical and pharmaceutical records from the beginning of the study. This opened a number of analytical pathways but these data lack important details on, for example, the outcome of medical visits. They also do not cover relevant dimensions of child health, such as prenatal and postnatal health, or procedures not covered by Medicare. The case for health-related administrative data linkages is best made by the Norwegian and Danish birth cohort studies. The *Danish National Birth Cohort*, for instance, takes most of its health data from a combination of registers using an integrated platform. It includes information on

diseases and hospitalisation during pregnancy, birth weight and length, gestational age at birth, birth complications, delivery methods, hospitalisations for mothers and children since birth, as well as child diagnoses such as cerebral palsy, infantile autism, cancer and diabetes (Olsen et al. 2001).

5.2.3 Linking social security and register data is now feasible

Some recent national birth cohort studies overseas link survey data to administrative data on additional life domains. One obvious example that would be feasible in Australia is data linkage to social security records. This could include how individuals meet the eligibility requirements for specific payments (including income and assets), the type of scheme, the amount of money received, allowances and concessions, and the duration of participation in the scheme. This has been done by the *French Longitudinal Study of Children*, the *Life Study*, the *Danish National Birth Cohort*, and the *Norwegian Mother and Child Cohort Study*.

A new birth cohort study that links to Centrelink records could offer new insights into significant issues for policymakers

In Australia, this course of action was shown to be feasible and fruitful by the *Youth in Focus* project. It is based on information provided by young people (aged 18 years and above) and their parents via survey, as well as information from Centrelink's administrative records. A new Australian birth cohort study that links to Centrelink records could offer new insights into very significant issues for policymakers, such as the intergenerational transmission of welfare dependency or the impacts of parental participation in social security schemes on parent-child interactions.

Other administrative data collections that existing or new Australian birth cohort studies could draw from include register data (on births, marriages, family deaths) and maternity and birth information from hospital records. Other, more innovative, data linkages have been projected for some of the reviewed international birth cohort studies, including linkages to mobile phone data (for the *Life Study*) and environmental data (for the *French Longitudinal Study of Children*) to examine health effects. The potential for similar linkages in Australia need to be assessed in implementation planning.

5.3 Biophysical and anthropometric data support population health

5.3.1 International studies and technological advances offer new insights

Social surveys that make direct physical and biological assessments help establish the social and genetic bases of disease and ill-health, and have scientific and policy value in cohort studies because children are followed from birth and over long periods (Manolio et al. 2006). Findings from birth cohort studies using data on the timing and duration of exposures can do more than make associations between risk factors and adverse health outcomes. They can for example identify causal pathways for disease aetiology and provide the detailed evidence base needed to develop health policy and preventive health strategies (Ben-Shlomo et al. 2013).

LSAC contains some measurements taken by interviewers of the study child’s weight, height, girth, body fat, head circumference, and blood pressure, but this information is less comprehensive than that collected by other major birth cohort studies overseas. International studies feature measures or samples of vision, body composition, oral fluids, shed milk teeth, urine, dry blood, placenta, umbilical cord, baby’s first stool and home dust. Some of the reviewed studies also take direct physical and biological measures of the parents. For instance, the *French Longitudinal Study of Children* collects

samples of mothers' blood and urine, hair and breast milk, and the *Millennium Cohort Study* samples both biological parents' saliva.

Due to recent technological developments, many of these biological measures can now be collected using relatively simple procedures, and administered by interviewers or by a study child's parents (Lindau and McDale 2007). Other types of measures would involve partnerships with hospitals and other medical institutions, or home visits by medical practitioners contracted by the survey managers.

If coupled with large sample sizes, as in the case of *Life Study*, the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study*, biological measures can generate genetic databanks. These can be used to speed up genetic research aimed at curing widespread health conditions (Rabbani et al. 2013).

In moderately sized studies, collecting biophysical measures remains important. For example, blood samples placed in storage can future-proof a new birth cohort study. It achieves this by facilitating future testing where methods do not yet exist or samples are not yet large enough to draw strong conclusions.

CASE IN POINT: New *Child Health CheckPoint* initiative confirms opportunities in the Australian context

Australian data collectors have not been oblivious to this international trend towards more comprehensive and extensive collection of biomarkers in birth cohort surveys. In 2014-15, LSAC will be collecting biological information from study participants as part of the new *Child Health CheckPoint*. This will be a one-off physical health check around the time when children become teenagers (11 to 12 years of age), and will involve detailed measurement such as the study child's heart and lung functioning, fitness, strength, vision, diet and physical activity. Collecting these physical and biological measures requires the use of special equipment and skills, and LSAC will partner with the Murdoch Children's Research Institute for this phase of data collection.

This information will substantially increase LSAC's potential to inform us about what factors predict good (and poor) health among young Australians, and how their health status affects their day-to-day activities and subsequent life outcomes. Because they are only collected once and relatively late in the child's life, the measures included in the *Child Health CheckPoint* cannot tell us much about the very important developmental stages taking place between ages 0 and 10 years, nor can we use the data to examine trends and growth in these measures as children age, or correlations between measures at different ages. A more systematic approach would be preferable, and this could resemble the *Millennium Cohort Study*. Under this model, repeated biomarkers are collected on several occasions at strategic points in the child's early years. Other important age-specific biomarkers are collected as a one-off measure. In this way, the *Millennium Cohort Study* collects important biophysical data whilst remaining operationally efficient.

5.4 Early-life measurements are essential

5.4.1 Data on prenatal, postnatal and early-life conditions are powerful policy tools

Research has found very strong links between physical, social and economic circumstances before, during and after birth and later-life outcomes, even beyond childhood (Lynch and Smith 2005). Of particular significance are prenatal, postnatal and early-life conditions. Factors of importance include paternal expectations and birth preparation, expectant mothers' health and daily routines, and the

results of tests undertaken during pregnancy or immediately after the birth of the child. Collecting related data is progressively recognised as an essential feature of birth cohort studies as most of this information is also highly relevant to policy. Examples include details on maternal use of substances or medication during pregnancy and how this affects child's health, and the impact of practices such as breastfeeding.

5.4.2 Innovation overcomes challenges to early-life data collection

The leading international birth cohort studies with relevance to Australia emphasise prenatal, postnatal and early-life data. Collecting prenatal, postnatal and early-life data within large-scale nationally representative birth cohort studies poses the challenge of data availability. Major birth cohort studies overseas have taken one of two routes to overcome these.

One way of collecting the requisite data is to gain access to mothers before birth, namely by sampling pregnant women instead of the children. This is the route taken by *Growing Up in New Zealand* and the first component of *Life Study*. This approach enables more precise and purposive measurement of pre-birth circumstances. This includes subjective data such as parental expectations and aspirations, and important bio-physical measures collected before birth and immediately after birth (placenta, umbilical cord, baby's first stool). This also has a key disadvantage: it is difficult to find a suitable sampling frame for pregnant mothers that allows for random sampling. In its absence, non-random survey designs must be used. For such designs, we do not know an individual's probability of being selected in the sample. In any case, prenatal data are very important and the relative merits of access to these data must be weighed up against the methodological challenges of non-random sampling and the availability of appropriate statistical techniques to deal with non-representativeness.

The second way to collect the requisite data is to partner and work closely with institutions that already hold a large amount of prenatal information, such as hospitals or medical registers. This is the route taken by the *Millennium Cohort Study*, the *French Longitudinal Study of Children*, the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study* and enables probabilistic survey designs using an available sampling frame. A lot of prenatal objective data can be collected using data linkage. This approach requires negotiations with data custodians and other stakeholders and it does not permit the collection of subjective information on attitudes and expectations in the lead up and immediately after a birth.

LSAC does not collect contemporary data prior to the child's birth. This is because children were sampled after birth using Medicare records as the sampling frame, and the study did not link prenatal or postnatal information from databanks held elsewhere.

Additionally, prenatal, postnatal and early-life information from children and parents should be collected at relatively frequent time intervals in the first years of the child's life. The youngest cohort of children in LSAC was interviewed once between the ages of 0 and 1 year, and not again until between 2 and 4 years, except for a small mail-out questionnaire in the year in between. This gap is too large for examining developmental pathways in detail. Other studies, most prominently *Growing Up in New Zealand*, collect substantial information during the first two years of life and then spread out the subsequent data collection points. Contact need not always be via costly face-to-face interviews, and can be achieved through other data collection methods (e.g. telephone or mail surveys) or data linkages, as shown by the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study*.

5.5 A national system of sequential studies improves scope and value to policy

5.5.1 The value of multiple studies is greater than the sum of their parts

Regardless of precise study features, there is inherent value in investing in a national system of sequential birth cohort studies that follow chronologically. The United Kingdom case provides the best example. The 1946 *National Birth Cohort* was followed by the 1958 *National Child Development Study* then the 1970 *British Cohort Study*, the 2000 *Millennium Cohort Study* and, most recently, the 2014 *Life Stu*dy (see Figure 2 for comparison with Australia's birth cohort studies).

Importantly, these studies have or are projected to track the study children into adolescence, adulthood and later life. This long-lasting investment in birth cohort studies has enabled researchers and policymakers in the United Kingdom to draw invaluable conclusions based on comparisons across national studies over time and, with studies occurring at the same time in comparable countries.

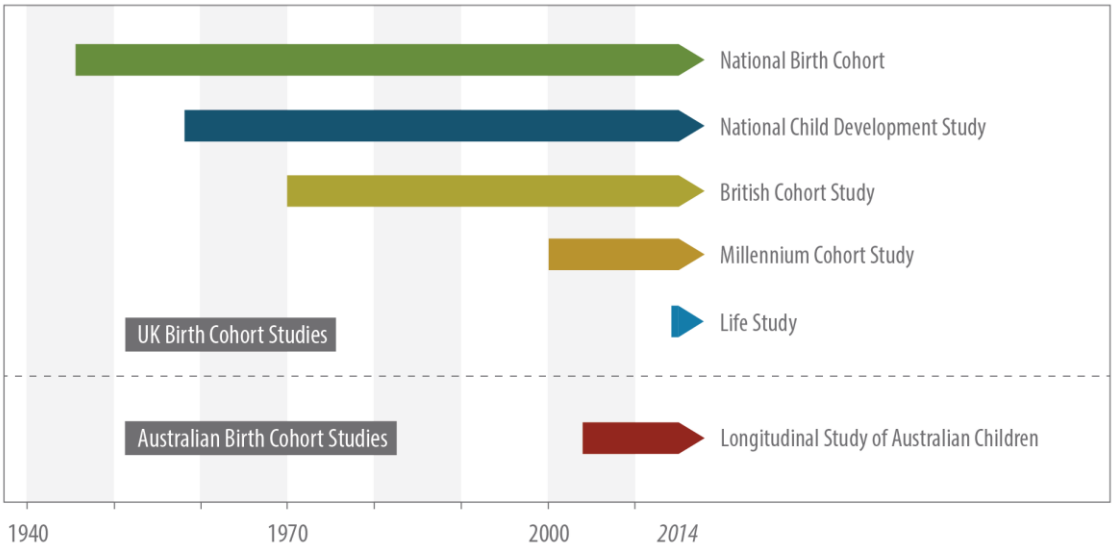


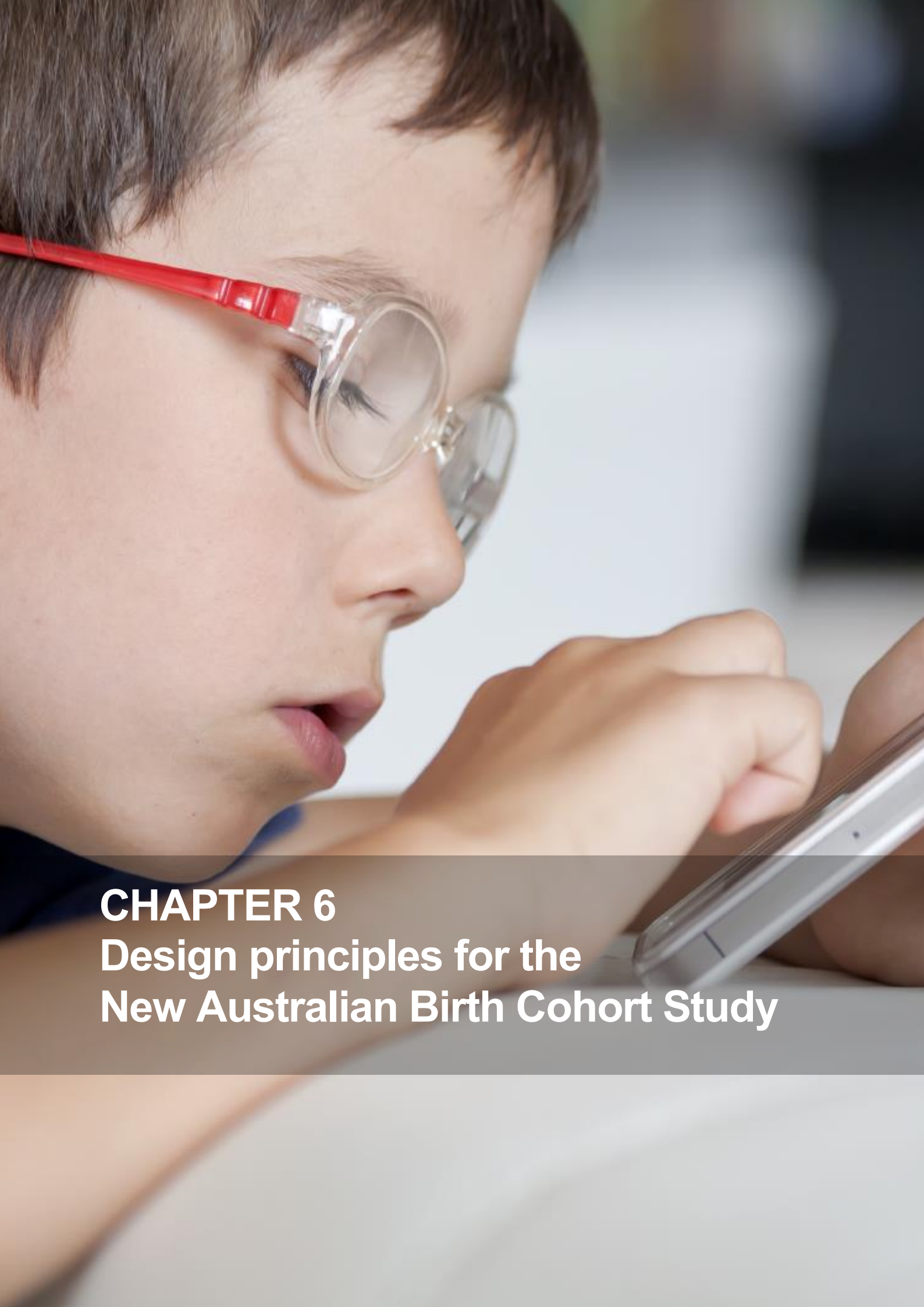
Figure 2: Comparison of national longitudinal birth cohort data in the United Kingdom and Australia

Cross-generational comparisons across national studies over time are very helpful tools for assessing social and economic change and the long-term effects of social policies. For example, Neuburger et al. (2009) combined data from the United Kingdom's 1946, 1958 and 1970 birth cohort studies. This enabled them to explore how gender pay gaps evolved over the life courses of men and women from different cohorts and who experienced different socio-economic circumstances.

