

Growing Up in New Zealand

Vulnerability Report 1: Exploring the Definition of Vulnerability for Children in their First 1000 Days

2014



Growing Up in New Zealand: A longitudinal study of New Zealand children and their families

Vulnerability Report 1: Exploring the Definition of Vulnerability for Children in their First 1000 Days

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Further information on *Growing Up in New Zealand* is available at www.growingup.co.nz

Foreword



A key goal across New Zealand's social sector is to ensure that every child thrives, belongs, and achieves.

This report from the *Growing Up in New Zealand* longitudinal study, *Vulnerability Report 1: Exploring the Definition of Vulnerability for Children in their First 1000 Days*, contributes to the increasing body of research and evidence about vulnerable children.

Growing Up in New Zealand is the country's largest, and most ethnically and economically diverse, longitudinal study as it follows 7000 children and their families, recruited from across the greater Auckland and the Waikato regions, as they grow up in contemporary New Zealand.

This report builds on the report released by the *Growing Up in New Zealand* team last month, called *Now We Are Two: Describing our first 1000 days*

The White Paper for Vulnerable Children started the conversation on vulnerability by suggesting there are several factors that may predispose a child to vulnerability. This report is the first stage of work to develop a greater understanding of vulnerability within the New Zealand context. Children who have a positive childhood experience are able to realise their full potential and flourish. Conversely, children who are vulnerable in their early stages of life may later become "at risk" children. The research findings presented in this report will assist us in identifying, at an early age, those children who need additional support to ensure they achieve their potential.

Information has been collected directly from these 7000 children and their families at three points of their life: during the antenatal period, at nine-months and at two-years. This unique insight provides a description of vulnerability across twelve risk factors at particularly important stages of a child's life.

One of the key findings is that risk factors tend to cluster. We see this with Māori and Pacific children, who tend

to be exposed to a greater number of risk factors for vulnerability at each time point and over time, than European or Asian children.

The report also shows that children exposed to multiple risk factors have an increased likelihood of experiencing poor health outcomes during their first 1000 days of life.

Through this report we can begin to better understand what characteristics of parents, families and their environments, are likely to promote resilience in the face of exposure to vulnerability, and are vital to improving the wellbeing of young children.

Because these risk factors exist across many dimensions, a cross-sector approach is needed to develop solutions and create better outcomes for at risk children and their families. I therefore strongly encourage you to read this report and consider the findings. By working together, we can ensure that every child has the opportunity to thrive, belong, and achieve.

The *Growing Up in New Zealand* team are evaluating the evidence further and are developing a second report, which will describe the dynamics of vulnerability over time.

My thanks to the *Growing Up in New Zealand* team and the University of Auckland for this important contribution to a critical issue. And again, a very sincere and special thanks to the families and children themselves for gifting us this important taonga.

A handwritten signature in dark ink, appearing to read 'Belinda Milnes'.

Belinda Milnes
Families Commissioner

Acknowledgements

'Exploring the definition of vulnerability' focuses on describing potential risk factors for adverse outcomes for our children and their families in New Zealand today. In order to be able to do that we are enormously grateful to the families of *Growing Up in New Zealand* that provide their personal information, time, honesty and on-going commitment.

Importantly, we recognise that on the whole our families are supporting their children to grow well, be healthy and work towards reaching their potential. While *'Exploring the definition of vulnerability'* focuses on potential risk factors and adverse outcomes it remains an important and explicit intent for *Growing Up in New Zealand* to use this information to determine where families are doing well, how children are developing resilience, and how policies and programmes can be developed to harness support systems for families and improve outcomes for all.

The authors of this report are members of the *Growing Up in New Zealand* team: the Research Director (Associate Professor Susan Morton), Associate Directors (Associate Professor Cameron Grant and Dr Polly Atatoa Carr), Senior Research Fellow (Dr Sarah Berry), Research Fellow (Dr Emma Marks), Senior Biostatistician (Arier Lee) and Biostatistician (Dr Xenia Chen). We also acknowledge the efforts of all those involved in the wider *Growing Up in New Zealand* team. We specifically thank Dr Jennifer Kinloch (previous Research Fellow) who worked on early analyses of markers of vulnerability, and those who contributed to the publishing of this report. Particularly we note that content of this report is informed by the data collected within the specific research domains and themes for *Growing Up in New Zealand*, each of which are led by expert Named Investigators on our team. Further information regarding the team and design for the study is available on our website: www.growingup.co.nz.

We would also like to acknowledge the key funders of *Growing Up in New Zealand*, who not only contribute to study sustainability, but also help to ensure that the information from our families contributes evidence to inform the policy environment in New Zealand. We thank the initial funders of *Growing Up in New Zealand*, in particular the Ministry of Social Development, supported by the Health Research Council and the University of Auckland. We acknowledge the continued support of the Vice-Chancellor of The University of Auckland as well as Auckland UniServices.

Many government agencies continue to contribute to the sustainability and utility of *Growing Up in New Zealand*. We thank particularly the Families Commission and we acknowledge funding and support received from the Ministry of Social Development, Ministry of Health and the Ministry of Education as well as Te Puni Kōkiri, and the Ministries of Justice, Science and Innovation, Pacific Island Affairs, Corrections, the New Zealand Police, Women's Affairs, Sport New Zealand and the Mental Health Commission. We also acknowledge the support of the Children's Commission, Department of Labour, Housing New Zealand, Office of Ethnic Affairs, Statistics New Zealand and the Treasury.

These agencies also contribute advice through the Policy Forum of *Growing Up in New Zealand* and we acknowledge the specific review and comments on the content of this report provided by members of this Forum. *Growing Up in New Zealand* also acknowledges the continued support and advice provided by: our Executive Board (chaired by Clare Ward); the national and international members of our Executive Scientific Advisory Board (chaired by Professor Carlos Camargo Jr.); our Kaitiaki Group (chaired by Professor Sir Mason Durie); and our Data Access Committee (chaired by Professor Jane Harding).

Directors Foreword



'Exploring the definition of vulnerability' is the second in a series of reports from the *Growing Up in New Zealand* study based on the information our families have provided about their children's first thousand days. It is my great pleasure and privilege to present this report on behalf of all those involved in *Growing Up in New Zealand*.

'Exploring the definition of vulnerability' tackles an important challenge facing our children and families – a challenge that has also engaged the policy community in recent years. It uses the information from the *Growing Up in New Zealand* families and children to explore what vulnerability means in the context of the current New Zealand pre-school population and our contemporary environment. The approach taken in this report builds on the comprehensive *Growing Up in New Zealand* cohort descriptions that were provided in three previous reports, *Before We Are Born* (2010), *Now We Are Born* (2012), and *Now We Are Two* (2014). The findings presented in *'Exploring the definition of vulnerability'* are critical for our children and for our future generations. If we can better determine how to identify those children (and their families) in need of additional support from their earliest days then we can ensure the best possible developmental outcomes and we will be growing a healthy and strong population for all of our futures.

We remain overwhelmingly grateful to the families and the children who contribute their stories so generously to the *Growing Up in New Zealand* team. It continues to be our privilege to bring together these collective stories and present them to those who are able to make a difference to theirs and all our children's lives and futures. I also continue to be extremely grateful to the team of dedicated and passionate people who ensure that this project continues to deliver on a day to day basis to bring our families voices together so as to provide evidence to ensure that change happens to improve outcomes for all children.

Key background messages:

The following points provide key background messages, describing why a more detailed understanding of childhood vulnerability, focussing on the first 1000 days of life, is needed for New Zealand children:

- Vulnerability in early life is a current policy focus in New Zealand;
- It is increasingly recognised that identification of vulnerable (or 'at risk') children early in their life offers the best opportunity to provide interventions to reduce the later downstream effects of being 'at risk';
- Identification of children who are vulnerable requires a better understanding of what specific risk factors are associated with vulnerability for individuals or population subgroups in the current New Zealand context;
- Single risk factors (such as absolute or relative poverty) are commonly used to define early vulnerability, however targeting single risk factors for intervention(s) has limited capacity to minimise downstream adverse outcomes associated with that risk factor at a population level;
- Evidence from international studies has suggested that sets of risk factors may better define vulnerability;
- These sets of risk factors tend to cluster at any one time point, as well as across multiple time points;
- The identification of combinations of risk factors to describe children who are likely to be vulnerable in early life is likely to be more useful for effective targeting of interventions than single risk factors alone;
- Exposure to risk factors is not constant over time, and routine datasets are not usually able to capture the dynamics of exposure at an individual level;
- Understanding the way in which exposure to risk factors change over time for individuals, including when they change, why and for whom is important for understanding when and how to intervene to reduce their impact;

- To determine the impact of exposure to sets of risk factors over time, specific, consistent and longitudinal measures need to be made, beginning early in life and before overt problems are identified. Such a contemporary, longitudinal approach to prospectively exploring the definition of vulnerability has not previously been available in the New Zealand context;
- *Growing Up in New Zealand* provides longitudinal information collected from the same children and their families at suitable intervals, to provide for the analysis of risk factor exposure, the impact of exposure at any one point and over time, and exploration of transitions in and out of potentially vulnerable states. Future analyses from this cohort will also explore what may mitigate (or exacerbate) the effects of exposure.

Key findings:

The following points are the key findings that have emerged from this detailed exploration of early life vulnerability within a contemporary New Zealand cohort (*Growing Up in New Zealand*):

- The *Growing Up in New Zealand* longitudinal study has detailed information about children, their families, and their environments, beginning in the antenatal period and throughout their first 1000 days, and is therefore able to provide evidence relevant to the current New Zealand population;
- The analysis of *Growing Up in New Zealand* data presented here explores risk factors for vulnerability in the first 1000 days of life with likely utility in the New Zealand context;
- The proportions of the *Growing Up in New Zealand* cohort who are exposed to likely risk factors that define vulnerability vary according to the factor being considered and change over time;
- Risk factors used to define vulnerability tend to cluster in the New Zealand context, notably according to: maternal characteristics and behaviours; features of the proximal home environment; and pregnancy specific conditions including poor maternal mental wellbeing and poor physical health in late pregnancy;
- Exposure to clusters of risk factors differs across population subgroups in New Zealand, with marked variation in exposure according to maternal ethnicity;
- Clustering of risk factors that define vulnerability is common, but risk factors do not cluster uniformly across the population;
- Relative exposure to vulnerability can be estimated by summing the total number of risk factors that children are exposed to at any one time point or over time;
- Māori and Pacific children tend to be exposed to a greater number of risk factors for vulnerability than New Zealand European or Asian children at each time point and across multiple time points;
- Exposure to multiple risk factors for vulnerability at any one time point increases the likelihood that children will experience poor health outcomes during their first 1000 days of development;
- Cumulative exposure to multiple risk factors throughout infancy increases the likelihood of experiencing common childhood infections such as ear infections as well as more serious respiratory illnesses requiring hospitalisation;
- Not all children who are exposed to risk factors for vulnerability experience specific poor health outcomes, although they are at increased risk than those experiencing few or no risks;
- Children who are exposed to no or few risk factors for vulnerability may also experience poor health outcomes during their early years;
- Identification of solutions to reduce the effects of early exposure to risk factors for vulnerability is likely to require cross-agency interventions as risk factors tend to cluster and exist across multiple domains;
- At an individual level exposure to risk factors for vulnerability during early life is not necessarily constant, and exposure profiles may change significantly over time;
- Understanding what characteristics of parents, families and their environments are likely to promote resilience in the face of exposure to vulnerability will be integral to optimising early life wellbeing for all New Zealand children.