Comparisons with synchronic studies in comparable countries can be used to evaluate national performance and circumstances against viable alternatives and position a country in the international setting (Larsen et al. 2013). For example, Bradbury et al. (2011) used data from LSAC, the *Millennium Cohort Study*, the *Early Childhood Longitudinal Study Birth Cohort* (United States), and the *Canadian National Longitudinal Survey of Children and Youth* to examine cross-national differences in children's readiness to learn.

One-off national birth cohort studies, even if optimally designed, do not realise their full value if no follow-up studies are launched. It is therefore a missed opportunity not to invest in a new Australian study that supports and extends LSAC. Without a new study, neither cross-national comparisons with emerging studies in other developed countries, nor comparisons with LSAC will be sufficient for

policy information. LSAC children will grow older and the changing circumstances of the Australian landscape will not allow findings from LSAC to be extrapolated to new cohorts of Australian children. This situation is more acute given Australia's rapid rate of social, economic and technological change.



CHAPTER 6
Design principles for the New Australian Birth Cohort Study

6 DESIGN PRINCIPLES FOR THE NEW AUSTRALIAN BIRTH COHORT STUDY

KEY POINTS

- A new Australian birth cohort study would focus on the next generation of children born in Australia and future-proofs national evidence-based policymaking. Delivering the study before the young people in LSAC and LSIC reach adulthood is critical.
- The lessons from LSAC, LSIC and leading international birth cohort studies can inform the core design principles on which the *New Australian Birth Cohort Study* should be based.
- The following seven design principles would deliver Australia a study that produces robust scientific evidence for social and economic policymaking:
    1. Allows for comparisons with the previous generation of Australian children in LSAC and with children in other relevant studies overseas (*continuity*).
    2. Ensures sufficient sampling of Indigenous and disadvantaged sub-populations (*oversampling*).
    3. Collects biomedical and physical data pre- and post-birth (*biophysical measurements*).
    4. Collects sufficient prenatal and postnatal data to determine their impact on later life outcomes (*early-life measurement*).
    5. Uses existing administrative records to enhance the data (*data linkage*).
    6. Capitalises on the contact opportunities of data collection to both explore the consequences of having children for the whole family and the effect of parents and networks on children's life outcomes (*family impact approach*).
    7. Applies new and future technological advances to improve data collection and the communication of results (*new technologies*).
- There are various methodological strategies that may be used to meet these design principles and it is feasible for the *New Australian Birth Cohort Study* to be designed in a way that delivers on all of them.

Getting the design right for the *New Australian Birth Cohort Study* is essential if it is to establish causal effects using accurate statistical inference. We have drawn from the experience of leading birth cohort studies overseas to design principles for a new Australian birth cohort study that will align with international best practice and have the proven potential to produce policy-relevant evidence. The strengths and limitations of Australia's current longitudinal birth cohort studies, LSAC and LSIC, are also instructive in the design of the *New Australian Birth Cohort Study*. The eight fundamental design principles explained in this section should inform the technical specifications of any future study supported by the Australian Government.

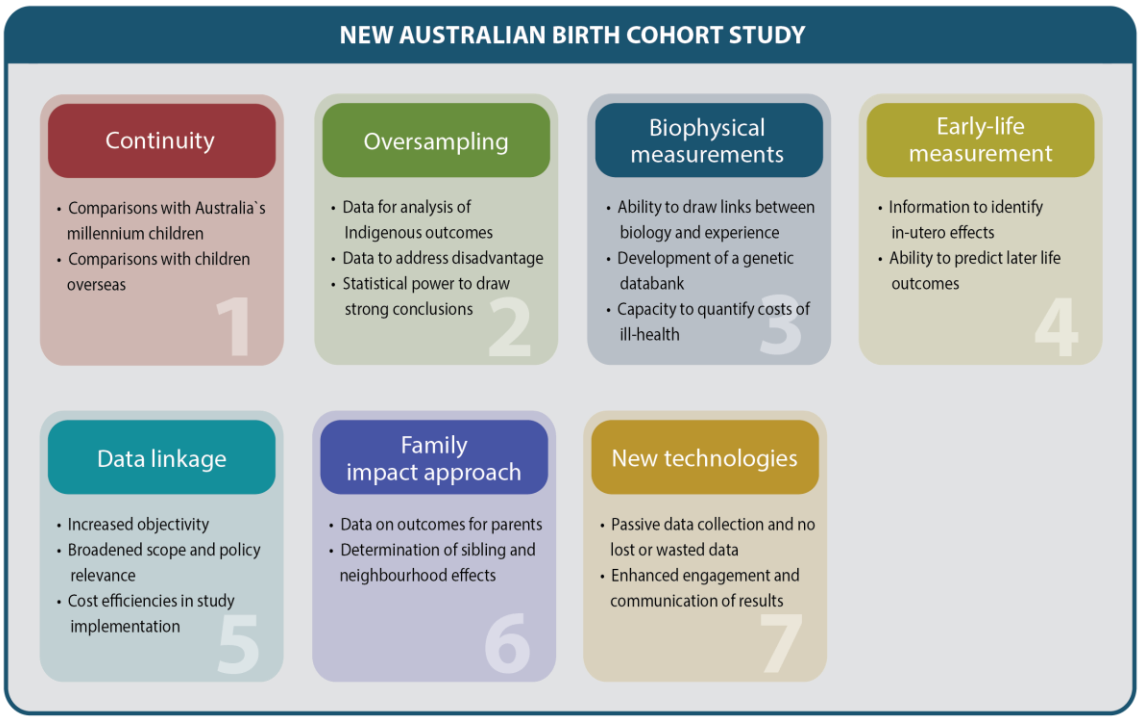


Figure 3: Design principles for the *New Australian Birth Cohort Study*

6.1 Improving the life outcomes of Australian children remains the goal

DESIGN PRINCIPLE 1: Maintain *continuity* with previous Australian birth cohort studies and leading overseas studies.

If a new Australian birth cohort study is not initiated at this time, the value of Australia's current birth cohort studies as well as the value of any future study will not be fully realised. Social and policy changes are occurring rapidly and their implications for the health, wellbeing and development of the next generation of Australian children need to be understood. Based on leading international examples, the optimum gap between longitudinal birth cohort studies is 12 to 15 years; children in LSAC are now aged 10 to 15 years, so we are now at the right time to initiate the next Australian birth cohort study.

In the *New Australian Birth Cohort Study*, it is important to maintain a study design that is relatively consistent with the design of LSAC so that cross-cohort comparisons can be made. Even though the new study needs to be larger and incorporate more measures than the previous national study, it is still possible to achieve a degree of cross-cohort comparison if there is a subset of continuing and selected measures, and the right sampling approach.

6.1.1 Overarching objectives remain the same for continuity

The primary objective of the *New Australian Birth Cohort Study* is to observe Australian children and their families throughout childhood and into adult life. This will provide a rich longitudinal resource of data that can be used to address future policy questions and hypotheses and test interventions relating to the health, wellbeing and development of Australian children.

In a broad sense, this objective remains consistent with the goals of LSAC. The key differences are that the study children and their families are part of a new generation of Australians, and the methodological tools for this research are further advanced in 2014 than they were when LSAC

started 10 years ago. The *New Australian Birth Cohort Study* would aim to provide a complete view of the social and biophysical lives of the next generation of Australian children.

This intent aligns with the research and policy motivations of LSAC, LSIC and major international studies, including the *Millennium Cohort Study* and the new *Life Study* in the United Kingdom. Maintaining this alignment greatly increases the policy utility of the *New Australian Birth Cohort Study* because of the potential for more comparative analyses.

6.1.2 Equivalent sampling strategies enable national cross-comparisons

Where possible, the design of the sampling strategy should encompass elements from LSAC and LSIC without jeopardising the integrity of the new cohort study. LSAC's sampling strategy was based on a nationally representative design, making it possible to get correct inferences about population characteristics from the sample data, as previously discussed.

The *New Australian Birth Cohort Study* should also be based on a nationally representative design to produce unbiased and precise statistical estimates of interest, and to allow cross-cohort comparisons with statistical estimates from LSAC, given that this is our most comprehensive national birth cohort data source.

6.1.3 Re-using selected measures supports comparability

Cross-cohort comparisons require that a selection of the measures used in LSAC and LSIC also be included in the new birth cohort study. These studies use a range of measures that remain relevant to any new study including: family demographics; housing; household finances; work status and social capital of the study child's parents; health of the study child and the parents; parenting practices; childcare arrangements; and the overall environment. There are also several measures of the study child's development; behaviour relating to health; risk factors; and cognitive, social, educational and emotional outcomes.

For some measures, the best-practice method of measurement or data collection may have advanced or been altered since LSAC and LSIC started. One approach may be to include the original *and* new methods in the new cohort study until sufficient data and evidence are available to conclude whether they are measuring the same or different phenomena. Ensuring continuity of core measures allows comparisons of outcomes for children of the same age between different cohorts.

6.2 Oversampling for disadvantage in a large-scale study provides analytical strength

DESIGN PRINCIPLE 2: Use a sufficiently large sample and aim to *oversample* those population subgroups that are disadvantaged

A primary goal in designing the *New Australian Birth Cohort Study* is to achieve national representativeness and enable robust analyses of policy-relevant social groups. We have seen that the leading international studies have at least 20 000 children in their cohorts and that the most recent studies are significantly larger (up to 100 000 children). In order to ensure that the *New Australian Birth Cohort Study* is aligned with best practice standards internationally and produces high quality data for defensible results, it is important to fund the largest sample size possible.

It is a fundamental aim of the sampling strategy for the *New Australian Birth Cohort Study* that all children born as members of the study population have a known and non-zero probability (chance) of being included in the selected sample. The study should also include children born in all months

throughout a single 12-month period to best control for invariant factors through the research design and capture seasonal birth effects.

Additional decisions on sampling must be made based on the purpose of the study. In the case of the *New Australian Birth Cohort Study,* we consider that the sampling strategy should be designed to:

- provide nationally representative data at the *country-level* to deliver evidence about what it means to grow up in Australia for the next generation
- generate *usable data for subgroups* of children, in particular those living in disadvantaged circumstances and Indigenous children
- produce data about children living and growing up in *all states and territories* of Australia, including metropolitan, regional and rural areas.

In the table below we have provided estimates for a range of sampling options, providing flexibility to the Australian Government in decision-making about study design. The samples sizes provided are considered to be minimum sizes for a feasible study, and additional explanatory notes are set out below:

- The target sample represents the total number of respondents who are approached to participate in the study.
- The achieved sample size at wave 1 represents the total number of respondents who agree to and actively participate in the study at inception. The experience of LSAC was a 54% participation response at wave 1; other studies, such as the *Millennium Cohort Study*, have achieved as high as an 80% participation response. A 70% participation rate at wave 1 is considered feasible if effective recruitment and engagement strategies based on local and international experience are implemented.
- The estimated achieved sample size at wave 5 is the total number of respondents who continue to participate in the study, accounting for attrition (estimated to be 20% over five waves, consistent with the LSAC experience).

It is our recommendation that the *New Australian Birth Cohort Study* uses the largest sample size possible, within fiscal constraints, in order to obtain reliable data about children living and growing up in all states and territories of Australia and to provide reliable data on disadvantaged subgroups (as described in section 6.2.4).

Table 4: Sampling options for the *New Australian Birth Cohort Study* (minimum sizes)

	Target sample size	Estimated achieved sample size (wave 1)	Estimated achieved sample size (wave 5)
1. Sample representative to national level	~17 800	~12 500	~10 000
1.1 Sample representative to national level and generating data for disadvantaged subgroups	~28 000	~19 700	~15 700
2. Sample representative to jurisdictional level	~28 600	~20 000	~16 000
2.1 Sample representative to jurisdictional level and generating data for disadvantaged subgroups	~37 800	~27 200	~21 200

A detailed explanation of how we calculated the minimum sample size for each option is set out in the sections following.

6.2.1 National representativeness requires 12 500 respondents at wave 1

Survey data from a birth cohort study are often used to provide national estimates of child outcomes. It is therefore important to ensure that these estimates are representative and statistically accurate at the national level. National representativeness at the country level is the status quo as currently provided in LSAC, and accuracy at lower jurisdictional and geographical areas requires a larger sample size (see section 6.2.3).