'Exploring the definition of vulnerability' is the first in a series of reports exploring aspects of vulnerability and resilience within the context of our unique population and the New Zealand environment. Future publications will consider the transitions of children in and out of states of vulnerability and determine what effects these transitions have on outcomes in early childhood as well as on later developmental outcomes throughout the life-course.



Associate Professor Susan Morton
Director, *Growing Up in New Zealand*

Contents

Foreword	ii
Acknowledgements	iii
Directors Foreword	iv
List of Tables	viii
List of Figures	ix
1. About Growing Up in New Zealand	1
1.1 Growing Up in New Zealand overview	2
1.2 The cohort	2
1.3 Conceptual framework	3
1.4 Data Collection Waves	4
1.5 The focus of this report	4
1.6 Looking to the future	5
2. Exploring Vulnerability in Early Childhood in New Zealand	7
2.1 Background	8
2.2 Definitions of vulnerability	8
2.3 Defining vulnerability in a contemporary New Zealand context	9
3. Methods Used to Explore Vulnerability	11
3.1 A life-course approach to defining vulnerability	12
3.2 Risk factors for vulnerability	12
3.3 Method of measuring how risk factors cluster or accumulate	14
3.4 Outcome measures	15
4. Exploring Vulnerability During the Antenatal Period	17
4.1 Proportion of children exposed to risk factors for vulnerability during the antenatal period	18
4.2 Clustering of exposure to risk factors for vulnerability during the antenatal period	18
4.3 Clustering of risk factors during the antenatal period	20
4.4 Association between cumulative exposure to antenatal vulnerability and early postnatal outcomes	27
4.5 Association between cumulative exposure to antenatal vulnerability and health outcomes at nine months	29
5. Risk Factors for Vulnerability at Nine Months of Age	33
5.1 Proportion of children exposed to risk factors for vulnerability at nine months	34
5.2 Clustering of risk factors for vulnerability at nine months of age	35

6.	Exposure to Risk Factors for Vulnerability During the Antenatal Period and at Nine Months of Age	41
6.1	Accumulation of exposure to vulnerability during the antenatal period and at nine months of age	42
6.2	Association between cumulative exposure to vulnerability risk factors and wellbeing outcomes at two years	43
7.	Exposure to Risk Factors for Vulnerability in the First 1000 Days	47
7.1	Accumulation of exposure to vulnerability from before birth throughout infancy and to two years of age	48
8.	Transitions in Exposure to Vulnerability Risk Factors in the First 1000 Days	53
8.1	Transitions in vulnerability risk exposure between the antenatal period and nine months of age	54
8.2	Transitions in vulnerability risk exposure between nine months and two years of age	56
8.3	Transitions in vulnerability risk exposure across the first 1000 days	57
9.	Insights from Exploring Early Vulnerability	59
9.1	Vulnerability within <i>Growing Up in New Zealand</i>	60
9.2	Implications of the clustering of risk factors for vulnerability	61
9.3	Added value from the longitudinal information	63
9.4	Future directions	63
9.5	Looking ahead	64
10.	Cited References and <i>Growing Up in New Zealand</i> Publications	66

List of Tables

Table 01: Antenatal risk factors for exploring vulnerability	13
Table 02: Outcome measures for exploring vulnerability	15
Table 03: Proportion of children exposed to risk factors for vulnerability during the antenatal period	18
Table 04: Co-occurrence of antenatal vulnerability risk factors	19
Table 05: Common clusters of risk factors for vulnerability in the antenatal period	21
Table 06: Total number of vulnerability risk factors in the antenatal period	26
Table 07: Exposure to passive smoking in infancy according to antenatal vulnerability risk	29
Table 08: Exposure to damp in infancy according to antenatal vulnerability risk	29
Table 09: Proportion of children exposed to risk factors for vulnerability at nine months	34
Table 10: Common clusters of risk factors for vulnerability at nine months	35
Table 11: Health related outcomes at two years of age by category of exposure to cumulative vulnerability	45
Table 12: Total number of vulnerability risks experienced at antenatal, nine months and two years of age	48
Table 13: Shifts in exposure to multiple risks between the antenatal and nine-month periods	54

List of Figures

Figure 01: Conceptual framework of <i>Growing Up in New Zealand</i>	3
Figure 02: Individual antenatal Factor scores by maternal ethnicity	22
Figure 03: Average antenatal Factor scores by maternal ethnicity	23
Figure 04: Individual antenatal Factor scores by mother's birth place	24
Figure 05: Average antenatal Factor scores by mother's birth place	25
Figure 06: Number of antenatal vulnerability risk factors experienced	26
Figure 07: Number of antenatal vulnerability risks experienced by maternal ethnicity	27
Figure 08: Proportion of children experiencing ear infections by exposure to cumulative vulnerability	30
Figure 09: Proportion of children experiencing admission to hospital with respiratory illnesses by exposure to cumulative vulnerability	31
Figure 10: Proportion of children experiencing accidents and injuries by exposure to cumulative vulnerability	32
Figure 11: Individual nine-month Factor scores by maternal ethnicity	36
Figure 12: Average nine-month Factor scores by maternal ethnicity	37
Figure 13: Individual nine-month Factor scores by mother's birth place	38
Figure 14: Average nine-month factor scores by mother's birth place	39
Figure 15: Cumulative vulnerability from before birth and throughout infancy	42
Figure 16: Cumulative vulnerability from before birth and throughout infancy by maternal ethnicity	43
Figure 17: Exposure to cumulative vulnerability and health-related outcomes up to two years of age	44
Figure 18: Distribution of cumulative exposure to vulnerability up to two years of age	49
Figure 19: Distribution of cumulative exposure to vulnerability up to two years of age by maternal ethnicity	49
Figure 20: Distribution of cumulative exposure to vulnerability up to two years of age by mother's birth place	50
Figure 21: Distribution of cumulative exposure to vulnerability up to two years of age by geographic location (urban vs. rural)	51
Figure 22: Change in exposure to symptoms of maternal depression between pregnancy and when their child was nine months old	55
Figure 23: Change in exposure to income tested benefit receipt between nine months and two years	56
Figure 24: Change in number of sole mother households between pregnancy, nine months and two years of age	57

1. About Growing Up in New Zealand



1.1 Growing Up in New Zealand overview

Growing Up in New Zealand is a longitudinal study that provides an up-to-date, population-relevant picture of what it is like to be a child growing up in New Zealand in the 21st century. This study has recruited approximately 7000 children before they were born, and to date has collected information from mothers, their partners and the children themselves repeatedly throughout the first thousands days of life (conception to age two years). *Growing Up in New Zealand* is unique in terms of its capacity to provide a comprehensive picture of contemporary child development across multiple domains of influence for children born in New Zealand, and for its inclusion of significant numbers of Māori, Pacific and Asian children as well as New Zealand European and other ethnicities. From its inception the *Growing Up in New Zealand* study has been explicitly designed to follow children from before birth until they are young adults, to understand both risk and protective factors, and to elucidate pathways of development across multiple domains of influence. This allows a comprehensive understanding of the complex interplay of all the factors that lead to child outcomes such as growth, health, behaviour and cognitive development.

Advantages of information collected from *Growing Up in New Zealand* as compared to routine data sources include: the depth and breadth of the detailed data collected regarding child development as well as the nature of parental and parent-child relationships, and the family context including how parents and children engage with their communities and environments; the strength of the data to determine associations between early exposures and later outcomes; the ability to measure these influences repeatedly for the same individuals over time, and therefore the ability to determine transitions in and out of states that influence child development; and the ability to link the longitudinal data to administrative data sources to add value and understanding across sectors. These critical aspects of the *Growing Up in New Zealand* data are evident in this exploration of risk factors for vulnerability in early life in the New Zealand population.

1.2 The cohort

Growing Up in New Zealand recruited pregnant women who were due to have their babies between the 25th of April 2009 and the 25th of March 2010. The geographical area chosen for recruitment was the region of the North Island covered by the three contiguous District Health Boards (DHBs) of Auckland, Counties Manukau and Waikato. Given the lack of a register of pregnant women, specific challenges for this study included ensuring that: all eligible pregnant mothers living in the selected recruitment region received a timely invitation for their children to participate; the cohort recruited was of sufficient size to provide adequate statistical power for complex analyses of developmental trajectories over time across the whole cohort of children as well as within subgroups (including by ethnicity); and that the cohort was broadly generalisable to contemporary New Zealand children. These challenges were met. *Growing Up in New Zealand* recruited 6822 pregnant women and 4401 of their partners. An additional 200 families in a 'Leading Light: Roopu Piata' group were recruited in late 2008. Key characteristics of the recruited main cohort families are similar to those of all families having children in New Zealand today, especially with respect to their ethnic and families' socio-demographic diversity (Morton et al. 2010; Morton et al. 2012a; Morton et al. 2013a; Morton et al. 2014b).