To achieve national representativeness in the *New Australian Birth Cohort Study,* states and territories could be grouped across three strata, with births then randomly sampled to ensure a broadly proportional allocation of the sample from within each geographical group. The groups would be based on comparability in terms of population size:

1. New South Wales, Queensland and Victoria
2. Western Australia and South Australia
3. Tasmania, Northern Territory and the Australian Capital Territory.

We recommend a minimum sample size of 500 in each grouping to support reliable statistical analysis. This determination is based on the following factors:

- In the 12 months to August 2011, there were approximately 276 000 births in Australia (ABS Census 2011).
- A sample size of approximately 400 is the minimum required when computing robust statistical estimates to within 5% of the true population value with a 95% level of confidence. This assumes that the statistical estimate for a measured outcome is reported as a proportion of the total population.
- If a higher degree of accuracy is required to achieve an estimate of within 3% of the true population value with a 95% level of confidence, then a larger sample size of 1068 is required.

Table 5 shows a proportional selection of births from the three geographic groups, illustrating that the minimum sample size can be reached with an achieved sample of 12 500 at wave 1.

Table 5: Sample allocation by geographic groupings for a nationally representative study

State/Territory	2011 Births	% Births	Allocation for achieved sample (wave 1)
New South Wales, Victoria and Queensland	213 877	77.0	9625
South Australia and Western Australia	48 070	18.0	2250
Tasmania, Northern Territory and Australian Capital Territory	13 978	5.0	625
TOTAL POPULATION	**275 925**	**100**	**12 500**

We note that if users need to compute estimates to state and territory level using data collected under this sampling approach, they will need to apply complex statistical weights to produce results.

6.2.2 Boosting the sample for Indigenous and disadvantaged families is recommended

Children and families who experience social and economic disadvantage are largely invisible in LSAC, despite being among the most at-risk and relevant to social policy. To build a credible longitudinal data resource for Indigenous and disadvantaged families, as well as more advantaged families, we need to oversample key population subgroups of policy interest.

It is not possible to collect data from a sufficient number of respondents in subgroups of particular policy interest within a nationally representative approach of 12 500 respondents because the proportional allocation of the sample to these subgroups is relatively small; just 375 Indigenous births (3%) and 625 births from persistently disadvantaged families (5%) would be included. This is not sufficient to provide robust statistical estimates for comparison with other subgroups.

Oversampling of Indigenous and persistently disadvantaged families is recommended if a nationally representative sample is used, resulting in a minimum achieved sample of 19 700 at wave 1.

To calculate the oversample for disadvantage in the *New Australian Birth Cohort Study*, we have defined four sub-populations upon which to base the study sample.

1. Indigenous (3% of the Australian population)
2. Persistently disadvantaged (lowest 5% of people on a disadvantage index)
3. Moderately disadvantaged (people on lowest 5-25% on disadvantage index)
4. Advantaged.

This process of defining sub-populations for oversampling is modelled on the approach used in the *Millennium Cohort Study.*

Using this approach, we recommend a total oversample of 7200 respondents from the Indigenous and persistently disadvantaged populations:

- Recruiting an additional 2750 Indigenous respondents will enable comparisons across five to six groups of Indigenous families on key variables (such as families living in urban locations compared with families in regional/remote locales).
- Recruiting an additional 4450 respondents from persistently disadvantaged families will ensure that there is enough sample to make comparisons across groups of interest for these families and to maintain a ratio of sample between persistently disadvantaged families and Indigenous families that is consistent with the ratio in the broader population (5% and 3%).
- The other groups (moderately disadvantaged and advantaged) do not need to be oversampled because they will be sufficiently represented.

With a small adjustment to the proportional allocation to boost the samples in the smaller state/territory group, a sample of size 12500 will achieve a sample of 1250 across Tasmania, Northern Territory and Australian Capital Territory; a sample of 2500 across South Australia and Western Australia (1250 from each State); and 8750 across New South Wales, Victoria and Queensland (approximately 2915 from each State).

Table 6: Suggested approach to oversampling disadvantage to achieve representativeness at the national level

State/Territory	Allocation for achieved sample of 10 000 (Wave 1)	Reallocation of sample for disadvantage	Total with oversampling
New South Wales, Victoria and Queensland	9625	8750	13 790
South Australia and Western Australia	2250	2500	3940
Tasmania, Northern Territory and Australian Capital Territory	625	1250	1970
TOTAL POPULATION	**12 500**	**12 500**	**19 700**

6.2.3 Jurisdictional representativeness is possible with 20 000 respondents

We consider that national representativeness with stratification by states and territories is important in a new Australian birth cohort study, and perhaps more important than in other countries where jurisdictional differences are not so significant and the population is not as dispersed. If feasible, the *New Australian Birth Cohort Study* should be designed so that reliable comparisons can be made between states and territories. This will allow policymakers to study the impact of national policies by region, and to assess how state/territory and other geographic and jurisdictional variations influence outcomes.

We consider that a minimum achieved sample size of 20 000 at wave 1 will produce study data that is representative by states and territories.

Table 7: Sample allocation by states and territories

State/Territory	2011 Births	% Births	Achieved sample size (wave 1)
New South Wales	89 296	32.0	6065
Victoria	67 123	24.0	4545
Queensland	57 458	21.0	3980
South Australia	18 654	7.0	1325
Western Australia	29 416	11.0	2085
Tasmania	5947	2.2	730
Northern Territory	3299	1.2	620
Australian Capital Territory	4732	1.6	650
TOTAL POPULATION	**275 925**	**100**	**20 000**

Consistent with our previous assumptions (stated in section 6.2.1), a minimum sample size of 500 is required in each of the geographic groups to support reliable statistical analysis; this sample size needs to be maintained at wave 5 of the survey. In this case, it means a minimum sample size of 500 in each of the smaller states and territories (Tasmania, Northern Territory, and Australian Capital Territory), after accounting for 20% study attrition. If the *New Australian Birth Cohort Study* does not achieve the minimum of 500 study children within each state and territory at this point in the study, the accuracy of the data will be compromised. An oversample of approximately 1000 respondents could be used to maintain a sufficient number of respondents in the Northern Territory, the Australian Capital Territory and Tasmania after five waves. This would be an efficient strategy to maximise the resulting data within resourcing constraints.

Users will readily be able to compute estimates to state and territory level using data collected under this sampling approach.

6.2.4 Sample boosting for Indigenous and disadvantaged families remains essential

Like the nationally representative sampling approach, it is also not possible to collect data from a sufficient number of respondents from Indigenous and deeply disadvantaged families, if state and territory differences are built into the sampling design. Oversampling is again recommended.

We recommend a total oversample of 7200 respondents from the Indigenous and persistently disadvantaged sub-populations in the *New Australian Birth Cohort Study* if a sampling approach is selected that achieves representativeness by jurisdiction. The moderately disadvantaged group will

make up an estimated 20% (5440) of the sample of 27 200 respondents, and will not need to be oversampled. The sampling rationale is as follows.

- The state/territory representative sample would only yield approximately 600 Indigenous births without oversampling; recruiting an additional 2750 Indigenous respondents will enable longitudinal comparisons after attrition across five to six groups of Indigenous families on key variables (such as families living in urban locations compared with families in regional/remote locales).
- The original state/territory representative sample would yield just 1000 births from persistently disadvantaged families and requires an additional 4450 respondents.
- The result is an achieved sample size of 27 200 births at wave 1.

6.2.5 Existing indices and records enable specific oversampling by disadvantage

There are established mechanisms in place in Australia to support oversampling of population subgroups. The *New Australian Birth Cohort Study* could use the following existing information for viable probability sampling by area:

- Socio-Economic Indexes for Areas (SEIFA), specifically the Index of Socioeconomic Disadvantage (to identify ABS Statistical Area Level 1 units corresponding to high proportions of disadvantaged and Indigenous families)
- Centrelink welfare recipient data (to identify disadvantaged families, within SEIFA, who are considered to be disadvantaged or persistently disadvantaged).

There are also several viable options for a population sampling frame for the new Australian birth cohort study, including but not limited to:

- birth registries (most up-to-date but with data custodianship by state governments)
- Medicare Australia records (variable lag-time in birth registration but with data custodianship by the Australian Government).

6.2.6 Some comparability with LSIC may be possible with an oversampling approach

When oversampling Indigenous births by geographical area, it may be possible to select several areas that are closely related to the areas chosen for LSIC.

Continuity with LSIC should be considered when selecting the Indigenous sample, keeping in mind that any cross-cohort comparisons will be limited by the small and decreasing respondent sample in LSIC. In the *New Australian Birth Cohort Study*, Indigenous births within a selected geographical area should be randomly selected from the chosen sampling frame. If the Statistical Area Level units correspond to those included in LSIC, it may be possible to achieve some cross-cohort comparisons with LSIC through careful weighting of the data. This will inevitably be difficult due to LSIC's purposive sampling strategy but it is not impossible.

Questionnaire design will also be an important factor if comparisons are made between the two studies. LSIC questionnaires were specifically designed to consider the uniqueness of Indigenous language, culture and circumstances. Not all questions asked of non-Indigenous families will be appropriate for Indigenous families (and vice versa). For this reason, measures required for comparisons must be well thought through in advance of the *New Australian Birth Cohort Study* to ensure consistent measurement across the two groups. Where measures are adapted to be culturally sensitive, the corresponding questions used for non-Indigenous families should be closely examined and tested to ensure that the interpretations from both sub-populations can be compared.

Considerable effort will be required to ensure the measures are semantically and normatively equivalent across the Indigenous and non-Indigenous sub-populations.

6.2.7 Geographic clustering allows for analysis of community effects

A multi-staged sampling strategy is also suggested for the *New Australian Birth Cohort Study*. This will achieve a representative sample, with some clustering of births by geographical area (known as geographical clustering) to enable measurement of community variation and effects.

To ensure that births are sampled from across urban, regional and remote areas, the states and territories of Australia need to be stratified (partitioned) by the major cities and the rest of state using the ABS Australian Statistical Geography Standard 2011 system of classification.

Regions defined by the ABS Statistical Area Level 2 classification are general-purpose, medium-sized areas that aim to represent a community, interacting together socially and economically, and could be randomly selected from within each stratum. For the Statistical Area Level 2 regions selected for participation in the study, the smaller ABS Statistical Area Level 1 units (200-800 people) in the Statistical Area Level 2 regions could be further sampled to form clusters of communities. Births could then be sampled from the chosen sampling frame with residential addresses corresponding to selected Statistical Area Level 1 units.

Geographic clustering is cost-effective because it concentrates data collection. It also supports the examination of community effects because sample members are drawn from the same spatial units. Geographic clustering was used in LSAC and is likely to be useful again in the *New Australian Birth Cohort Study* for both practical and methodological reasons.

6.3 Improved biophysical measures are vital to population health

DESIGN PRINCIPLE 3: Use enhanced *biophysical measures* collected via multiple modes.

Using biophysical measurements is vital for establishing the social and biological basis of disease and ill-health and informing preventive health measures. Increasing the scope of biophysical measures in our national birth cohort data is one of the most exciting opportunities in the *New Australian Birth Cohort Study*.

6.3.1 New and improved methods enhance data collection

Since LSAC began in 2004, new and improved methods in both the social and the biological sciences have emerged. These can be used to track key aspects of a child's development and identify factors of influence in increasingly sophisticated and reliable ways. Examples include:

- advancements in the objective measurement of a child's individual growth and functioning
- better measures of the environment through geographic information system coding
- improved data collection based on advances in technology, such as web and mobile application assessments that capture information as it is generated.

With very large sample sizes, biophysical measures can be used to build genetic databanks and interrogate the incidence of health conditions that may be relatively rare. This is possible in the *Life Study*, the *Danish National Birth Cohort* and the *Norwegian Mother and Child Cohort Study*, which all have sample sizes over 90 000. Biophysical measures in the smaller *New Australian Birth Cohort*

DNA samples for genomic analysis are increasingly seen as a cornerstone of cohort data collection

Study are still very important and may have increased value in the future as analytical processes in this area develop further.

Objective and direct health measures obtained by health professionals are crucial, especially during rapid growth in early life when objective measurements are important for ascertaining if key developmental milestones have been reached. Well-established protocols are needed for basic metrics of body composition and the assessment of physical and cognitive capabilities. Opportunities may arise to train the caregiver in the appropriate method for collection of basic anthropometric data, such as for a child's height and weight. Even under such circumstances, measures obtained under controlled conditions provide an objective point from which to validate subsequent survey data.

Other biophysical data may require specialist equipment and professional techniques for young children, facilitated through a home or clinic visit. These visits also help to reduce non-response for these measures, such as taking blood samples that can subsequently be used to test for biomarkers and the early detection of disease. DNA samples for genomic analysis are increasingly seen as a cornerstone of cohort data collection, with research rapidly advancing on the interplay of genetic and epigenetic factors that predispose an individual to or protect against poor health outcomes. Recent findings have examined distinct epigenetic signatures that reflect child and adult socio-economic status. They suggest that low socio-economic status in early life changes gene expression in ways that may be linked to adverse health outcomes in adult life (Borghol et al. 2012). This illustrates the value of biophysical measures in showing how biological and environmental factors jointly determine health and other outcomes

Home-kits are available for obtaining swabs. However, collecting samples on the occasion of a clinic or home visit by a health professional is a more effective method. It not only ensures sample quality (reducing the risk of contamination), but an on-site health professional is invaluable for providing information and reassurance about the use of DNA data. This is likely to take on further importance as participants gain awareness of the extensive implications of DNA analysis.