1.3 Conceptual framework

Growing Up in New Zealand, with its longitudinal design, is multidisciplinary in nature and includes a translational dimension, with an explicit intent to relate to both the current policy context and inform future policy development. This study builds on the demonstrated value and lessons learnt from earlier New Zealand longitudinal studies, while reflecting the scientific and demographic changes that have occurred since the 1970s. The conceptual framework for *Growing Up in New Zealand* takes a life-course approach to child development and therefore seeks to facilitate an understanding of the dynamic interactions between children and their environments across a broad range of influences from their immediate family environments to their wider societal context over time (Figure 01). The information collected from the cohort families from before birth and over time is centred on the child as the participant (as described in Report 1: Before We Are Born; Report 2: Now We Are Born; Report 3: Now we are Two: Describing our first 1000 days;

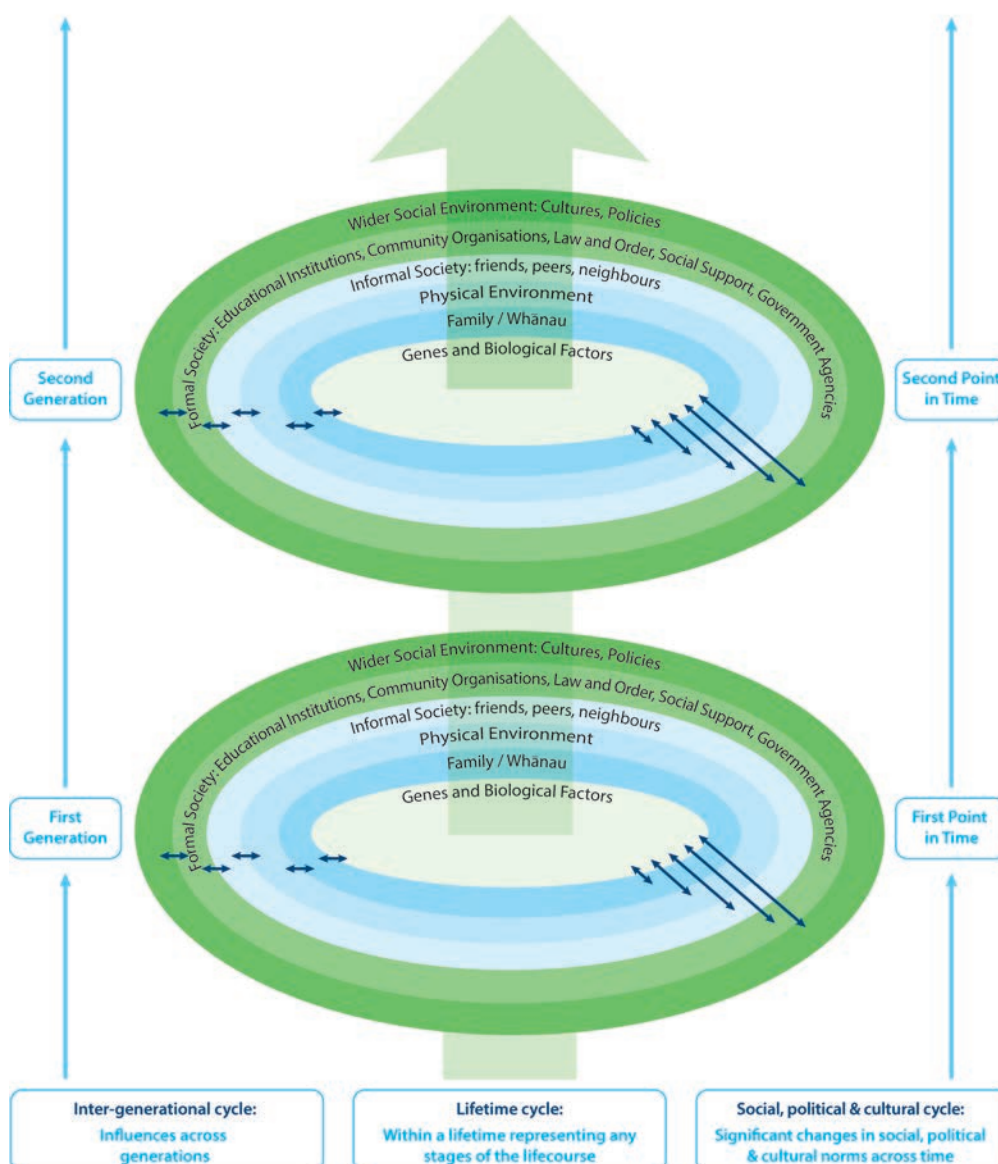


Figure 01: Conceptual framework of *Growing Up in New Zealand*

and other publications available at www.growingup.co.nz). The conceptual model for the study incorporates the notion that the development of all children begins from before they are born (intergenerational) and that each life-course outcome is the result of a complex interplay over time between the individual's biology and their environment (Figure 01).

1.4 Data Collection Waves

Growing Up in New Zealand was designed as a longitudinal study, with anticipated contact with the cohort up to the age of 21 years. Trajectories of early life development from before birth are recognised as critical for the on-going health, wellbeing and resilience of children and their families.

The longitudinal information collected within the first two years of the children's lives includes that from face-to-face interviews (collected during the antenatal period, at nine months, and at two years), telephone interviews (collected at six weeks, 35 weeks, 16 months, and 23 months) and data linkage (between the *Growing Up in New Zealand* data and perinatal health records including the National Minimum Data Set and the National Immunisation Register). More detail about all the Data Collection Waves is described in previous *Growing Up in New Zealand* publications (for example Morton et al. 2013a and Morton et al. 2014b).

Each Data Collection Wave of *Growing Up in New Zealand* seeks age-appropriate and policy relevant information across six inter-connected domains: family and whānau; societal context and neighbourhood; education; health and wellbeing; psychological and cognitive development; and culture and identity (further information is available at www.growingup.co.nz). Attention is given to ensuring that the methods utilised to collect domain-specific evidence acknowledge the diverse New Zealand population and environmental context, particularly the unique opportunity that *Growing Up in New Zealand* provides to examine the factors which contribute to the wellbeing of Māori whānau in New Zealand in the 21st century. The information presented here focuses on those specific and selected measures that describe likely risk factors for child vulnerability as well as child-specific health, wellbeing, and developmental outcomes.

1.5 The focus of this report

'Exploring the definition of vulnerability' is the second report from *Growing Up in New Zealand* that utilises information collected about the cohort children during their first thousand days of life, from conception until two years of age. It builds on 'Now we are Two: Describing our first 1000 days', which provided an overview of the cohort children at age two, and highlighted that the majority of New Zealand two year olds are thriving within their family environments (Morton et al. 2014a). The focus of this report is to explore what set of risk factors might be used to define 'vulnerability' in the context of New Zealand children and their families.

Importantly not all children who are identified as potentially being vulnerable from early life will develop poor developmental outcomes downstream. Understanding what particular characteristics of parents, families and their environments promote resilience in the face of exposure to early vulnerability will also be integral to optimising wellbeing for all New Zealand children, and will be a focus of later reports in this series.

As the first in a series that will be dedicated to this important topic, *'Exploring the definition of vulnerability'* describes how vulnerability can be usefully defined in the context of the diverse families and environments that comprise contemporary New Zealand, recognising that there is no accepted standard definition of what constitutes early vulnerability. It also describes how exposure to early vulnerability is associated with early health outcomes from birth up to two years.

Information from the following Data Collection Waves are the focus of *'Exploring the definition of vulnerability'*:

- Exploring vulnerability within the antenatal period focuses on the antenatal data collection, particularly that from the pregnant mothers of the *Growing Up in New Zealand* cohort and is described in Section 4. Section 4 also utilises outcome data from the nine month data collection to explore the potential early impact of exposure to vulnerability from before birth.
- Section 5 focuses on the nine month data to explore the distribution of risk factors for vulnerability in infancy (up to nine months).
- Section 6 describes vulnerability across both the antenatal and infancy period and considers the impact of accumulated exposure to vulnerability on outcomes collected when the *Growing Up in New Zealand* children were two years old.
- Section 7 uses the antenatal, nine month and two year data to explore exposure to vulnerability over the first thousand days of the cohort's development.
- Section 8 considers the transitions in and out of key states of vulnerability for individuals followed longitudinally.

1.6 Looking to the future

This report, *'Exploring the definition of vulnerability'*, and future work focused on vulnerability transitions will provide a foundation for subsequent reports within the 'Vulnerability and Resilience' series that will utilise information beyond the first thousand days of the children's lives. The second report in this 'Vulnerability and Resilience' series (which will also utilise data from the first 1000 days) is planned for release in early 2015 and will further explore transitions in and out of vulnerability over time. Importantly, it will consider what familial, community and societal factors might be associated with the prevention, adaptation and mitigation of exposure to risk factors over time that increase child vulnerability and the likelihood of poorer early developmental outcomes.

Analyses within the 'Vulnerability and Resilience' series will be extended to include developmental outcomes throughout the pre-school period when it will be possible to begin to address the associations of risk factors and vulnerable states with specific outcome measures across multiple domains including health and wellbeing, cognitive and social development, and educational participation and achievement. This will also enable consideration of the important question: 'vulnerable to what?' as it is anticipated that the effects of exposure to vulnerability are unlikely to be universal. Future analyses will also provide a fuller understanding of which particular subgroups of New Zealand children are at risk in early life so strategies to optimise wellbeing can be better targeted to their needs.

Additionally, when further longitudinal information is available from the *Growing Up in New Zealand* cohort, conducted at significant life transitions, it will be possible to explore the factors at individual, family, community and societal level that are associated with resilience, that is what works to optimise developmental trajectories of contemporary New Zealand children in the face of early disadvantage. This will deliver much needed evidence about the determinants of resilience in early childhood in New Zealand, and will provide new insights and policy targets, in an area of research that has previously focused predominantly on the later life course periods of adolescence and early adult life.

2. Exploring Vulnerability in Early Childhood in New Zealand



2.1 Background

Reducing the impact of vulnerability in early childhood has become an important area of policy focus in New Zealand as well as in the United Kingdom and Europe (Sabates and Dex 2012). The Green and White papers developed by the Minister of Social Development in 2011 (New Zealand Government 2011a; New Zealand Government 2011b), together with the subsequent Children's Action Plan in 2012 (New Zealand Government 2012) are designed to reduce the impact of exposure to early life vulnerability so that every child born in New Zealand today can 'thrive, belong and achieve.'

To achieve this objective it is first necessary to be able to identify children, or groups of children, who are vulnerable as early in their lives as possible. Research has shown that the early life development period is critical for laying the foundations for later life outcomes (for example Bronfenbrenner 1979; Barker 1998; Ben-Shlomo and Kuh 2002; Lynch and Smith 2005; Gluckman and Hanson 2006). In addition, theoretical models that simulate the impact of possible interventions strongly support the notion that intervening at the earliest possible opportunity affords the greatest likelihood of improving subsequent life-course outcomes (Halfon et al. 2013).

Vulnerability has been previously defined according to the presence of family- and or environment- specific risk factors that have been significantly associated with poor developmental outcomes across the life-course. Such risk factors have been particularly associated with disease outcomes (physical and mental), poor cognitive development and low educational achievement, and anti-social behaviours (Fergusson et al. 1994; Fergusson et al. 2003). The risk factors have almost always been identified as a result of retrospective analyses designed to explore the determinants of poor outcomes once the poor outcomes have already occurred. While there are multiple risk factors now known to be associated with poor later life outcomes it is not unusual in either the scientific or policy literature for a single factor to be the focus of these analyses, and thereafter used as a proxy for defining child vulnerability. In particular, measures of poverty (absolute or relative) or particular maternal characteristics (such as teenage pregnancy) are often used as a singular measure to determine the proportion of children who are vulnerable or 'at risk'. However, it is increasingly recognised that interventions targeting single risk factors before the adverse outcomes have developed are both inefficient (because not all those exposed are at risk), and insufficient (because usually there are multiple overlapping risk factors contributing to the vulnerable state) to effectively reduce the burden of later poor outcomes at a population level (Chittleborough et al. 2011).

2.2 Definitions of vulnerability

Defining child vulnerability in a contemporary population context requires a multi-dimensional framework that considers characteristics specific to the child and their family as well as their broader environments (including their communities, services, informal and formal societal structures and the policy context in which they grow). Risk factors used to define vulnerability should ideally be characteristics that are able to be measured with consistency and validity within a particular population, and they should be able to identify children who if exposed are at greater risk of adverse outcomes from early in their lives than those children not exposed. Ideally the risk factors should be able to identify children who are vulnerable before poor developmental outcomes occur or poor developmental trajectories are established.