6.3.2 In situ data collection is now effective and inexpensive

Another advantage of home visits is the opportunity to either supply or collect portable monitoring devices that are becoming increasingly sophisticated, convenient and affordable. These devices can be worn by the participant (accelerometers that measure physical activity) or placed in the home (to measure pollutants or particulate matter). These in situ data provide a far more accurate and detailed assessment of risk than is possible from simple categories based on survey data. Accelerometers, in particular, are a relatively inexpensive mode of data collection that are easy for respondents to use and have been trialled effectively in the *Millennium Cohort Study* and the *Avon Longitudinal Study of Parents and Children*.

6.4 Early-life measurement can predict later life outcomes

DESIGN PRINCIPLE 4: Facilitate early-life measurement including prenatal factors.

The *New Australian Birth Cohort Study* should collect prenatal and postnatal information that has been shown to influence future life outcomes. This information should not be confined to the child but should include information collected directly or indirectly from parents on:

- prenatal physical measures relating to the parents and the unborn child
- prenatal information on values and expectations of the parents with regard to childrearing

- physical and biological measures, such as samples from placenta, umbilical cord, blood, urine and saliva samples, and a sample of the dried blood spot used for newborn screenings.

6.4.1 Collection of prenatal data is feasible within a nationally representative study that is carefully managed

Sampling pre-birth is attractive because it means that we can collect the best prenatal and early-life measures. Capturing this information before the birth of the study child (where possible and relevant) means that issues such as recall bias are controlled. The *Avon Longitudinal Study of Parents and Children* (South East England) and the *Growing Up in New Zealand Study* sampled from hospitals and birthing centres within the selected areas to recruit pregnant mothers pre-birth. Because mothers were selected while pregnant, all social, physical and biological measures related to the mother and unborn child could be collected directly. In addition to medically related measures, social and attitudinal measures could also be collected from the mother pre-birth.

There are challenges inherent in doing this in Australia. There is a risk that a sample recruited through hospitals and birthing centres might not be nationally representative. We have already noted the importance of using a nationally representative area-based design. This means that the *New Australian Birth Cohort Study* can be used to make reliable national population estimates and conduct state and regional analysis as well as deliver robust comparisons with LSAC data.

Capturing all desirable information pre- and post-birth requires a national list of all pregnant mothers several months before giving birth. Although lists of hospitals and birthing centres could be compiled by each state and territory, the list would not be exhaustive, excluding mothers who chose not to give birth in registered hospitals or birthing centres. Hospitals and birthing centres could be selected into the study using a multi-stage design that used stratification by area and by size of hospital/centre within an area (related to number of births within a period of time). However, this is a highly clustered area-based study requiring a large number of participants from each centre. There is a risk that it may not be sufficiently representative of child outcomes across Australia.

The alternative is to design a representative study similar to that used for LSAC which includes a selection of children post-birth and uses a stratified area-based design. This allows comparability across cohorts. The linkage with pre-birth medical records enables partial access to prenatal data. If the *New Australian Birth Cohort Study* uses this approach, children will be selected for the study post-birth and consent will be obtained from the child's mother or guardian to access appropriate hospital, general practitioner and medical records for both mother and baby. Data on values and expectations of parents and families pre-birth are difficult to collect under these circumstances, but medical and biological data can be obtained more reliably.

There is no question about the value of collecting prenatal data and early-life measures, given their demonstrated relationship to later life outcomes, and the relative merits of approaches to collect this data (pre-birth sampling or retrospective data linkage) need to be carefully considered when designing the final specifications for the *New Australian Birth Cohort Study*.

6.5 Data linkage builds data quality while reducing costs

DESIGN PRINCIPLE 5: Capitalise on existing administrative data through extensive *data linkage.*

Data linkage can produce comprehensive information about growing up in Australia. Many sources of administrative data are accessed by our health, education, welfare and justice systems. Such data can provide detailed longitudinal information about the circumstances of a child's life course that

would otherwise be missed in a cohort study. The data can be used to place a child's wellbeing outcomes into context.

Data linkage can also be used to reduce the burden of research for study participants, particularly those from hard-to-reach groups. Study participants quickly experience response fatigue if they are repeatedly asked for information that they have already provided in previous surveys or for administration. Linking to existing data records avoids unnecessary questioning and also reduces recall error.

Important new opportunities exist to extend and enhance data linkage in the *New Australian Birth Cohort Study*

6.5.1 Data linkage should be incorporated from the inception of the study

The *New Australian Birth Cohort Study* should continue to link the following administrative records to the new dataset in relation to the study child, as previously done in LSAC:

- Australian Early Development Index (for early childhood development across communities)
- NAPLAN data (for educational attendance and achievement)
- Medicare Australia data (for child health costs and immunisation records)
- the National Childcare Accreditation Council (for nature and quality of childcare used)
- ABS population census data (for aggregate population characteristics and social context).

Important new opportunities exist to extend and enhance data linkage in the *New Australian Birth Cohort Study* and increase the scope and rigour of results. The new administrative data that could be linked to the new study include:

- welfare payment data for parents and family members (Department of Human Services) – for calculating the costs and benefits of social welfare measures for children and families)
- childcare census (Department of Education) – for identifying access to and quality of childcare in communities
- national population surveys at the area level, such as national health surveys and labour force surveys – for aggregate statistics on health and employment at the community level
- hospital and clinical data from pre-birth – for early-life measures such as in utero foetal and mothers' health
- policing data – for contact with the criminal justice system
- death registry data – for correct classification of non-response and attrition due to death of a study participant or family member and removal from study contact list
- geographical databases – for showing trends in various population characteristics and forecasts by location.

Potential sources of administrative data that will add value to the data collected by a new birth cohort study should be identified early in the design process to allow data linkage from the beginning of the study, preferably when selecting samples and identifying participants. Seeking consent for data linkage from families at the time of recruitment and when the study is being launched may improve consent rates and is more efficient than having to request permission in later years of the study.

6.5.2 Data linkage practices are now more advanced and feasible

There are several challenges to linking administrative data records with survey data, but it is feasible. A degree of data linkage has been achieved for several studies in Australia including LSAC, LSIC,

Youth in Focus and the *Australian Longitudinal Study of Women's Health*. One of the challenges is managing consent and linking data in the absence of a unique national identifier for an individual that is common across all sources of data. These are available in some international jurisdictions that have National Identity Cards. In Australia, records are instead linked across multiple variables including name, address, and other demographic variables. This can lead to errors in matching records but data integrating authorities have recently been established by the state and federal governments to ensure a high level of integrity in data-linkage processes.

6.6 A family impacts approach tells a more complete story

DESIGN PRINCIPLE 6: Take a *family impacts approach* to better capture the consequences for Australian families of having children.

Compelling evidence continues to emerge on how the personal circumstances and experiences in very early life play a key role in shaping developmental trajectories throughout the life course. It is essential that this information is incorporated in the *New Australian Birth Cohort Study*. The converse is true as well: having a child has consequences for everyone in the family and there is an opportunity in the *New Australian Birth Cohort Study* to capture better measures of this interplay.

6.6.1 Family characteristics and behaviours are integral to child development and to outcomes for parents and families

LSAC already collects comprehensive information on parenting behaviours, parental education and employment, parental networks and community characteristics. The primary parent also reports in detail on the study child. Other information is also collected from a secondary carer in the household, or a parent living elsewhere, if non-resident (from wave 2 onwards). Limited information is also collected about the quality of relationship between children and parents.

The primary focus of parental information is to address outcomes for children. The impact on family members of having a child is not sufficiently explored in LSAC. This is an important opportunity because the study has already established the basis for research contact. For adults, the birth of a child and subsequent parenting has many impacts we do not yet fully understand such as the effect on identities and attitudes to issues such as education, work, employment and gender roles, physical and mental health, and economic and social participation. The birth and raising of a child also impacts on existing family relationships among parents, other children and extended family. These factors can also affect parental education and employment, parents' relationship quality, family stability, parenting behaviours, and the economic and social wellbeing of the family.

If we collect from data from and about parents, the *New Australian Birth Cohort Study* represents a relatively modest extension of the LSAC model. If some reporting on siblings is also included, the study could provide a broader evidence base to address policy in relation to:

- economic and social outcomes for parents
- relationship quality between parents and related issues such as family stability, divorce and separation
- the economic and social wellbeing and participation of the family
- sibling effects on infant and child outcomes.

6.6.2 Community effects need to be untangled from family circumstances

Individual child outcomes may be influenced by the characteristics they are born with, and their family circumstances, but they will also be influenced by the neighbourhoods and community environment in which they live and how this changes as they grow. Therefore, data also need to be collected on the child's community including neighbourhood resources, availability and characteristics of childcare, pre-schools and schools. The quality of childcare received outside the home, the school environment and the social and economic characteristics of other households and families within the neighbourhood may all influence a child's educational and wellbeing outcomes.

The advanced statistical techniques and computational power for analysing complex multi-level data from the study now exist

Again, LSAC contains good measures of community resources and characteristics through parent questionnaires. There is scope in a new larger study to incorporate additional measures that more comprehensively profile the structure, resources and constraints of communities and networks, and to link new data on factors such as services and service use at the geographic level. LSAC has already been linked to Medicare, NAPLAN, and childcare administrative data. Additional federal and state data on topics, such as school infrastructure and school climate, could more fully capture processes associated with children being born into families in communities, and interacting with institutions including schools, childcare, health and social services.

Untangling these higher level community effects from the effects of family and individual behaviours and characteristics is essential. These influences need to be considered simultaneously and unpacked to determine their effects. The advanced statistical techniques and computational power needed for this now exist.

6.7 New technologies maximise efficiency and innovation

DESIGN PRINCIPLE 7: Use *new technologies* for data collection and communicating results.

Technological advances present exciting opportunities to generate evidence with greater efficiency, minimise the attrition of study participants, and encourage broader engagement in research and policymaking.

6.7.1 Passive data collection is increasingly useful under consent conditions

Passive data collection is one of the most important developments in social survey research. Mobile device data are increasingly being used to collect instant information from respondents and achieve significant cost efficiencies. One in three primary school children have their own mobile phone, and children as young as eight carry smartphones (Australian Communications and Media Authority 2013). Internet use is seen as increasingly important by Australian children as demonstrated by an Australian Communications and Media Authority study finding that the proportion of eight to nine year olds who felt the internet was at least "very important" in their lives had almost doubled from 25% in 2009 to 49% in 2012. The *New Australian Birth Cohort Study* could also capitalise on the accessibility of digital trace data generated through this activity.

It is not possible to predict all the opportunities that are inherent in new technology for the *New Australian Birth Cohort Study*, but recent advances are indicative of the scope. Wearables such as Fitbit® capture comprehensive information about activity and sleep. Google Glass® is leading innovation in video capture. When using these devices to capture real-time data, there is no lost or wasted data.

Under the right conditions of consent, passive data collection from children and their families is a possibility for the *New Australian Birth Cohort Study*. Mobile devices capture a great deal of detail and they are likely to be the most efficient and appropriate means of collecting data passively for a limited period (e.g. one week per year).

CASE IN POINT: Children prepare digital diaries for UK research

Children at schools in East Sussex in the United Kingdom are using digital media to personally record and document their lives as part of a new study being launched by the Centre for Innovation in Research in Childhood and Youth in 2014. Students participating in the *Curating Childhoods* study will use videos, photographs and other media to record a day in their life, and the resulting rich mixed-mode data will be archived in the United Kingdom's Mass Observation Archive.

6.7.2 New media offer new engagement opportunities

Incentives for participation in the study can be generated through enhanced communication of the research results using new technologies, such as interactive websites and social media. In Australia, the ABC produced the *Life Series*. It follows a small group of children as they grow up and uses their experiences to illustrate and communicate scientific evidence on child development to a broad audience of television viewers. The *Life Series* is inspired by LSAC data and research findings. An effective engagement plan such as this can create a sense of value and belonging for *New Australian Birth Cohort Study* respondents. This may also help to reduce respondent attrition.

6.8 Implementation issues are successfully managed in Australia and overseas

The following implementation considerations have been successfully managed in Australia and overseas in relation to existing longitudinal birth cohort studies:

- Development of measurement protocols for data collectors.
- Ethical clearance for research involving human participants.
- Data storage capacity and protocols.
- The maintenance of data protection and confidentiality.
- Recruitment and retention of respondent children and families.

These issues, among others, are relevant to the *New Australian Birth Cohort Study* but there are sufficient exemplars and precedents to indicate that their management is viable.

CHAPTER 7
Policy and economic benefits of the new study

7 POLICY AND ECONOMIC BENEFITS OF THE NEW STUDY

KEY POINTS

- A new Australian birth cohort study, and in particular one used in parallel with LSAC, would help inform a range of policy concerns of relevance to the Australian Government, including those yet unknown that it may face in the near future.
- The *New Australian Birth Cohort Study* would generate up-to-date data and new knowledge about important social processes and patterns.
- The data could be used to assess the impact of policy initiatives:
  - by comparing LSAC cohorts with the new birth cohort children if a policy change has occurred between generation groups
  - through comparisons within the new birth cohort if a policy change affects some cohort children and not others
  - by using the cohort as a control group for policy experiments in circumstances where a policy change affects children outside the study whose outcomes can be reasonably compared to the cohort.
- Improved knowledge from the *New Australian Birth Cohort Study* could be used to design policy solutions and early interventions that are informed by good evidence. This would reduce the risk of implementing and maintaining policies that do not achieve their intended effects or are not cost-efficient.
- Cost-savings would flow on to the government through improved policy solutions, better targeted interventions, and ultimately, improved individual and population outcomes for Australian children and families.

We have considered several policy examples with a view to illustrating the real-world impacts of implementing the *New Australian Birth Cohort Study*. We show how the study could benefit the next generation of Australian children and their development by addressing childhood obesity, social disadvantage, parents' workforce participation, and childcare support and standards. Each policy concern has distinct challenges that could be best informed by new longitudinal data, as summarised in Table 6. The range of policy concerns that could be addressed is much broader.