The multi-dimensional risk factors that can be used to define vulnerability often over-lap and cluster at any one time point, and over time they may either persist or diminish (Sabates and Dex 2012). Understanding how these risk factors co-exist, change over time, and prospectively affect development across multiple domains is possible using multi-disciplinary information collected from longitudinal studies. Such data can also identify individual, family, community and societal factors that may be protective at different times in the children's life-course, as well as determine how these factors persist or abate over time and how much this contributes to the burden of poor developmental trajectories (Fergusson et al. 2003). These important questions cannot be addressed using cross-sectional data, such as that provided in routinely collected administrative datasets.

2.3 Defining vulnerability in a contemporary New Zealand context

In this report longitudinal information collected from *Growing Up in New Zealand* (Morton et al. 2013a) is used to explore risk factors that may define vulnerability for contemporary New Zealand children. Previously published work from national and international studies (Chittleborough et al. 2011 and Statistics New Zealand 2012) are used to inform the selection of the likely set of risk factors that can be used to define vulnerability. The risk factors identified in this way are key socio-demographic variables that are measured routinely and consistently in New Zealand which means they could have utility for the early identification of vulnerable children and also the targeting of possible interventions. The proportions of children who are likely to be 'vulnerable' based on exposure to these risk factors from before they are born (antenatally) as well as in infancy (at nine months) and at two years of age are also described.

The risk factors are amongst the detailed, comprehensive longitudinal and multidisciplinary information collected from the *Growing Up in New Zealand* children and their families. This rich longitudinal information will also allow an exploration of which broader family and environmental factors may contribute to persistent exposure to vulnerability and which factors are associated with a change (positive or negative) in exposure to vulnerability over time.

Analyses considering the distribution and impact of exposure to multiple risk factors have been carried out for historical cohorts and the more recent Millennium Cohort Study in the United Kingdom (Sabates and Dex 2012), but have not been undertaken in the context of the contemporary New Zealand child population. In particular, Māori and Pacific children in New Zealand experience significant inequalities in developmental outcomes. The size of the Māori and Pacific cohort in the *Growing Up in New Zealand* study provides an unique opportunity for the analyses in this and later reports to consider whether (and to what extent) the distribution of exposure to vulnerability over time can help us to understand how these inequalities develop in the contemporary New Zealand family and environmental context. This information can in turn inform the development of appropriate intervention strategies to effect change, and ensure all children thrive, achieve and belong.

3. Methods Used to Explore Vulnerability



3.1 A life-course approach to defining vulnerability

This report takes a life-course approach (Kuh and Ben-Shlomo 1997) to exploring the definition of vulnerability and to understanding the health and developmental consequences of exposure to vulnerability in the first 1000 days of life.

'Exploring the definition of vulnerability' utilises data from the *Growing Up in New Zealand* longitudinal study to define the dynamic nature of exposure to risk factors for vulnerability and to consider the effects of cumulative exposure on early developmental outcomes. As the baseline data was collected during pregnancy it is possible to understand how exposure to risk factors for vulnerability from before birth can affect early life outcomes and how exposure to risk factors may change during the postnatal period.

The *Growing Up in New Zealand* cohort is still relatively young compared to other contemporary child cohorts internationally (such as the Longitudinal Study of Australian Children and the Millennium Cohort), so this report sets the foundations for exploring associations of 'vulnerability' with trajectories of development and wellbeing throughout childhood and into adolescence. Importantly the *Growing Up in New Zealand* cohort aligns well to current New Zealand births so this exploration can also be generalised to the wider New Zealand pre-school population (Morton et al. 2014c).

The outcomes described in this report represent early wellbeing outcomes, albeit ones which have been shown to be significantly associated with later developmental outcomes. Over time they will become starting points for later developmental trajectories and outcomes as longitudinal information becomes available beyond the two year data collection point.

3.2 Risk factors for vulnerability

Defining vulnerability in early childhood requires identifying the characteristics, or risk factors, that are likely to make children more susceptible to poor developmental outcomes than those who are either not exposed to those factors, or who endure less exposure over time. The set of risk factors that are identified must be age and context appropriate, as discussed by Sabates and Dex (2012) in their work utilising the information from the Millennium Cohort Study in the United Kingdom. To have utility for identifying children who may be vulnerable they also need to be factors that are routinely available and measured in a standard way across the population of interest. The risk factors should also be appropriate across the diversity of the population in which vulnerability is being defined.

Growing Up in New Zealand is able to consider factors that are present in the family and the environment even before the children are born because initial data collection occurred during pregnancy (antenatally). In this report, likely risk factors for vulnerability in the antenatal period are grouped according to whether they are proximal family variables; distal family variables; or measurements of the physical home environment. These groupings align well to the concentric rings of influence on child development in the *Growing Up in New Zealand* conceptual framework diagram (Figure 01).

Growing Up in New Zealand has measured fourteen of the risk factors that have been utilised in international studies to define vulnerability, chosen because they have each been shown to be associated with poor outcomes across the life-course in multiple studies, usually in retrospective analyses. For each of these risk factors, exposure has been dichotomised in explicit and standard ways in the international and the New Zealand context. This facilitates comparisons of the effects of exposure to vulnerability on developmental trajectories for children growing up in different population and environmental contexts, often with different strategies designed to mitigate the effects of exposure over time.

Table 01 describes the risk factors used to explore vulnerability in the antenatal period (with information regarding the cut off used to explore 'at risk').

Table 01: Antenatal risk factors for exploring vulnerability

Category	Risk factor	Risk factor definition
Proximal family variables	Maternal depression	Edinburgh Postnatal Depression Score of 12 or over indicating likely maternal depression
	Maternal physical wellbeing	Self-rated health in late pregnancy as poor or fair
	Maternal smoking in pregnancy	Continuing to smoke regularly/every day after the first trimester of pregnancy
	Maternal alcohol use	Continuing to consume any alcohol after the first trimester of pregnancy
	Maternal age	Teenage mother at time of pregnancy
Distal family variables	Relationship status	Mother with no current partner
	Maternal education	Mother with no formal secondary school qualifications
	Financial stress	Reporting highly stressful money problems
Home environment	Deprivation area	Living in NZDep2006 area deciles 9 or 10
	Unemployment	Mother not on leave, actively seeking work but not currently working
	Tenure	Living in public rental accommodation
	Income tested benefit	In receipt of an income tested government benefit
	Overcrowding	Having 2 or more persons on average per bedroom
	Mobility	Moved house more than five times in the previous five years before cohort pregnancy

At the nine month and two year time points the definition of risk factors remain as consistent as possible with the antenatal definition and categorisation of 'at risk', however in moving between the antenatal and postnatal period there are some necessary changes to the following risk factors:

- Maternal smoking (smoking regularly/every day);
- Maternal alcohol use (consuming any alcohol);

- Mobility (moved house since the last interview – that is in the last 12 to 15 months);
- Unemployment (mother actively seeking work but not currently working and no employment beginning in the next four weeks).

The definitions of all the other risks at the nine month and two year time points remain the same as those described in the antenatal period (Table 01).

3.3 Method of measuring how risk factors cluster or accumulate

Two methods are used in this report to describe how the resulting set of risk factors used to define early vulnerability cluster and accumulate.

The first method uses an exploratory factor analysis to describe ways in which the risk factors tend to cluster across the cohort. Factor analysis is useful here because the methodology explores the underlying correlation between the variables, and it allows an exploration of whether there are clusters of risk factors that might help identify groups of children who are at particular risk because these identifiable risk factors commonly co-occur.

The second method acknowledges that while risk factors for vulnerability do tend to cluster, they do not do so uniformly across the whole cohort. Therefore another approach to consider the effect of being exposed to multiple risk factors (accumulation of risk) that has been utilised in similar international analyses, is to consider the total number of risk factors for vulnerability that children are exposed to at any time point as well as over time.

The distribution and clustering of risk factors is stratified by maternal ethnicity using self-identified and self-prioritised maternal ethnicity, which for the purposes of this report have been analysed at the following levels: New Zealand European, Māori, Pacific, Asian and Other. Sabates and Dex (2012) note that rarely has the distribution of exposure to vulnerability been explicitly considered across different ethnic groups. In these analyses maternal ethnicity is importantly not used as a risk factor for vulnerability. Instead patterns of risk factor exposure and accumulation are explored for the children of mothers who identify with different ethnic groups to see if they experience different patterns of exposure to vulnerability. This may provide insight from early life into why we see persistent inequalities in developmental outcomes by ethnicity within New Zealand.

3.4 Outcome measures

Once the exposures to the potential risk factors for vulnerability have been described, their associations with early markers of wellbeing in the perinatal and early childhood period are explored prospectively. This report focuses on health related outcomes, which are particularly important in the New Zealand context because of the high burden of poor health that New Zealand children bear in comparison to children in other OECD countries (OECD 2009), and because of the inequalities seen in these outcomes between population subgroups.

The outcome measures used to describe poor early wellbeing used in this report are described in Table 02, in chronological order:

Table 02: Outcome measures for exploring vulnerability

Time point	Outcome	Adverse outcome definition
Perinatal and early postnatal period	Low birth weight (LBW)	Weighing less than 2500grams at birth
	Exclusive breastfeeding	Exclusive breastfeeding for less than one month after birth
	Incomplete immunisations	Incomplete immunisations in first nine months
Up to nine months	Ear infection	Ear infection confirmed by a doctor
	Respiratory infection	Respiratory infection requiring hospital admission
	Accidents or injuries needing medical attention	More than two vs. none or one
Nine months to two years	Incomplete immunisations	Incomplete immunisations up to two years
	Ear infection	Ear infection confirmed by a doctor
	Skin infection	Skin infection confirmed by a doctor
	Respiratory infection	Respiratory infection requiring hospital admission
	Accidents or injuries needing medical attention	More than two vs. none or one

4. Exploring Vulnerability During the Antenatal Period



4.1 Proportion of children exposed to risk factors for vulnerability during the antenatal period

The proportion of children exposed to any one of the fourteen risk factors that has previously been used to define vulnerability in international cohort studies varies considerably for New Zealand children during the antenatal period (Table 03). The proportion of children exposed ranged from approximately 5% of the cohort who were born to teenage mothers to 28% of the cohort who were born into households living in areas situated within the two most deprived deciles (NZDep2006).

Table 03: Proportion of children exposed to risk factors for vulnerability during the antenatal period

Risk factors for vulnerability	Exposed	
	Yes n (%)	No n (%)
Maternal depression (EPDS ≥ 12)	989 (16.2)	5130 (83.8)
Maternal physical wellbeing (poor/fair)	689 (10.2)	6056 (89.8)
Maternal smoking (after 1st trimester)	651 (10.7)	5464 (89.4)
Maternal alcohol (after 1st trimester)	907 (13.4)	5840 (86.6)
Maternal age (<20)	325 (4.8)	6434 (95.2)
Relationship status (no partner/single)	582 (9.5)	5522 (90.5)
Maternal education (no secondary school qualifications)	479 (7.1)	6261 (92.9)
Financial stress (regular)	1068 (17.7)	4957 (82.3)
Deprivation area (NZDep2006 9 & 10)	1860 (27.5)	4897 (72.5)
Unemployment	539 (8.4)	5903 (91.6)
Tenure - public rental	467 (7.7)	5603 (92.3)
Income tested benefit	946 (15.6)	5134 (84.4)
Overcrowding (≥ 2 per bedroom)	860 (14.1)	5249 (85.9)
Mobility (> 5 moves in 5 years prior to pregnancy)	1061 (15.8)	5676 (84.3)
Total	6760*	

*Total number of participants with complete data.

4.2 Clustering of exposure to risk factors for vulnerability during the antenatal period

Previous studies of vulnerability risk factors, conducted in international cohorts, have shown that risk factors are not independent but rather, have a tendency to cluster. Our analysis within *Growing Up in New Zealand* has shown that this is also true for New Zealand specific data. The risk factors described in Table 03 were correlated, and these correlations are shown in Table 04.

Table 04: Co-occurrence of antenatal vulnerability risk factors

Antenatal risk factor	Depression	Physical wellbeing	Smoking	Alcohol	Age	Relationship status	Education	Financial stress	Deprivation area	Unemployment	Tenure	Income tested benefit	Over Crowding	Mobility
Depression														
Physical wellbeing	2.60*													
Smoking	2.54*	3.55*												
Alcohol	1.08	0.82	1.83*											
Age	1.66*	2.74*	4.09*	0.77										
Relationship status	2.72*	3.05*	5.47*	1.11	8.68*									
Education	2.28*	3.49*	8.19*	1.16	7.34*	4.77*								
Financial stress	3.49*	2.66*	2.67*	0.91	1.52*	1.78*	2.24*							
Deprivation area	2.02*	2.63*	3.35*	0.72*	2.77*	3.21*	3.84*	1.86*						
Unemployment	2.02*	2.25*	3.48*	0.82	3.22*	3.48*	2.92*	1.57*	2.76*					
Tenure	2.45*	2.74*	4.41*	0.86	3.00*	4.51*	5.49*	2.04*	11.87*	2.62*				
Income tested benefit	2.81*	3.17*	7.82*	1.17	5.63*	10.21*	6.99*	2.52*	4.53*	4.81*	7.19*			
Over Crowding	1.75*	2.10*	2.06*	0.55*	2.70*	1.56*	2.91*	1.71*	3.38*	2.48*	5.11*	2.78*		
Mobility	1.48*	1.48*	1.83*	1.44*	1.73*	1.56*	1.50*	1.41*	0.88	1.34*	0.73	1.93*	0.61*	

* Denotes significant correlation between risks at p<0.05.

Interestingly the way in which these risk factors were correlated with each other showed some important differences in the New Zealand context compared to the international literature. In particular two of the risk factors: pre-pregnancy mobility; and alcohol consumption after the first trimester; were not consistently associated with disadvantage using the New Zealand cohort information. In the *Growing Up in New Zealand* cohort greater alcohol consumption in pregnancy was associated with greater material advantage (Morton et al. 2012a) and high mobility was seen across all *Growing Up in New Zealand* families before pregnancy and during their children's first thousand days of life (Morton et al. 2014b). This mobility is experienced at high rates right across the socio-economic spectrum. These two factors are therefore not included in the further analyses in this report that explore clustering and cumulative exposure to vulnerability. Mobility will however be a key parameter that will be explored in future *Growing Up in New Zealand* reports as a potential modifier of the association between early vulnerability and adverse developmental outcomes, and as a potentially important risk (or protective) factor in its own right.

4.3 Clustering of risk factors during the antenatal period

This section uses twelve antenatal risk factors to further explore the definition of vulnerability in the antenatal period and for population subgroups.

4.3.1 Exploring clustering of antenatal risk factors using factor analysis

Exploratory factor analysis was the first method used to determine whether there were common clusters of familial and environmental risk factors for vulnerability experienced during the antenatal period. Three clusters of risk factors were identified – they are identified as Factors 1 through 3 (with a capital F) and are described below:

1. The first cluster (Factor 1 in Table 05) generally describes maternal characteristics and behaviours – notably being a teenage mother, being without a current partner in late pregnancy, having completed no formal secondary school qualifications, currently smoking and being in receipt of an income-tested benefit.
2. The second cluster (Factor 2 in Table 05) generally describes features of the proximal home environment – that is mothers living in rental accommodation, in an overcrowded household, and in a deprived area according to the NZDep2006 classification.
3. The third cluster (Factor 3 in Table 05) generally describes more acute or pregnancy specific conditions – that is mothers experiencing current financial stress, reporting poor maternal mental wellbeing and poor physical health during late pregnancy.

Overall, these three clusters of risk factors explained approximately 42% of the variation in all twelve risk factors across the cohort, with Factor 1 explaining 23%, Factor 2 explaining 9.5% and Factor 3 explaining 9% of the variation. The ranking of the twelve risk factors in Table 05 represent their relative influence within the three summary Factors.

Table 05: Common clusters of risk factors for vulnerability in the antenatal period

Risks 1-12	Factor 1	Risks 1-12	Factor 2	Risks 1-12	Factor 3
Age	0.674	Tenure	0.695	Financial stress	0.741
Relationship status	0.643	Overcrowding	0.691	Depression	0.690
Education	0.604	Deprivation area	0.665	Physical wellbeing	0.452
Smoking	0.540	Income tested benefit	0.277	Smoking	0.269
Income tested benefit	0.528	Education	0.184	Income tested benefit	0.214
Physical wellbeing	0.345	Smoking	0.182	Deprivation area	0.129
Tenure	0.210	Unemployment	0.107	Education	0.089
Depression	0.196	Physical wellbeing	0.089	Relationship status	0.084
Unemployment	0.194	Financial stress	0.047	Tenure	0.084
Deprivation area	0.072	Depression	0.047	Unemployment	0.052
Financial stress	-0.001	Relationship status	0.021	Overcrowding	0.023
Overcrowding	-0.004	Age	-0.052	Age	-0.140

Note: The table above reports the results of an exploratory factor analysis which used a principal components extraction method. The use of both the Kaiser's criteria (eigenvalue>1) test and scree test showed that a three Factor model was most likely for the antenatal dataset. Risk factors considered to be most influential (using a cut-off of an eigenvalue ≥ 0.4 to avoid duplication of risk factors across the three clusters) are highlighted for each Factor.

The Factor score for each individual (mother of cohort child) can be plotted in three dimensions to indicate scores according to each cluster and by specific maternal characteristic, including self-prioritised ethnicity. This plot is reproduced here in two dimensions (Figure 02).

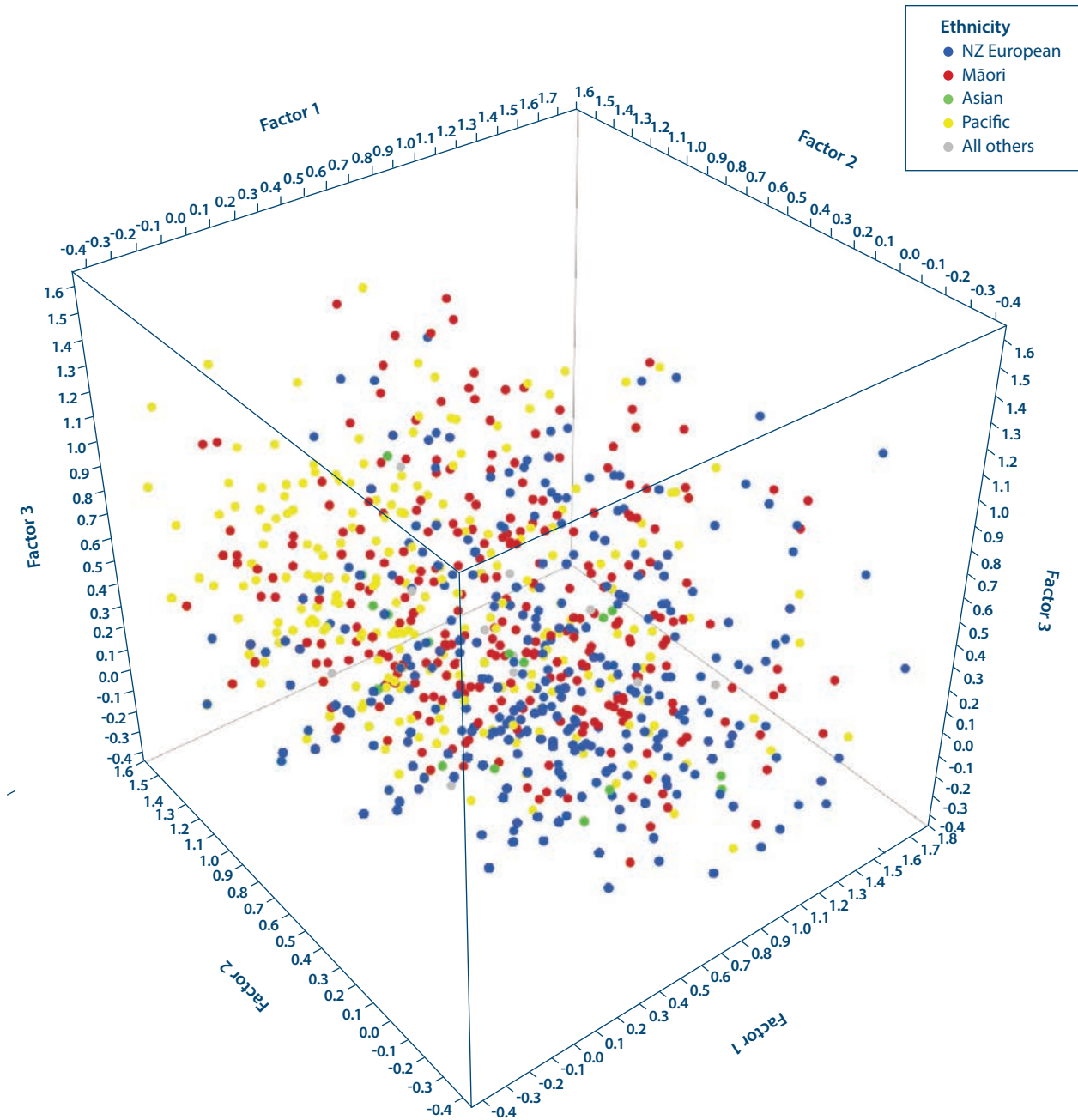


Figure 02: Individual antenatal Factor scores by maternal ethnicity

While there is considerable heterogeneity in terms of exposure to each of the three clusters of risk factors by maternal ethnicity, there is some indication that mothers who identify their main ethnicity as Pacific tend to have higher Factor 2 scores, particularly compared to New Zealand European mothers. This indicates that children of the *Growing Up in New Zealand* cohort born to Pacific mothers are most likely to be living in rental accommodation, in overcrowded conditions and in high deprivation areas.