EXAMPLES OF POLICY CONCERNS RELEVANT TO THE NEW AUSTRALIAN BIRTH COHORT STUDY

- Childhood poverty and social disadvantage affect cognitive development and brain size (Hanson et al. 2013). What are the most effective intervention strategies for supporting children from disadvantaged families, and how can Australia's income support system best support children and families at risk?
- Around one-quarter of Australian children are obese (ABS 2012). How can we curb increasing rates of childhood obesity to improve health outcomes for young Australians and reduce associated health costs?
- The labour force participation rates of mothers in Australia are low (OECD 2014). How can the labour force participation rates of mothers be improved during the intensive childrearing years, and what is the relationship between infant health and paid maternity leave?
- The Australian Government has projected that its childcare spending will rise from $6.7 billion in 2013-14 to $8.5 billion by 2017-18 (Productivity Commission 2014). How should childcare support best be allocated to families? In what numbers and where are childcare services needed? And what requirements should be imposed on services?
- Children who bully at school are at significant risk of antisocial criminal and poor health outcomes in later life (Lodge 2014). What are the factors that may interrupt the developmental trajectory towards antisocial behaviour and how can anti-bullying interventions be most effective?
- Around 21% of young Australians are likely to experience mental illness (Ivancic et al. 2014). What are the costs and benefits of prevention, identification, early intervention and treatment for high prevalence mental health conditions such as depression in young people?
- 72% of Australian teenagers go online more than once a day (Australian Communications and Media Authority 2014). What is the optimum level of digital engagement for children to support cognitive and physical health and ensure they are equipped with the skills to participate in the digital economy?
- The *Family Violence Act* enacted changes to family law in 2012, including changes to reporting of family violence and child abuse. What are the effects of changes to family law in Australia on children and families?
- The Australian Government is implementing a $28.4 million Remote School Attendance Strategy to support education participation by Indigenous children. What interventions are most effective in supporting Indigenous families to give their children a good start in life through schooling?
- Youth unemployment has continued to rise since the Global Financial Crisis in 2008; in February 2014 the unemployment rate for 18-24 year olds was 28% (Roy Morgan 2014). What are the downstream impacts of diminished job opportunities for this generation, and how can their prospects be improved through education?

Table 6: Examples of how the *New Australian Birth Cohort Study* would build Australia's data capability and better inform policy

CURRENT CAPABILITY	CAPABILITY WITH NEW STUDY	POTENTIAL POLICY IMPACTS
How can we improve educational outcomes for children from very disadvantaged families?		
Low–Moderate • insufficient analytic sample sizes for disadvantaged subgroups • dated information (economic and social context for disadvantage has changed since LSAC and LSIC started) • good linkage to Australian Early Development Census and NAPLAN	**High** • increased data linkage (Centrelink, Australian Tax Office, the Australian Early Development Census, NAPLAN, comprehensive state education data) • oversampling of disadvantaged subgroups, allows detailed investigation (by state/territory, community, household structure, extent or duration of disadvantage) and more robust analysis • cross-cohort comparisons enable the identification of changing trends • a strong control group for matching with new intervention groups	**Significant (economic and social)** • design, monitoring and evaluation of targeted interventions for children from at-risk families • strong evidence base to examine cost-effectiveness of early intervention • reduced health, social welfare and other costs and increased social and economic participation associated with children from welfare dependent families
What are the consequences for education and employment of intergenerational welfare dependency?		
Low–Moderate • Department of Social Services administrative data can identify extent of intergenerational welfare dependency only • unlinked administrative data do not contain other relevant information (parent and offspring attitudes to work and employment, occupational and educational plans and aspirations, parenting practices, risk factors and social/environmental exposures) • linking administrative data to LSAC does not provide sufficient sample size	**High** • linking administrative data to new cohort allows detailed investigation of individual, family, and ecological/contextual factors associated with welfare dependency, education and employment for parents and carer • oversampling disadvantaged subgroups allows detailed investigation by state/territory, community, household structure, payment type, extent or duration of disadvantage • linking LSAC and *New Australian Birth Cohort Study* data with relevant administrative datasets could be used to track the movements of new parents on and off-benefits and measure related outcomes for children over time (e.g. cognitive development, educational outcomes)	**Significant (economic and social)** • potential redesign of the income support system for best effects in reducing intergenerational welfare dependency • testing and monitoring of policy changes to eligibility criteria and conditions • improved understanding of the flow-on effects of income support system changes to other government programs and payments • curbing of welfare churn and benefit substitution through evidence-informed policies

CURRENT CAPABILITY	CAPABILITY WITH NEW STUDY	POTENTIAL POLICY IMPACTS
How do in utero exposures predispose children to obesity?		
Moderate • some evidence linking pregnancy complications, such as gestational diabetes, with offspring obesity • limited data on influence of maternal diet and physical activity in utero for obesity risk among today's children • *Child Health CheckPoint* data (used with LSAC) starts at age 11–12 years only so there is an absence of longitudinal early-life measures	**High** • data on combination of exposures in utero • baseline data on risks of childhood obesity	**Significant (economic and social)** • identification of at-risk children based on prenatal and early-life data • design and monitoring of interventions that address maternal and parental factors (incl. diet and lifestyle behaviours) • improved health outcomes for at-risk children and reduced associated health costs
What is the right mix and timing of interventions to reduce obesity?		
Low–Moderate • some evidence on risks associated with growth rates in early life, such as catch up growth for low birth-weight babies. • limited data on the combination of factors operating in the family context (pre and post natal) that influence growth rates and body composition • individual and population risks change over time and contemporary risks are not captured	**Moderate–High** • new data to investigate the role of parental behaviours in setting of childhood dietary patterns and physical activity levels • cross-cohort comparisons between LSAC and *New Australian Birth Cohort Study* enable identification of changing or new exposures in early life, such as the impact of a shift from television to tablets on physical activity and screen time	**Significant (economic and social)** • identification of critical periods (specific time windows) for targeted health interventions • evaluation of health interventions, as both single programs and based on cumulative multi-program effects • reduction of the disease burden (economic and social) of long-term obesity in children and adults • identification of emerging risk factors for timely preventive health interventions rather than reactive policy development
How should Australia's paid parental leave scheme be targeted to ensure children get the best start in life?		
Moderate • isolated datasets on paid parental leave and infant health and wellbeing cannot be linked • one-off 2005 study nested in LSAC (the Parental Leave in Australia Survey) is now dated • post-PPL data has not been collected • insufficient sample sizes for policy groups of interest (e.g. sole-parent households, disadvantaged sub-populations)	**High** • quasi-experimental data on LSAC (children before paid parental leave) and the *New Australian Birth Cohort Study* (children after paid parental leave) for identification of policy effects • linkage with administrative databases (Australian Tax Office, Centrelink, Medicare and education records) increases accuracy of available data • important data relating to direct effects (birth outcomes) and indirect effects (reduced stress and increased capacity for caring by mothers; increased involvement by fathers)	**Significant (economic and social)** • justification of paid parental leave income thresholds and conditions based on research evidence • determination how much time in paid leave mothers and fathers are provided

CURRENT CAPABILITY	CAPABILITY WITH NEW STUDY	POTENTIAL POLICY IMPACTS
How can childcare support be allocated most efficiently to support both early childhood development and labour force participation by families?		
Moderate • a range of children's outcome variables and the extent of parental labour force participation in LSAC • limited information on childcare options available to families (formal or informal) • limited coverage of disadvantaged and vulnerable families	**High** • oversampling of disadvantaged and vulnerable families enables inferences to be made for all relevant subgroups • linkage with administrative data from the Federal Department of Education datasets such as the Child Care Management System and the National Early Childhood Education and Care Workforce Census • detailed information on children's outcomes and parental participation in the labour force	**Significant (economic and social)** • more efficient resource allocation for children from disadvantaged families • targeting of childcare support payments for best effect • determination of the appropriate mix of childcare services to support labour market engagement by parents and early life outcomes for children • optimisation of labour force participation without endangering child health and wellbeing
How can developmentally vulnerable children be identified and supported through the childcare system?		
Low • LSIC provides detailed information for Indigenous Australians, who are one specific group of vulnerable families • comparisons between LSIC and LSAC (or other data on the general population) is difficult due to the use of different measures and sampling approach • limited coverage of disadvantaged and vulnerable families	**High** • oversampling of disadvantaged and vulnerable families, including children with an Indigenous background, so inferences can be made for all relevant subgroups. • collection of detailed child outcome information, and information on the activities and characteristics of the chosen (and available) childcare services	**Significant (economic and social)** • targeted interventions to support at-risk children achieve developmental targets before they start school • contribution to reducing inequality in Australia

7.1 Reducing disadvantage for at-risk children and families

FACTS UP FRONT

- Approximately 5% of Australians experience deep and persistent social and economic disadvantage (McLachlan et al. 2013)
- In 2010, 24.1% of children in one-parent households lived in poverty, up from 20.8% in 2001 (Wilkins 2014).
- Longitudinal research overseas shows that early life experiences of poverty influence the rate of human infant brain development (Hanson et al. 2013).
- Reducing disadvantage leads to enhanced social and economic participation and productivity, and reduced costs in relation to healthcare, welfare and justice, making government funds spent on responding to disadvantage available for other purposes.

7.1.1 The dynamics of disadvantage need to be understood to reduce it

Australia's strong economic growth over the last 20 years has improved economic opportunities and living standards. Yet there is increasing concern from policymakers that some Australians have not benefited and have instead been disadvantaged (McLachlan et al. 2013), which prevents families and individuals from realising their full potential for lifetime wellbeing.

Deep disadvantage is associated with financial hardship, social and physical isolation, chronic or persistent health problems, family breakdown, and missed opportunities for social and economic participation. The personal cost means that the lifetime wellbeing of those experiencing disadvantage falls short of its potential. To communities and society, disadvantage is potentially associated with social problems such as crime, unemployment, homelessness, lower social connectedness, a weaker civil society and threats to social cohesion. Little is known about how people move in and out of disadvantage and how it is passed from one generation to the next.

The income support system and other related policy mechanisms aim to provide a safety net for Australians who are unable to support themselves and their families through work, savings or other means. This results in a continual requirement for data to help the government understand the implications of policy changes on outcomes for children and families, including those most at risk of persistent disadvantage.

Families and schools are also important sites of intervention for policymakers. Interventions need to be rigorously tested in these sites to determine the optimum mix and timing of preventive and remedial policy solutions to address disadvantage for children growing up in Australia. Research may point to other relevant sites for intervention.

7.1.2 Existing data on disadvantage are insufficient and increasingly dated

The lack of data is one of the key barriers to developing an effective evidence base for understanding and addressing disadvantage in families and its transmission to children living in disadvantaged families (McLachlan et al. 2013). Longitudinal data are essential to understand key features of Australian disadvantage, such as its distribution, causes and downstream effects. These data must track people over their lifetime and take account of the community, family, economic and social contexts within which their lives are embedded. Currently, available data provide some snapshot information but are insufficient in breadth and depth for detailed policy development.

The new study would enable robust analysis of disadvantaged subgroups that are of particular policy interest

Birth cohort studies that apply life course theory to human wellbeing can inform and address the policy problems of deep and persistent disadvantage. The existing key resources are longitudinal studies such as LSAC and LSIC, as well as panel longitudinal studies (including multiple cohorts) such as the *Household, Income and Labour Dynamics in Australia* survey and *Journeys Home* study. The world has changed substantially since LSAC and LSIC started. Not only are the children in LSAC and LSIC ageing but these studies are also becoming dated in other ways. The economic and social context for disadvantage has changed since these studies started. The economic and social processes associated with disadvantaged have also likely changed. Understanding these processes is vital to designing interventions that can make a difference and reduce government expenditure in this area.

Moreover, LSAC is Australia's most significant national birth cohort study but it is too small to generate high quality evidence for small sub-populations. Small birth cohort studies do not enable robust analyses of disadvantaged subgroups that are of particular policy interest. Indigenous people are among Australia's most disadvantaged, but the LSAC sampling strategy engages with only 417 Indigenous children across Australia. This is too small a sample size to draw conclusions on this sub-population. LSIC was designed as a satellite study to supplement LSAC, but the life pathways and outcomes for Indigenous Australian children cannot be accurately compared with other subgroups because of the study design (see section 3).

Existing data resources are not sufficient to inform the evidence base for policy for disadvantage because:

- they do not contain a large enough sample of disadvantaged individuals and households to trace movements into and out of disadvantage, to quantify persistence or life course duration or to robustly establish causes and effects
- the children of LSAC and LSIC are now too old for the birth and early years focus that is critical to understanding how disadvantage affects development
- they are not sufficient in sample size or with respect to some biophysical and social factors to help us fully understand processes of resilience or vulnerability or provide comparative control groups to inform policy and program experiments.

7.1.3 Oversampling of disadvantaged families would be a key feature of a new birth cohort study

The *New Australian Birth Cohort Study* would be a representative large-scale study featuring oversampling of disadvantaged families to address the shortcomings of existing studies for informing the policy challenges of disadvantage. A new study of sufficient size and data richness would provide input for:

- the development of frameworks for the early identification, prevention and remediation of disadvantage, based on an in-depth understanding of dynamics, causes and effects
- systematic analyses of the extent, causes and effects of disadvantage at the population and sub-population level
- policy experiments by providing statistically representative control groups of disadvantaged populations for comparisons with other groups, such as those obtained by sampling from administrative sources

- insight into the factors associated with vulnerability to disadvantage, which would inform policies and programs to promote resilience and address sources of vulnerability
- a comparative basis for analyses of LSAC, or with overseas studies such as the United Kingdom's birth cohort studies or *Growing Up in New Zealand*.