The average antenatal Factor scores are plotted by maternal self-prioritised ethnicity in Figure 03.

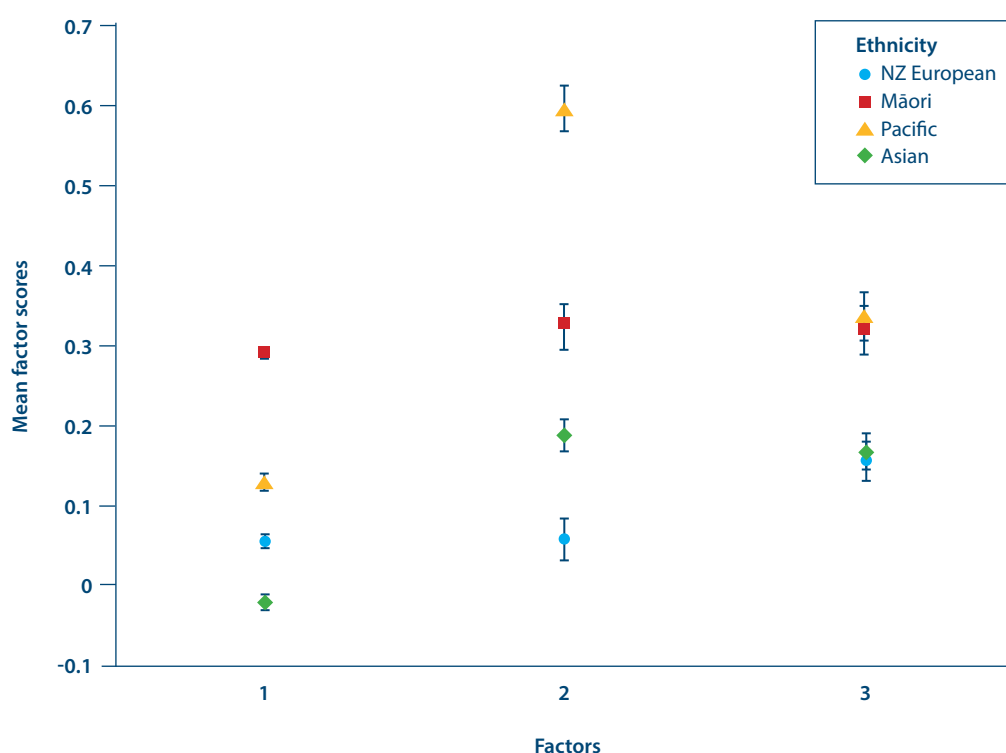


Figure 03: Average antenatal factor scores by maternal ethnicity

A comparison of the average Factor scores suggests that Māori mothers tend to have higher average scores across all three Factors, although lower average Factor 2 scores than Pacific mothers, particularly in comparison to New Zealand European mothers. Asian mothers had the lowest Factor 1 scores, that is they were the least likely to be teenage mothers, to be single, to have no educational qualifications, to smoke during pregnancy and/or be in receipt of an income tested benefit.

Further analyses were conducted to see if there were different patterns of clustering of risk factors according to where the mothers of the cohort children were born. The representation of the 3-D plot of Factor scores according to mother's place of birth is shown in Figure 04.

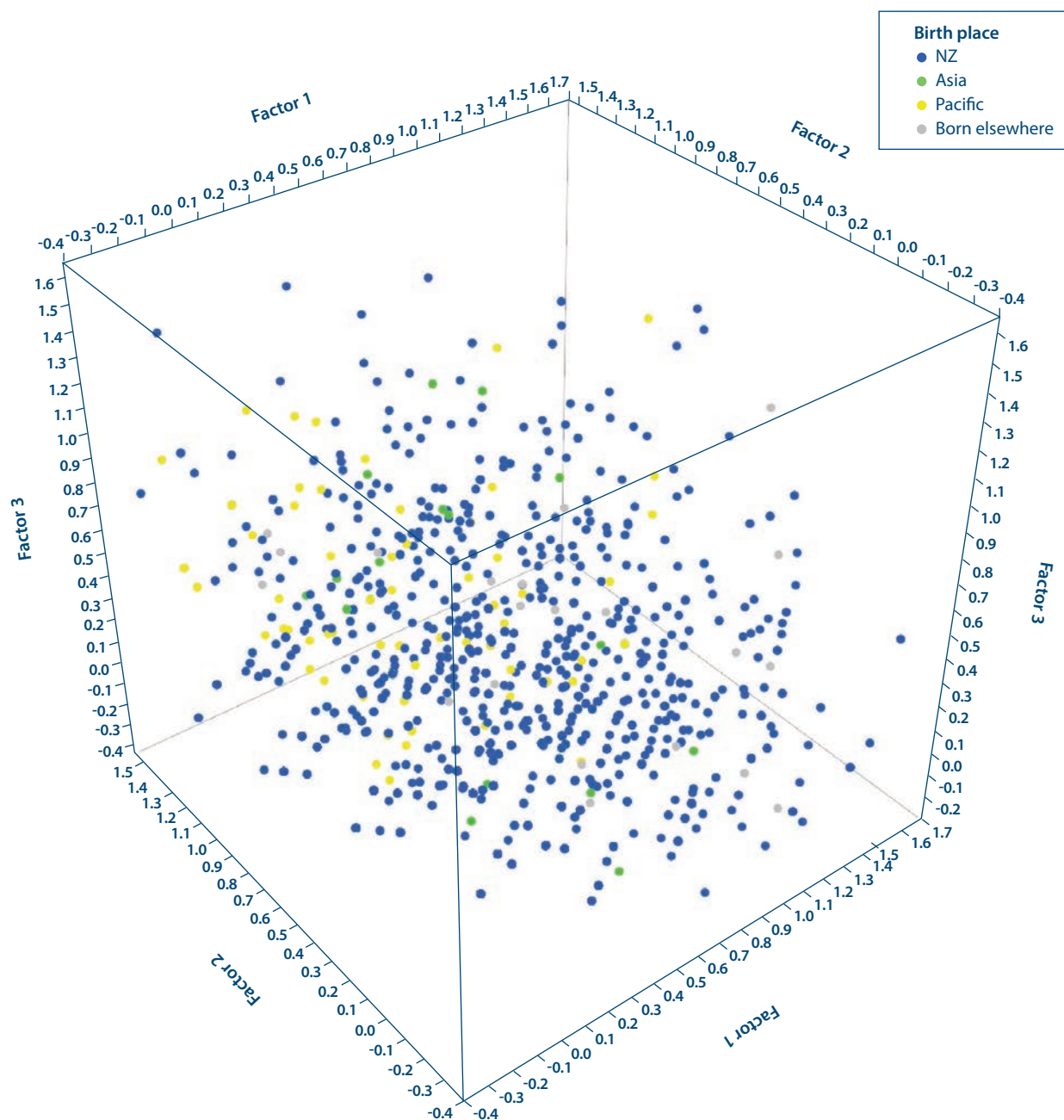


Figure 04: Individual antenatal Factor scores by mother's birth place

Comparing the Factor scores for mothers born in New Zealand with those born elsewhere, it appears that those mothers who were born in the Pacific (rather than those born in New Zealand) are more likely to have high Factor 2 scores (exposed to a disadvantaged proximal home environment). There are no clear differences in the patterning of Factor scores by maternal place of birth for mothers born elsewhere.

The average Factor scores were also plotted by maternal birth place for mothers born in the Pacific or Asia. Numbers were too small, and diversity too great, for averages to be meaningful for those born elsewhere (Figure 05). This confirmed that mothers born in the Pacific rather than those born in New Zealand or Asia tended to have the greatest average exposure to clusters of risk factors associated with a disadvantaged proximal home environment.

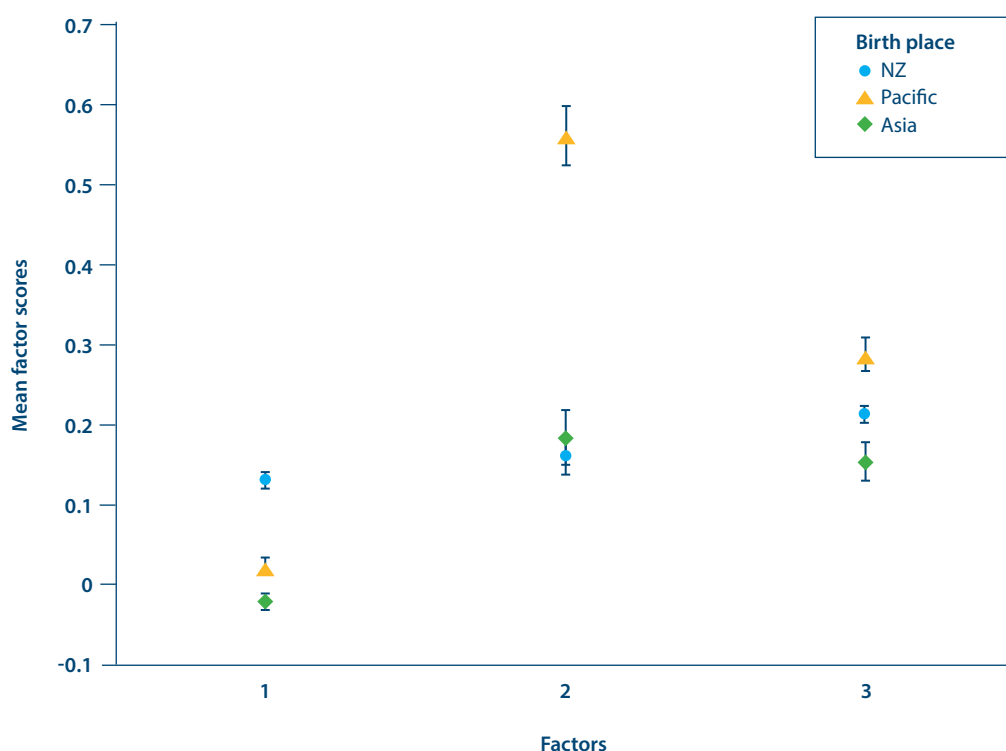


Figure 05: Average antenatal Factor scores by mother's birth place

4.3.2 Using the total number of risk factors as a measure of vulnerability exposure during the antenatal period

The second method used in this report to determine how risk factors cluster and exposure to vulnerability accumulates is to count the total number of familial and environmental risk factors children are exposed to during the antenatal period. This method has been used internationally as a measure of cumulative exposure to vulnerability, to overcome the observation that although some children are exposed to multiple risk factors from before their birth, risk factors do not cluster uniformly.

Table 06: Total number of vulnerability risk factors in the antenatal period

Number of risk factors	Frequency	%	Cumulative Frequency	%
0	2874	42.5	2874	42.5
1	1626	24.1	4500	66.6
2	838	12.4	5338	79.0
3	534	7.9	5872	86.9
4	357	5.3	6229	92.2
5	245	3.6	6474	95.8
6	158	2.3	6632	98.1
7+	127	1.9	6752*	100.0

*Total number of participants with complete data.

Approximately one third of all *Growing Up in New Zealand* children are exposed to any two or more risk factors from before their birth, according to maternal characteristics measured during late pregnancy (Table 06 and Figure 06).

Children born to Māori and Pacific mothers were more likely to be exposed to a greater number of risk factors for vulnerability from before birth than children born to New Zealand European mothers (Figure 07).

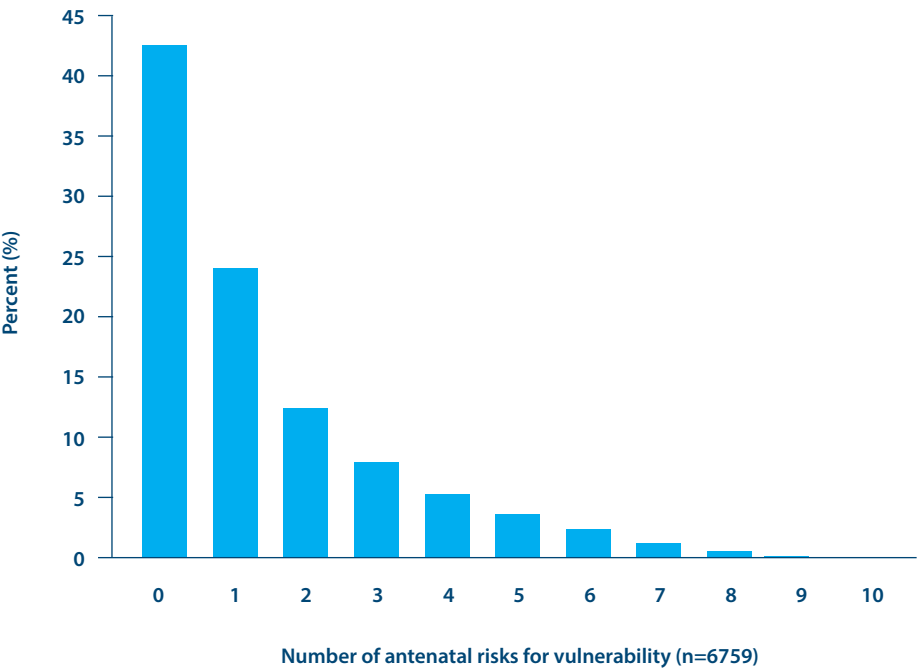


Figure 06: Number of antenatal vulnerability risk factors experienced

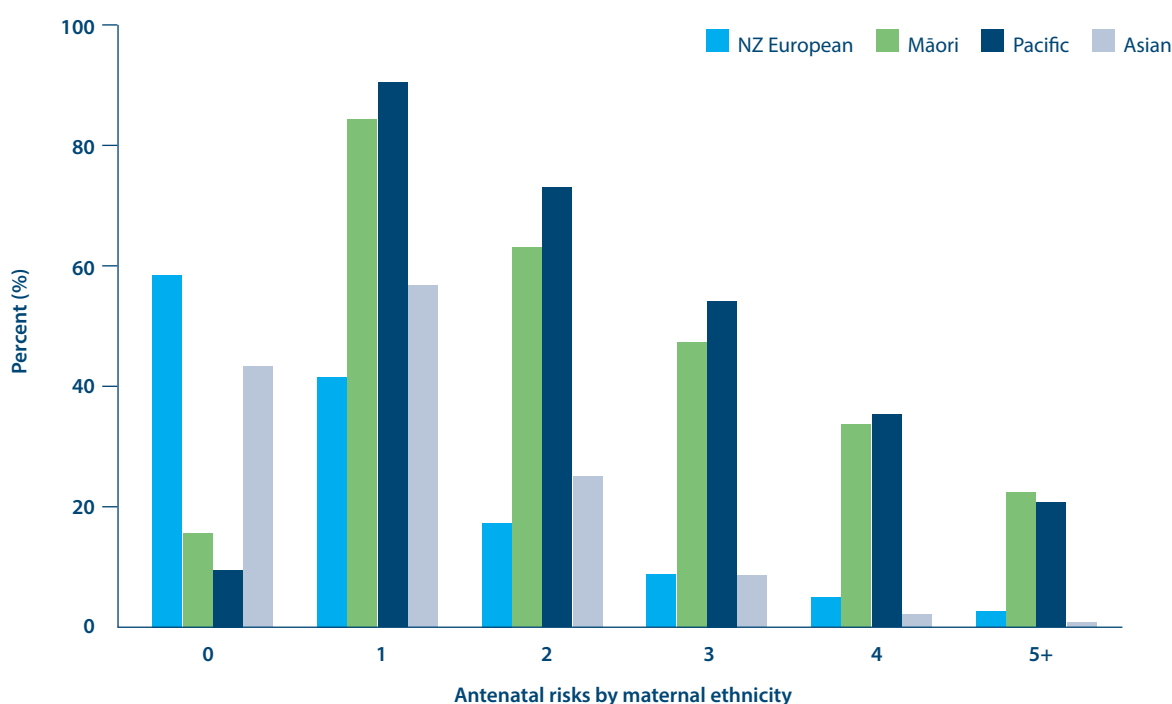


Figure 07: Number of antenatal vulnerability risks experienced by maternal ethnicity

4.4 Association between cumulative exposure to antenatal vulnerability and early postnatal outcomes

The effect of exposure to cumulative vulnerability before a child's birth (the degree of cumulative exposure defined by the total number of risk factors experienced in the antenatal period) was explored with respect to standard early postnatal markers of a less than 'healthy start to life.'

Results are either expressed here as odds of having a poor outcome according to a threshold point in terms of the number of antenatal risk factors which seemed to 'tip the balance' for experiencing different outcomes, or as graphics which display a graded association between cumulative exposure and a particular outcome. Importantly the number of risk factors needed to 'tip the balance' for increasing the likelihood that children might experience poor outcomes was not the same across all outcomes. This will be important to examine further as we continue to investigate other developmental outcomes and begin to address the question of 'vulnerable to what?'

4.4.1 Antenatal vulnerability and early life health outcomes

The first postnatal measure explored was infant birth weight, specifically whether infants were more likely to be born low birth weight (LBW being less than 2500 grams at birth). LBW is known to be associated with poorer developmental trajectories in childhood and throughout adult life and is a critical early life outcome (Gluckman and Hanson 2006). Using the method of summation of risks, children born to mothers exposed to two or more vulnerability risk factors

during pregnancy were 33% more likely to be born LBW than infants born to mothers exposed to no or only one vulnerability risk (OR = 1.33, 95% CI 1.02 - 1.73). After adjustment for ethnicity, the likelihood of LBW was further increased with exposure to two or more vulnerability risk factors (OR = 1.54, 95% CI 1.14, 2.07).

The second and third markers of wellbeing in early infancy explored were the duration of exclusive breastfeeding and the completion of immunisations during early infancy. Longer exclusive breastfeeding duration has been associated with higher cognition in childhood (Der et al. 2006) and completion of immunisations is associated with better child health outcomes (Martin et al. 2014). The threshold for increased vulnerability was slightly different for these two early markers of wellbeing. Infants whose mothers were exposed to two or more vulnerability risks around the time of birth were slightly less likely to be exclusively breastfed beyond their first month of life than infants whose mothers experienced one or no risks during the antenatal period (OR = 1.07, 95% CI 0.92, 1.25). For incomplete immunisation, infants exposed to three or more risks during the antenatal period were more likely to be incompletely immunised by the age of nine months than those exposed to two or less antenatal risks (OR = 1.33, 95% CI 1.11, 1.61).

4.4.2 Antenatal vulnerability and the home environment

Wellbeing in infancy is also known to be influenced by the physical environment of the home (Boston and Chapple 2014). Therefore the association between exposure to vulnerability risk factors in the antenatal period and an unhealthy home environment was considered for the *Growing Up in New Zealand* infants as a way to explore how vulnerability exposure might be linked to poor health outcomes in early life.

In postnatal life approximately one in three children in the cohort were living in a household where at least one adult regularly smoked around them (Morton et al. 2012a). The likelihood of being exposed to passive smoking during infancy varied considerably according to the relative exposure to vulnerability risk factors in antenatal life, with greater antenatal vulnerability exposure associated with a greater chance of the infant being exposed to passive smoking on a regular basis. The relationship showed a graded effect (Table 07). For comparison with other outcomes the odds for infants exposed to passive smoking for those children with two or more risks of vulnerability compared to those with one or no vulnerability risks during the antenatal period is provided. Children exposed to two or more risk factors for vulnerability in the antenatal period had odds of living with a regular smoker more than five times greater than those exposed to one or no risk factors before they were born (OR=5.75, 95% CI 5.11, 6.48).

Table 07: Exposure to passive smoking in infancy according to antenatal vulnerability risk

Number of antenatal vulnerability risk factors	Smoker in the household in first nine months				
	No		Yes		Total
	n	%	n	%	n
0	2402	87.5	343	12.5	2745
1	2057	57.9	1494	42.1	3551
2	911	45.4	1095	54.6	2006
3	446	35.7	803	64.3	1249
4	221	29.2	535	70.8	756
5+	110	24.8	333	75.1	443

Similarly the more maternal risk factors experienced during the antenatal period the greater the likelihood that a *Growing Up in New Zealand* infant would regularly be sleeping in a room that was damp after they were born (Table 08). This relationship was also graded. For those infants exposed to two or more vulnerability risk factors, the odds of sleeping in a damp environment were more than twice as high than those infants who were exposed to one or no vulnerability risk factors (OR=2.27, 95% CI 2.0, 2.6).

Table 08: Exposure to damp in infancy according to antenatal vulnerability risk

Number of vulnerability factors	Heavy condensation in room where baby sleeps				
	No		Yes		Total
	n	%	n	%	n
0	2325	84.9	415	15.2	2740
1	2584	73.2	948	26.8	3532
2	1364	68.2	636	31.8	2000
3	832	66.9	411	33.1	1243
4	481	64.1	270	35.9	751
5+	269	61.1	171	38.9	440

4.5 Association between cumulative exposure to antenatal vulnerability and health outcomes at nine months

As comprehensive data has been collected at nine months of age within *Growing Up in New Zealand* this report is able to determine the impact of exposure to vulnerability risk factors on outcomes at this stage of infancy. Here, the likelihood that children experienced three common and serious health outcomes (ear infections, respiratory illness and accidents or injury) is examined according to the absolute number of maternal risk factors for vulnerability that children were exposed to in the antenatal period. It is important to note that because outcomes

in this report are based on maternal self-report the doctor diagnosis or hospital admission condition was added to confirm the presence of poor health. It is highly likely that this underestimates the true incidence of infections in cases where for example medical attention was not sought. Linkage to routine health records which is now underway will allow these analyses to be extended further in time.