CASE IN POINT: The *New Australian Birth Cohort Study* could be used to evaluate changes to income support eligibility

The Federal Budget 2014 proposed the tightening of eligibility requirements in relation to a range of benefits, including Sole Parent Allowances, Disability Support Payments, and Newstart and Youth Allowance. Analysis of Centrelink administrative data can show the effect of such changes on movements off benefits and between benefits and on payment duration. The *New Australian Birth Cohort Study* could be used to determine the potentially wide-ranging social and economic impacts of these policy changes for adults and children.

Using birth cohort survey data on childhood development linked to the Centrelink, Medicare and Pharmaceutical Benefit Scheme records of parents and children, we can see how being on benefits and changes in benefit status impact on a range of related family outcomes including household income, parental employment, family wellbeing, use of government and non-government support services, and children's health, development and school achievement. The large sample size of the *New Australian Birth Cohort Study* further allows these questions to be examined for different groups, different benefit types or in different communities. The results would provide comprehensive information about the flow-on effects of income support system changes in Australia and resulting cost-benefits in economic and social terms.

7.2 Developing preventive health measures to address childhood obesity

FACTS UP FRONT

- Around 60% of Australian adults are classified as overweight or obese, with more than 25% classified as obese (ABS 2012).
- In line with the adult population, the prevalence of the condition has progressively risen among Australia's children, with one in four (24%) now classified as overweight or obese, rising to one in three (31%) for those living in disadvantaged areas (AIHW 2012).
- Overseas research suggests that children who are overweight in kindergarten are four times as likely as normal-weight children to become obese by year eight (Cunningham et al. 2014).
- Childhood obesity very often progresses into adulthood and the consequences play out at the individual, community and national level.
- In purely economic terms, obesity imposes immense financial burdens on healthcare systems and the community at large. In 2005, overweight and obese Australian adults cost the economy an estimated $21 billion in direct healthcare and direct non-healthcare costs, with an additional $35.6 billion in government subsidies (Colagiuri et al. 2010).

7.2.1 An evidence base is needed to identify emerging risk factors and guide policy for combating childhood obesity

Over the last three decades, Australia and other nations have experienced a rising prevalence of obesity among the general population. Obesity is a serious medical condition linked with markedly increased risks for a wide range of debilitating, chronic and life-threatening conditions in later life, including diabetes, cardiovascular disease, and various cancers. No region or country can yet claim effective programs for dealing with childhood obesity. The priority for Australian policymakers is an evidence base that can guide an integrated and comprehensive set of preventive health strategies and reliably identify effects of existing policies on obesity rates in Australian children.

The emerging risk factors contributing to childhood obesity need to be understood and addressed. Much is known about existing lifestyle factors contributing to childhood obesity, including the risks posed by high levels of sedentary activity and a poor quality diet but the nature of the risks is not static. For instance, the factors operating in the family and school environment continue to evolve for the youngest generation of Australians. There are ongoing changes in information technologies (such as the shift in focus from televisions to tablets) that pose potentially new influences on behavioural patterns, including screen time and physical activity.

CASE IN POINT: The *New Australian Birth Cohort Study* would specify the costs of obesity and inform more efficient solutions

There is an opportunity for cost-benefit analysis of health outcomes for Australian children in the *New Australian Birth Cohort Study*, achieved through data linkage. By linking repeated measures of health and development during childhood (including recorded physical activity levels and the prevalence of obesity) with Medicare Benefit Schedule records and subsidies for prescription medications provided through the Pharmaceutical Benefits Scheme, we can investigate the wider health service costs of sedentary behaviour and obesity in early life.

This data could determine the comparative pharmaceutical costs and healthcare utilisation costs (such as visits to family doctors and specialists provided through Medicare) among obese children and children with different levels of physical activity. At what point do costs increase significantly? What are the overall costs, generalised to the population? What are the variations among different subpopulation groups? How do family and cultural attitudes towards obesity and the availability of health services affect the extent to which parents seek medical help for their children?

The data is also important to understand the costs over time of co-occurring disorders (comorbidities) that are linked with obesity and low physical activity levels. Is there a pattern across comorbidities, relative to physical activity levels? When do comorbid disorders develop? What are the costs and duration of their treatment?

This new knowledge could point to particular development stages where preventive health interventions could make the most difference. This would reduce healthcare costs by avoiding the development of a cluster of adverse health outcomes. The data would also highlight extended treatments and expensive treatments that would be needed less often if obesity rates and physical activity levels were improved.

7.2.2 Early-life factors are important for understanding the prevalence of childhood obesity

The underlying drivers behind rising prevalence of childhood obesity are many and complex. These drivers include behavioural, cognitive, biological and environmental factors that interact and influence

health outcomes and associated costs at an individual and population level. Despite this complexity, the consensus is that during early life, from in utero through to infancy and early childhood, there are critical periods that lead to obesity developing. This applies not only in childhood but also in adulthood.

Dietary and physical activity behaviours established in early life can have persistent effects on adiposity throughout childhood, as the following examples illustrate.

- The offspring of mothers who have gestational diabetes are at much greater risk of obesity and type 2 diabetes later in life (Keith et al. 2006).
- Evidence suggests a link between faster weight gain in early life, rather than just birth weight, and a subsequent increased risk of obesity and metabolic diseases (Ong and Loos 2006; Singhal 2010).
- Parental dietary behaviour has a major effect on a child's early diet and the subsequent risk of excessive weight gain (Fisher and Birch 1995).

A further challenge for preventive health interventions is posed by critical periods. These are specific windows of time which are critical for subsequent development, and exposures or interventions after such a period have no additional influence on reducing disease risk. For instance, exposures such as high glucose, high fat and/or high insulin even in utero, may already predispose individuals towards obesity via epigenetic effects (Singhal et al. 2003).

In tackling childhood obesity, the focus must shift beyond child-specific policies to include interventions that address maternal and parental factors before and after the child's birth.

7.2.3 Inadequate longitudinal data for early life limits the evidence base on childhood obesity

Childhood and family interventions for obesity require good longitudinal data about the most influential factors and the appropriate timing of interventions. They also require data for monitoring and evaluation. The evidence on childhood obesity in Australia remains limited by a lack of longitudinal data in early life. Such data could provide insights on causal pathways and deliver the detailed guidance needed to develop comprehensive preventive health programs. Studies undertaken by the ABS (such as in the *Australian Health Survey* which includes young children) are cross-sectional and have only very limited data on parents. For instance, it is not possible to use parental body mass index to examine obesity risks for children.

The *New Australian Birth Cohort Study* would be ideally placed to generate national findings on childhood obesity and evaluate the potential long-term disease burden. In contrast with cross-sectional surveys, longitudinal birth cohort studies can help unravel the causal pathways that underlie obesity and subsequent related disease aetiology. This includes the role of cumulative exposures or events during critical or sensitive periods. Birth cohort studies contain repeated measures that can be used to identify the presence of risk factors *prior to* health outcomes occurring.

It is important that Australia has the longitudinal data available to capitalise on the evolving health science

The *Raine Study* is an important smaller scale birth cohort study in Australian health (including obesity), but the respondents are already over 20 years of age. Rather than being from the national population, respondents were drawn from Western Australia only. The *Raine Study* remains useful for future comparisons to determine

changing trends in obesity rates, but findings are not easily generalised to the wider population in the way that they would be in the *New Australian Birth Cohort Study*.

7.2.4 Early-life health data need to keep pace with genetic research

Knowledge about the childhood obesity epidemic will inevitably improve with advances in genetic and epigenetic research. It is important that Australia has the longitudinal data available to capitalise on the evolving science. For example, DNA samples for genomic analysis are becoming fundamental to cohort data collection given our increasingly better knowledge of the interactions between genetic and epigenetic factors that predispose an individual to or protect against obesity.

A range of health data needs to be collected at an early age. The study design of LSAC allows data to be incorporated from the *Child Health CheckPoint*, but LSAC and LSIC did not collect important prenatal and postnatal data such as:

- maternal diet and physical activity during pregnancy and the child's early years of life, and paternal diet and physical activity during the child's early life
- maternal health during pregnancy, including medications taken during pregnancy and pregnancy complications, such as gestational hypertension, preeclampsia, and gestational diabetes
- children's rate of growth and body composition through the early years of life.

These data could be routinely included as part of the *New Australian Birth Cohort Study.*

Moreover, in order to provide evidence relevant to policymaking about obesity, the focus of birth cohorts needs to include the current generation. Australia's LSAC and LSIC child cohorts are growing up. Each age cohort study is subject to a unique set of circumstances and influences. Comparisons between LSAC and the *New Australian Birth Cohort Study* could generate important insights into trends relating to childhood obesity and inform early preventive health strategies to reduce the associated health costs.

7.3 Improving the impact of parental leave on outcomes for children

FACTS UP FRONT

- The labour force participation rates of Australian mothers are low by international standards, particularly among those with pre-school children (OECD 2014).
- The employment participation rate for Australian mothers is well below that of fathers and women aged 25 to 54 years without children (Productivity Commission 2014), and about 58% of employed mothers with a child aged under 15 years worked part-time in 2011–12, a proportion that has changed little over recent decades (Productivity Commission 2014).
- Engaging mothers in the workforce is essential to national prosperity, gender equality and to individual and family wellbeing. A recent Grattan Institute estimate suggests that raising women's labour force participation by 6% could have a pay-off to the Australian economy of $25 billion per year (Daley et al. 2012).
- Overseas studies have shown that universal parental leave can have benefits at the population level by reducing post neo-natal mortality (28 days to 12 months) and fatalities in children less than five years old (Ruhm 2000; Tanaka 2005).

7.3.1 More evidence is needed to understand the impact of paid parental leave for families and infant health

Improving the participation and retention of mothers in the workforce is at the forefront of the national policy agenda (Productivity Commission 2014) and has impacts for both national productivity and early childhood development. Most working mothers value their jobs and want to work but working while caring for young children comes with significant trade-offs.

International research shows that good government policy can provide contexts which support working mothers and families during intensive childrearing (Borrell et al. 2014). Enhancing mother and child health has been a fundamental goal for maternity leave policy in most nations (International Labour Office 2010). Maternity leave gives families time whereas employment gives families income; both resources are important for child and family health. Evidence on whether unpaid maternity leave improves health is mixed, and when health effects are detected they often tend to be small (Baker and Milligan 2008). Paid maternity leave can reduce the time–income trade-off for families by delivering both resources. The optimum balance of paid parental leave (including duration, rate of pay and eligibility) is still untested in the Australian context with regard to a wide range of child health and development outcomes.

7.3.2 Data on paid parental leave and its impact on child health and wellbeing are limited

To date, there has been limited data collected in Australia on paid parental leave and its impact on the wellbeing of children and their development.

The government-funded evaluation of Australia's Paid Parental Leave scheme (2011-14) includes a longitudinal extension study, the *Millennium Mums Survey*. It provides detailed information on mothers' experiences with work around the time of giving birth and in the few years after. It also collects basic information on infant and toddler health and wellbeing but its value is limited because it does not focus on other child development outcomes.

The only study to provide valuable insights into the relationship between women's workforce participation, parental leave and infant health is the *Parental Leave in Australia Survey* of 2005. This was a one-off cross-sectional study nested within LSAC. It asked the mothers of LSAC cohort B about any paid parental leave they took around the time of their child's birth and when they returned to work (see Soloff et al. 2005). The data were used by the Productivity Commission in its 2009 recommendations to introduce paid parental leave in Australia (see Impact Case Study 2 for further detail).

The strength of the *Parental Leave in Australia Survey* is that by nesting within LSAC it has excellent measures of child wellbeing to supplement information from mothers and fathers on their experiences with work and childrearing. However LSAC collects data only biennially. As a result it misses important incremental stages in child development that are difficult to identify and assess retrospectively including mothers' work experiences during pregnancy that might influence foetal health, child wellbeing and development during infancy. The *Parental Leave in Australia Survey* was also collected *prior* to the introduction of paid parental leave in Australia and does not capture the contemporary policy context.

7.3.3 A new birth cohort study offers benefits in the study of workforce participation

Current debate in Australia about the specifications of the national paid parental leave scheme could be better informed if there was reliable longitudinal evidence on the effects of parental labour force participation and paid maternity leave on Australian children. A larger sample size in the *New*

Australian Birth Cohort Study would increase our understanding of the impact of policy implementation and change on different population subgroups, and the costs and benefits of paid parental leave for children, families, employers and the economy.

For example, the *New Australian Birth Cohort Study* would enable researchers to follow mothers' employment patterns, access and uptake of parental leave (paid and unpaid) in more detail. The larger sample size has the benefit of capturing transitions that only small numbers of mothers may experience and has more statistical power to examine whether and why some groups of mothers and their children fare differently under the same policy. These trajectories and pathways could then be mapped against infant and child development and wellbeing.

The *New Australian Birth Cohort Study* could include questions that would enable more accurate and effective data linkage with administrative databases, such as the Australian Tax Office, Centrelink, Medicare and education records. The increased capacity for data linkage would improve policy insights into the impact of paid leave on mothers' employment outcomes. Rather than relying on mothers' recall, policymakers could examine administrative data on women's earnings or their reliance on government family payments and how this varies depending on their access to paid leave and other workplace entitlements.

CASE IN POINT: The New Australian Birth Cohort Study would determine the wide-ranging effects of paid parental leave in Australia

Universal paid parental leave in Australia is relatively new and in its formative stages, with ongoing debate about the nature of ideal paid leave package. Australia first introduced a national Paid Parental Leave scheme in January 2011. The scheme provides eligible working parents with up to 18 weeks of Australian Government-funded Parental Leave Pay when they take time off from work to care for a newborn or recently adopted child.

Fathers also form an integral part of the policy context, and encouraging their ongoing participation in both home and work life is likely to significantly affect the early development of children. The Australian Government introduced Dad and Partner Pay on 1 January 2013. Eligible fathers and partners can receive two weeks of pay at the rate of the national minimum wage, when they take unpaid leave to spend time with their newborn or recently adopted child.

During the 2013 election campaign, paid parental leave was an area of key policy difference, with the Coalition Government proposing to increase the time off for working parents to 26 weeks and to pay a replacement wage for mothers earning up to $150 000 per year, and to discontinue Dad and Partner Pay. As at September 2014, these proposed amendments had not been tabled in parliament. The *New Australian Birth Cohort Study* would provide information on questions at the heart of the current policy debate, such as:

- What combinations of work and leave during children's early years can optimise child development outcomes?
- How does paid leave modify employment patterns in different work types (permanent, self-employed, casual), and what are the related impacts on child health and wellbeing?
- How do different family forms (married, de facto, single parent) affect parental leave-taking and effects for children?
- What is the optimum financial compensation level of paid leave for working families with regard to childhood outcomes?

7.4 Enhancing childcare support, standards and availability

FACTS UP FRONT

- An estimated 165 000 parents with children aged under 13 years would like to work, or work more hours (most of them part time) but are not able to do so because they are experiencing difficulties with the affordability and availability of childcare (Productivity Commission 2014).
- There are 16 500 approved childcare services in Australia, 58% more than in 2002 (Productivity Commission 2014).
- Nearly one in four parents working part time or not working, with a child 12 years or under, reported being unable to work due to unmet need for childcare (Productivity Commission 2014).
- The effective allocation of childcare funding may improve psychological wellbeing for children growing up in disadvantaged families (through access to high-quality childcare services), and improve their educational outcomes. This leads to better labour market prospects and increased productivity in the long-term.

7.4.1 The meaning of 'quality childcare' needs to be better understood

Better quality childcare may improve child development outcomes and address inequalities in opportunities, but exactly what *quality* means in this context or how it influences development and outcomes for children is not known. Researchers and policymakers do not know which characteristics of childcare services are most crucial in improving children's outcomes, and whether the needs of different groups of children are similar or not.

Important factors include the type of activities that are undertaken with the child, the qualifications of the carers, and the nature and quality of the child-carer relationship. Some of this information is currently collected in LSAC but the range of factors collected directly from the childcare service used by the family could be broadened. In addition, information could be added through linkage to available administrative data (Federal Department of Education data such as the Child Care Management System and the National Early Childhood Education and Care Workforce Census) and this would allow investigation of the factors that are important for improving children's outcomes.

There is no in-depth analysis of the actual demand for childcare services and whether available care matches requirements

Evidence indicates a shortage of childcare services in some areas (Productivity Commission 2014), but there is no in-depth analysis of the actual demand for childcare services, and whether available childcare matches parents' requirements. Waiting lists are not an accurate representation of the actual shortage. They may overestimate the shortage because there may be double-counts as parents join several lists to improve their chances, or there may be parents that have not unsubscribed after finding a childcare place. Parents may be discouraged by the long lists and not add their names, even though they would like to use childcare. The relationship between childcare availability and childcare choice is not well understood.

CASE IN POINT: The *New Australian Birth Cohort Study* fills data gaps identified by the Productivity Commission report on childcare

The Productivity Commission's 2014 report on childcare discusses the challenges of optimally allocating support to families (the Child Care Benefit compared with the Child Care Rebate). It discusses which types of childcare should attract support and for what purposes.

The Commission makes a large number of recommendations based on the available data but it also indicates the need for information and research that can:

- identify developmentally vulnerable children and how to meet their special needs
- provide ongoing monitoring and evaluation of early intervention programs for children from disadvantaged backgrounds.

The *New Australian Birth Cohort Study* could address these information needs by oversampling Indigenous and disadvantaged families so that a sufficiently large sample is available to identify vulnerable children and to follow their progress and outcomes over time. Study data could be used to identify the effects of different intervention programs on children in the cohort, or cohort children could form a valid control group for testing new interventions prior to broader roll-out.

The Commission also recommended that the "Australian Government should establish a program to link information for each child from the National ECEC Collection to information from the Child Care Management System, the Australian Early Development Index, and NAPLAN testing results to establish a longitudinal database" (Productivity Commission 2014). Data linkage in the *New Australian Birth Cohort Study* could fulfil this need.

7.4.2 More-detailed survey data is required by policymakers

Australia has insufficient information on a range of important measures relating to childcare including:

- the gross cost of each childcare service used per family
- whether relatives (in particular grandparents) are living within a certain distance, whether they are employed, and whether they are in good health and potentially suitable carers
- parental income from employment separately from other parental income (and separately for each parent)
- availability of formal childcare services close to home or close to the parents' workplace.

Without reliable evidence on such measures, policymakers may draw false conclusions.

The general population surveys that collect information on childcare use by families in Australia are:

- the *Household, Income and Labour Dynamics in Australia Survey*
- the ABS *Survey of Income and Housing* and the *Household Expenditure Survey*
- the *Childhood Education and Care Survey* (formerly, *Child Care Survey*)
- LSAC and LSIC.

The *Household Income and Labour Dynamics Australia* survey collects childcare information for children in reasonable detail, and rich information on the parents' labour market participation and income. There is no information on early child outcomes (since household members only start being interviewed from the age of 15) or on the characteristics of the childcare services.

Australian Bureau of Statistics surveys are limited as they are cross-sectional and do not report outcomes for children. The *Survey of Income and Housing* collects aggregate data on the total number of hours of care and total cost within the income unit for all children under 12 years of age, but does not separate formal and informal care. More information is collected in the *Survey of Income and Housing* (hours, use and type of childcare used for each child under 12 years). However, this information is not made available in the basic or the expanded Confidentialised Unit Record Files provided by the Australian Bureau of Statistics.

Information collected by the *Childhood Education and Care Survey* is richer than that collected by the earlier *Child Care Survey* and includes some details of parental activities with children. Even so, it only collects full information at one point in time and on two randomly selected children at most. The survey also has limited information on financial variables (e.g. income from employment of parents is not collected separately from other income) and on children's outcomes.

LSAC and LSIC collect valuable data via questionnaire on the gross cost of each childcare service used, the availability and engagement of extended family in childcare, and parental income. There is, however, limited coverage of Indigenous and disadvantaged children for whom childcare may offer important benefits.

7.4.3 The new study would have many advantages over existing data

The *New Australian Birth Cohort Study* would allow in-depth investigation of the childcare and child support policies implemented since the start of the previous birth cohort. As the design of the new study would be based on the current LSAC birth cohorts, comparisons could be made between the different Australian birth cohorts and also with birth cohort studies in other countries.

The *New Australian Birth Cohort Study* would also avoid some of the shortcomings of the existing data. It could integrate income data from the Australian Tax Office and the Department of Human Services to ensure accurate and complete information on total income and on income support. This information could be complemented with detailed survey questions on parental income, to identify earnings for each parent as well as on other non-government non-labour income. Information on available formal childcare services could be obtained through data linkage with information from data already collected by the Federal Department of Education through the Child Care Management System and the National Early Childhood Education and Care Workforce Census. These datasets contain information on childcare fees and the number of places and vacancies. This integrated data is required to better understand the financial implications of using childcare on families and choices regarding labour force participation and non-parental childcare.

In addition, given the potential importance of childcare to children from disadvantaged families (e.g. families depending on income support or from an Indigenous background), and the relatively small proportion of families in this category, the *New Australian Birth Cohort Study* will produce more reliable evidence in this area using oversampling. This will allow policymakers to identify the bottlenecks in childcare provision, and to determine how best to allocate additional expenditure that would lead to more use of childcare, more labour force participation, better child outcomes, and better opportunities for children from disadvantaged backgrounds.

Glossary and references

GLOSSARY

accelerometry: a technique used to monitor people's movements. In the context of social research, it has been used to objectively ascertain a person's level of physical activity.

adiposity: a person's level of body fat.

anthropometrics: measurements of the properties of the human body, such as weight, height, and body shape, for the purpose of study and comparison.

clustered sampling: a technique used to select individuals for participation in surveys when natural but relatively homogeneous groupings are evident. It involves dividing the study population into groups (clusters), selecting only some of these groups, and then probabilistically selecting individuals from the selected groups. Clusters are typically defined as geographical areas or locations.

control group: in the context of experimental research, the control group is made up of the people who do not receive the treatment. Their outcomes are compared to those of the treatment group(s) to determine whether the treatment has had an effect.

cross-sectional study: a study, typically a survey, which is conducted at a single point in time. The term is used as an antonym for longitudinal study.

cross-sequential design: a design feature of birth cohort studies that involves collecting data on children of different ages at the same time to reduce the time committed to studying developmental outcomes.

desirability bias: the tendency of survey respondents to answer questions in a way that will be viewed favourably by others, for example, by over-reporting socially acceptable behaviour and under-reporting socially undesirable behaviour.

disease aetiology: the branch of medical science devoted to studying the cause of disease.

epigenetics: the study of changes in our genome that do not involve alterations of the DNA or genetic code. Unlike genetics, epigenetics refers to the factors that control whether, how and when genes are activated or come into play.

invariant factors: in the context of birth cohort studies, these refer to contextual characteristics (such as public policy, political context, and environmental exposures) that are common to all children born in the same time period.

life course theory: an interdisciplinary approach used to guide social research that rests on the principles that people's life outcomes are shaped by the socio-historical and geographical context in which they live, the timing and sequencing of their life events, their connections to other people and their capacity to deal with life changes.

longitudinal birth cohort studies: a birth cohort study examines the characteristics and outcomes of a group of people born during the same time period. A longitudinal birth cohort study observes participants more than once, typically over an extended or indefinite period of time.

non-probabilistic survey designs: survey designs in which individuals in a population have an unknown probability of being selected into the sample, thus undermining statistical inference.

purposive sampling: a non-probabilistic survey design that is employed to satisfy some need other than generalisation of findings (e.g. including members of a hard-to-reach population, reducing data collection costs or undertaking a study in the absence of a sampling frame).

recall error: in the context of social surveys, this refers to cognitive errors made by respondents when they are trying to remember information they have been asked about (e.g. the date in which an event occurred or the duration of a life situation).

sampling frame: a list of all those in a population from which a sample can be taken for study.

stratification: a survey sampling technique that first separates individuals into exhaustive and mutually exclusive *strata* (i.e. groups) based on their characteristics (e.g. their level of disadvantage), and then randomly selects individuals from each *stratum*.

survey wave: the time points at which respondents are observed in a longitudinal study.

REFERENCES

ABS (see Australian Bureau of Statistics)

AIFS (see Australian Institute of Family Studies)

AIHW (see Australian Institute of Health and Welfare)

Australian Bureau of Statistics (ABS) (2012). Australian Health Survey: First Results, 2011-12. Cat. No. 4364.0.55.001. Canberra: Australian Bureau of Statistics

Australian Communications and Media Authority (2014). Aussie Teens Online, http://apo.org.au/node/40520, last accessed 2nd September 2014

Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) (2009). Footprints in Time: The Longitudinal Study of Indigenous Children - Key Summary Report from Wave 1. Canberra

Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) (2009a) Longitudinal Study of Australian Children: Key Research Questions. LSAC Discussion Papers, July 2009, Canberra

Australian Government Department of Social Services (DSS). (2013). The Longitudinal Study of Australian Children, Annual Report 2011-2012, November 2013. Canberra

Australian Government Department of Social Services (DSS). (2014a). The Longitudinal Study of Australian Children, Annual Report 2012-2013, September 2014. Canberra

Australian Government Department of Social Services (DSS). (2014b). The Longitudinal Study of Indigenous Children Data User Guide 2014. Australian Government Department of Social Services, Canberra

Australian Government Productivity Commission (2009). Paid Parental Leave: Support for Parents with New Children, Report Number 47. Canberra

Australian Government Productivity Commission (2014). Childcare and Early Childhood Learning, Draft Report, Canberra

Australian Institute of Family Studies (AIFS). (2013). Longitudinal Study of Australian Children Data User Guide - November 2013. Melbourne

Australian Institute of Health and Welfare (AIHW). (2013). A Picture of Australia's Children 2012. Canberra

Baker, M. and Milligan, K. (2007). Maternal Employment, Breastfeeding and Health: Evidence from Maternity Leave Mandates. NBER Working Paper Series (w13188)

Barker, D. J. P. (1998). Mothers, Babies and Health in Later Life. Edinburgh: Churchill Livingstone

Baxter, J. (2007). Children's Time Use in the Longitudinal Study of Australian Children: Data Quality and Analytical Issues in the 4-Year Cohort. LSAC Technical Papers, No 4. Canberra

Ben-Shlomo, Y., Mishra, G. D., and Kuh, D. (2013). Life Course Epidemiology. In: Ahrens, W. and Peugot, I. (eds.) Handbook of Epidemiology (2nd ed.). Bremen: Springer

Biddle, N. (2011). An Exploratory Analysis of the Longitudinal Survey of Indigenous Children. Australian National University, Centre for Aboriginal Economic Policy Research

Biddle, N. (2014) Data about and for Aboriginal and Torres Strait Islander Australians. Issues paper No. 10. Closing the Gap, Clearinghouse. Online at: http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129548209

Borghol, N., Suderman, M., McArdle, W., Racine, A., Hallett, M., Pembrey, M., Hertzman, C., Power, C. and Szyf, M. (2012). Associations with Early Life Socio-economic Position in Adult DNA Methylation. International Journal of Epidemiology. 41: 62-74

Borrell, C., Palència, L., Muntaner, C., Urquía, M., Malmusi, D. and O'Campo, P. (2014). Influence of Macrosocial Policies on Women's Health and Gender Inequalities in Health. Epidemiologic Reviews, 36: 31-48

Boyd, A., Golding, J., Macleod, J., Lawlor, D. A., Fraser, A., Henderson, J., Molloy, L., Ness, A., Ring, S. and Davey Smith, G. (2012). Cohort profile: the 'children of the 90s'—the index offspring of the Avon Longitudinal Study of Parents and Children. International journal of epidemiology (advance access).

Boyd, J. H., Ferrante, A. M., O'Keefe, C. M., Bass, A. J., Randall, S. M. and Semmens, J. B. (2012). Data Linkage Infrastructure for Cross-Jurisdictional Health-Related Research in Australia. BMC Health Services Research, 12: 480

Bradbury, B., Corak, M., Waldfogel, J. and Washbrook, E. (2011). Inequality during the Early Years: Child Outcomes and Readiness to Learn in Australia, Canada, United Kingdom and United States. Forschungsinstitut zur Zukunft der Arbeit Discussion Paper series (No. 6120)

Butz, W. P. and Torrey, B. B. (2006). Some Frontiers in Social Science. Science, 312: 1898-1900

Bynner, J. and Joshi, H. (2007). Building the Evidence Base from Longitudinal Data. Innovation: The European Journal of Social Science Research, 20: 150-179

Bynner, J., Wadsworth, M., Goldstein, H., Maughan, B., Purdon, S., Michael, R., Sylva, K. and Hall, J. (2007). Scientific Case for a New Birth Cohort Study: Report to the Research Resources Board of the Economic and Social Research Council. London: Longview

Calderwood L., Rose, N., Ring, S. and McArdle, W. (2014). Collecting Saliva Samples for DNA Extraction from Children and Parents: Findings from a Pilot Study Using Lay Interviewers in the UK. Survey Methods: Insights from the Field. Retrieved from http://surveyinsights.org/?p=3723, last accessed 2nd September 2014

Colagiuri, S., Lee, C. M. Y., Colagiuri, R., Magliano, D., Shaw, J. E., Zimmet, P. Z. and Caterson, I. D. (2010). The Cost of Overweight and Obesity in Australia. Medical Journal of Australia, 192: 260-264

Cunningham, S. A., Kramer, M. R. and Narayan, K. V. (2014). Incidence of Childhood Obesity in the United States. New England Journal of Medicine, 370: 403-411

Daley, J., McGannon, C. and Ginnivan, L. (2012). Game-Changers: Economic Reform Priorities for Australia. Grattan Institute: Melbourne

De Maio, J. A., Zubrick, S. R., Silburn, S. R., Lawrence, D. M., Mitrou, F. G., Dalby, R. B., Blair, E. M., Griffin, J., Milroy, H. and Cox, A. (2005). The Western Australian Aboriginal Child Health Survey: Measuring the Social and Emotional Wellbeing of Aboriginal Children and Intergenerational Effects of Forced Separation. Perth: Curtin University of Technology and Telethon Institute for Child Health Research

De Vaus, D. A. (2004). Diversity and Change in Australian Families: Statistical Profiles. Melbourne: Australian Institute of Family Studies

Dezateux, C., Brocklehurst, P., Burgess, S., Burton, P., Carey, A., Colson, D., Dibben, C., Elliott, P., Emond, A., Goldstein, H., Graham, F.K., Knowles, R., Leon, D., Lyons, R., Reay, D., Vignoles, A. and Walton, S. (2013). Life Study: A UK-wide Birth Cohort Study of Environment, Development, Health and Wellbeing. The Lancet, 382: S31

Dodson, M., Hunter, B. and McKay, M. (2012). Footprints in Time: The Longitudinal Study of Indigenous Children: A Guide for the Uninitiated. Family Matters, 91: 69-82

DSS (see Australian Government Department of Social Services)

Edwards, B. (2012). Growing up in Australia: The Longitudinal Study of Australian Children: The First Decade of Life. Family Matters, 91: 7-17

FaHCSIA (see Australian Government Department of Families, Housing, Community Services and Indigenous Affairs)

FaHCSIA Research and Analysis Branch (2013). Guide to Australian Longitudinal Studies. Australian Government Department of Families, Housing, Communities Services and Indigenous Affairs, Canberra

Fisher J. O., and Birch L. L. (1995). Fat Preferences and Fat Consumption of 3- to 5-Year-Old Children Are Related to Parental Adiposity. Journal of the American Dietetic Association, 95: 759-764

Gray, M. (2006). Indigenous Families and Communities. Family Matters, 75: 1-9

Hansen, K. (ed.). (2014). Millennium Cohort Study a Guide to the Datasets (Eight Edition). Centre for Longitudinal Studies, Institute of Education, London

Hanson, J. L., Hair, N., Shen, D. G., Shi, F., Gilmore, J.H., Wolfe, B.L. and Pollack, S. D. (2013). Family Poverty Affects the Rate of Human Infant Brain Growth. PLoS ONE, 8: e80954

Head, B. and Alford, J. (2008). Wicked Problems: The Implications for Public Management. Paper presented at the 12th Annual Conference of the International Research Society for Publication Management, March 2008

Henderson, M., Hotopf, M and Leon, D. A. (2009). Childhood Temperament and Long-Term Sickness Absence in Adult Life. British Journal of Psychiatry, 194: 220-23

Hull, B., Lawrence, G., MacIntyre, C. R. and McIntyre, P. (2001). Immunisation Coverage: Australia 2001. Research report conducted at the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS). University of Sydney

Institute of Education (IoE). (2011). Impact of the Millennium Cohort Study, November 2011. Institute of Education, London

International Labour Office (ILO). (2010). Maternity at Work: A Review of National Legislation. Geneva: International Labour Organization

IoE (see Institute of Education)

Irwin, L. G., Siddiqi, A., and Hertzman, C. (2007) Early Child Development: A Powerful Equalizer. Geneva

Ivancic, L., Perrens, B., Fildes, J., Perry, Y. and Christensen, H. (2014). Youth Mental Health Report. Mission Australia and Black Dog Institute

Keith, S. W., Redden, D. T., Katzmarzyk, P. T., Boggiano, M. M., Hanlon, E. C., Benca, R. M., Ruden, D., Pietrobelli, A., Barger, J.L., Fontaine, K.R., Wang, C., Aronne, L.J., Wright, S.M., Baskin, M., Dhurandhar, N.V., Lijoi, M.C., Grilo, C., DeLuca, M., Westfall, A.O., and Allison, D.B. (2006). Putative Contributors to the Secular Increase in Obesity: Exploring the Roads Less Traveled. International Journal of Obesity, 30: 1585-1594

Kneebone, L. B., Christelow, J., Neuendorf, A. and Skelton, F. (2012). Footprints in Time: The Longitudinal Study of Indigenous Children: An Overview. Family Matters, 91: 62-68

Kuh, D. and Davey-Smith, G. (1993). When is Mortality Risk Determined? Historical Insights into a Current Debate. Social History of Medicine, 6: 101-123

Kumari, M., Wadsworth, M., Blake, M., Bynner, J. and Wagner, G. G. (2006). Biomarkers in the Proposed UK Longitudinal Household Study. Longview

Lindau, S. T. and McDade, T. W. (2008). Minimally-Invasive and Innovative Methods for Biomeasure Collection in Population-Based Research. In: Weinstein, M., Vaupel, J. W. and Wachter, K. W. (eds.) Biosocial Surveys. Washington: The National Academies Press

Lodge, J. (2014). Children Who Bully at School. Australian Institute of Family Studies, Canberra

Lynch, J. and Smith, G. D. (2005). A Life Course Approach to Chronic Disease Epidemiology. Annual Review of Public Health, 26: 1-35

Lynn, P. (ed.). (2009). Methodology of Longitudinal Surveys. Wiley: West Sussex

Maggi, S., Irwin, L J., Siddiqi, A. and Hertzman, C. (2010). The Social Determinants of Early Child Development: An Overview. Journal of Paediatric Child Health, 46: 627-635

Manolio, T. A., Bailey-Wilson, J. E. and Collins, F. S. (2006). Genes, environment and the value of prospective cohort studies. Nature Reviews Genetics, 7: 812-820

Marmot Review (2010). Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post 2010. London

Mayer, K. U. (2009). New Directions in Life Course Research. Annual Review of Sociology, 35: 413-433

McLachlan, R., Gilfillan, G. and Gordon, J. (2013). Deep and Persistent Disadvantage in Australia. Productivity Commission Staff Working Paper, Canberra

Morton, S.M.B., Atatoa Carr, P.E., Bandara, D.K., Grant, C.C., Ivory, V.C., Kingi, T.R., Liang, R., Perese, L.M., Peterson, E., Pryor, J.E., Reese, E., Robinson, E.M., Schmidt, J.M., and Waldie, K.E. (2010). Growing Up in New Zealand: A Longitudinal Study of New Zealand Children and their Families. Report 1: Before We Are Born. Auckland: Growing Up in New Zealand

Schmidt, J.M., and Waldie, K.E. (2014). Growing Up in New Zealand: A Longitudinal Study of New Zealand Children and their Families. Now We Are Two: Describing Our First 1000 Days. Auckland: Growing Up in New Zealand

Mullan, K. (2014). Longitudinal Analysis of LSAC Time Diary Data: Considerations for Data Users. LSAC Technical Papers, No 11. Canberra

Neuburger, J., Kuh, D. and Joshi, H. (2009). Trends in the Relative Wage Opportunities of Women and Men across Three British Generations. CLS Cohort Studies Working Paper, 2009/2

OECD (see Organisation for Economic Cooperation and Development)

Olsen, J., Melbye, M., Olsen, S. F., Sørensen, T. I., Aaby, P., Andersen, A. M. N., Taxbøl, D., Hansen, K.D., Juhl, M., Schow, T.B., Sørensen, H.T., Andrewsen, J., Mortensen, E.L., Olesen, A.W. and Søndergaard, C. (2001). The Danish National Birth Cohort - Its Background, Structure and Aim. Scandinavian Journal of Public Health, 29: 300-307

Ong, K. K. and Loos, R. J. (2006). Rapid Infancy Weight Gain and Subsequent Obesity: Systematic Reviews and Hopeful Suggestions. Acta Paediatrica, 95: 904-908

Organisation for Economic Co-operation and Development (OECD) (2014). Short-Term Labour Market Statistics, http://stats.oecd.org/Index.aspx?DataSetCode=STLABOUR, last accessed 2nd September 2014

Perales, F., Baffour, B. and Mitrou, F. (2014). Differences in the Quality of the Survey Interview Process between Indigenous and non-Indigenous Australians. Mimeo. Institute for Social Science Research, The University of Queensland

Power, C., Kuh, D. and Morton S. (2013). From Developmental Origins of Adult Disease to Life Course Research on Adult Disease and Aging: Insights from Birth Cohort Studies Annual Review of Public Health, 34: 7-28

Productivity Commission (see Australian Government Productivity Commission)

Quach, J., Oberklaid, F., Gold, L., Lucas, N., Mensah, F. and Wake, M. (2014). Primary Health-Care Costs Associated with Special Health Care Needs up to Age 7 Years: Australian Population-Based Study. Journal of Paediatrics and Child Health (ahead of print)

Rabbani, B., Tekin, M. and Mahdieh, N. (2013). The Promise of Whole-Exome Sequencing in Medical Genetics. Journal of Human Genetics, 59: 5-15

Richards, M., Power, C. and Sacker, A. (2009). Paths to Literacy and Numeracy Problems: Evidence from Two British Birth Cohorts. Journal of Epidemiology and Community Health, 63: 239-244

Richards, M., Shipley, B., Fuhrer, R. and Wadsworth, M. E. J. (2004). Cognitive Ability in Childhood and Cognitive Decline in Mid-Life: Longitudinal Birth Cohort Study. British Medical Journal, 328: 552-556

Roy Morgan Research (2014). Unemployment Jumps in February (Up 1% to 12.3%). Retrieved from http://www.roymorgan.com/findings/5464-australian-unemployment-february-2014-201403040532, last accessed 21st October 2014

Ruhm, C. J. (2000). Parental Leave and Child Health. Journal of Health Economics, 19: 931-960

Sanson, A., Nicholson, J., Ungerer, J., Zubrick, S., Wilson, K., Ainley, J., Berthelsen, D., Bittman, M., Broom, D., Harrison, L., Rodgers, B., Sawyer, M., Silburn, S., Strazdins, S., Vimpani, G. Bittman, M. and Wake, M. (2002). Introducing the Longitudinal Study of Australian Children. LSAC Discussion Papers No.1. Canberra

Schoon, I., Parsons, S., Rush, R. and Law, J. (2010). Childhood Language Skills and Adult Literacy: A 29-year Follow-Up Study. Pediatrics, 125: 459-e466

Sen, A. (2003). Development as Capability Expansion in Readings in Human Development. In: Fukuda-Parr, S. and Kumar, S. (eds.) Readings in Human Development. New York: Oxford University Press

Singhal, A. (2010). Does Weight Gain in Infancy Influence the Later Risk of Obesity? Journal of Pediatric Gastroenterology and Nutrition, 51: S119-S120

Singhal, A., Wells, J., Cole, T. J., Fewtrell, M., and Lucas, A. (2003). Programming of lean body mass: a link between birth weight, obesity, and cardiovascular disease? The American Journal of Clinical Nutrition, 77(3), 726-730

Soloff, C., Lawrence, D. and Johnstone, R. (2005). Sample Design. LSAC Technical Papers, No 1. Canberra

United States Government Department of Health and Human Services (2010). Rethinking Maternal Child Health: The Life Course Model as an Organising Framework. Washington

Wilkins, R. (2014). Families, Incomes and Jobs. In: Statistical Report on Waves 1 to 11 of the Household, Income and Labour Dynamics in Australia Survey. Melbourne Institute for Applied Economic and Social Research, Melbourne

Zubrick, S. R., Taylor, C. L., Lawrence, D., Mitrou, F., Christensen, D. and Daley, R. (2009). The Development of Human Capability across the Life Course: Perspectives from Childhood. Australasian Epidemiologist, 16: 6-13