4.5.1 Ear infections during infancy

Firstly, ear infections confirmed by a doctor up to the age of nine months were examined as an example of a common childhood infection in the New Zealand context. While ear infections are routinely treated in the community, they have potentially serious sequelae for child development in terms of hearing impairment if repeated, not treated effectively, or not treated at all (Klein 2000).

Ear infections were reasonably common within the *Growing Up in New Zealand* cohort in their first nine months, with just under a quarter of the cohort having experienced at least one ear infection in this time, as diagnosed by their doctor (Morton et al. 2012a). The likelihood of experiencing an ear infection in infancy was associated with cumulative exposure to vulnerability in the antenatal period with some evidence of a graded effect (Figure 08). For comparison with the earlier threshold results, children exposed to two or more vulnerability risk factors compared to those exposed to none or one were significantly more likely to have had an ear infection diagnosed by a doctor in their first nine months of life (OR = 1.5, 95% CI 1.33, 1.70).

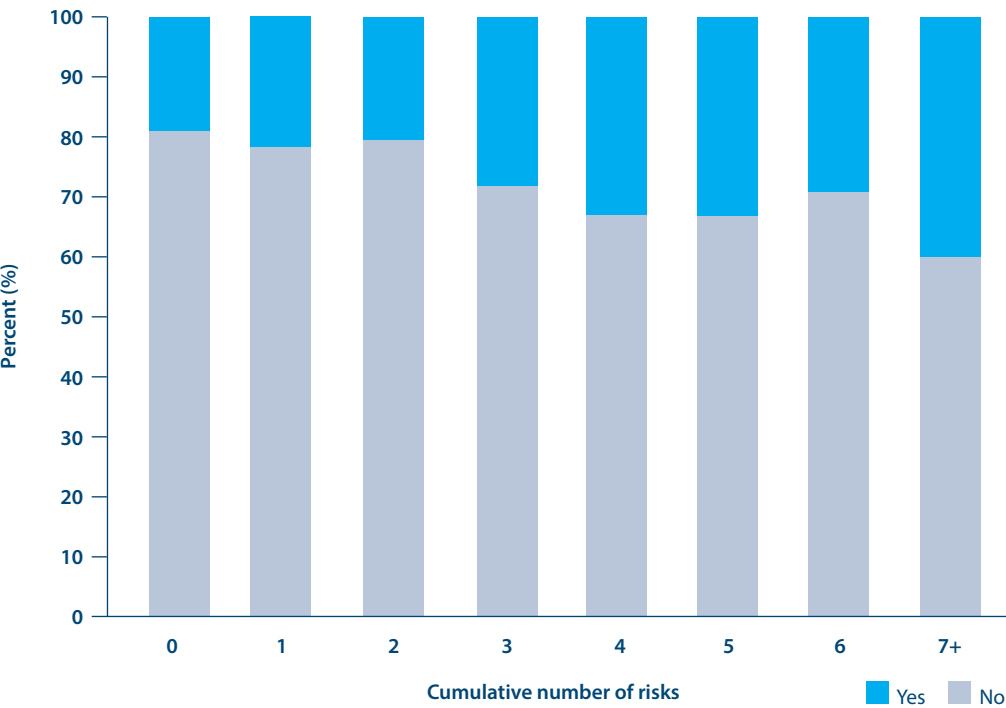


Figure 08: Proportion of children experiencing ear infections (Yes/No) by exposure to cumulative vulnerability

4.5.2 Respiratory illness requiring hospital admission during infancy

The likelihood of experiencing respiratory infections requiring admission to hospital during the first nine months of a child's life was also explored. This outcomes provides an example of a more serious childhood illness which is a significant concern in New Zealand in comparison to other child populations (Grant et al. 2011).

Overall, chest infections and other respiratory illnesses (wheezing, bronchiolitis, bronchitis, asthma, pneumonia and croup) had been experienced by approximately one in four of the *Growing Up in New Zealand* children by the age of nine months, and approximately one in five of the infants who had experienced these respiratory illnesses had been hospitalised as a result of their illness (Morton et al. 2012a). Children who were exposed to greater vulnerability from before birth were more likely to have been admitted to hospital with respiratory illnesses by nine months of age in comparison to those children exposed to fewer (or no) vulnerability risk factors (Figure 09).

The absolute numbers of children who experienced serious respiratory illness were lower for each cumulative vulnerability exposure category than for the more common ear infections, but the gradient is considerably steeper at the extremes of exposure. Children exposed to two or more risk factors were over three times more likely to have been admitted to hospital with a respiratory illness before they were nine months old in comparison to those children not exposed to any or one vulnerability risk factor during the antenatal period (OR =3.42, 95% CI 2.70, 4.34).

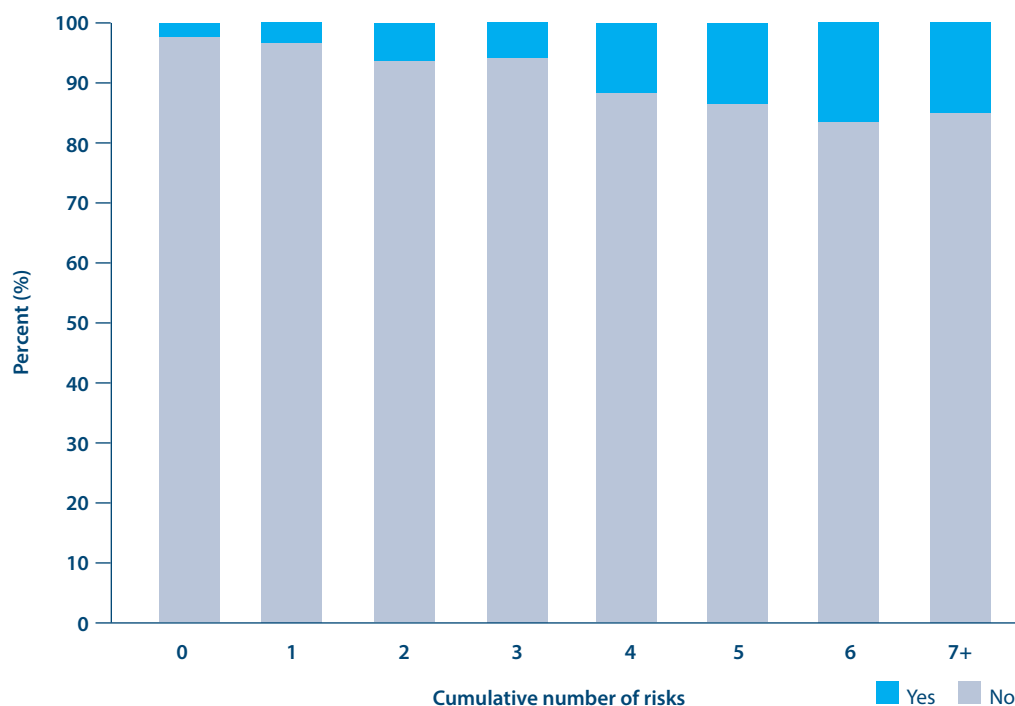


Figure 09: Proportion of children experiencing admission to hospital with respiratory illnesses (Yes/No) by exposure to cumulative vulnerability

4.5.3 Accidents and injuries requiring medical attention during infancy

The third health outcome at nine months of age used to explore the impact of cumulative vulnerability was those children who had experienced two or more accidents or injuries in infancy. New Zealand children experience more accidents and injuries than any other child population across the 30 OECD countries where these statistics are regularly compared (OECD 2009).

Within *Growing Up in New Zealand*, approximately one in eight of the cohort had experienced an injury or accident by the age of nine months (Morton et al. 2012a). Children who were exposed to greater vulnerability from before birth were again more likely to have experienced more than one accident or injury requiring medical attention during their first year of life (Figure 10). In particular children who were exposed to two or more risk factors were significantly more likely to have experienced an accident or injury than those not exposed to any or just one vulnerability risk factor during the antenatal period (OR = 1.57, 95% CI 1.34, 1.83).

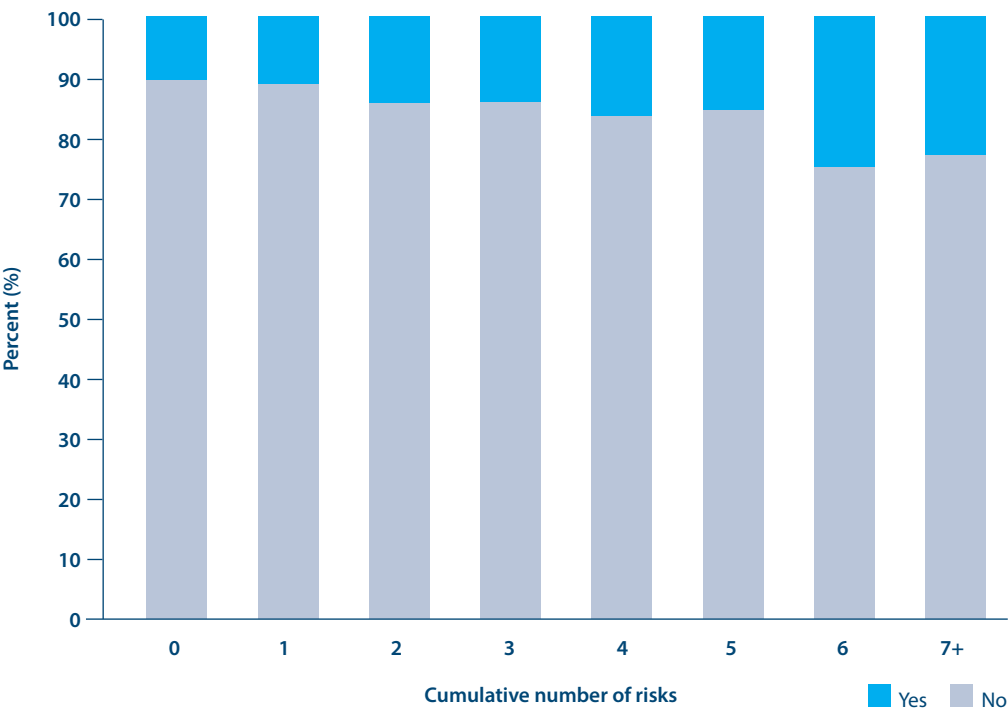


Figure 10: Proportion of children experiencing accidents and injuries (Yes/No) by exposure to cumulative vulnerability

5. Risk Factors for Vulnerability at Nine Months of Age



An advantage of longitudinal studies that follow the same individuals over time is that rather than being limited to the measurement of risk factors at a single time point, it is possible to measure change in exposure to risk factors over time. This section explores exposure to the same risk factors for vulnerability, but this time as measured in the postnatal period (at the nine month data collection point). The risk factors refer to characteristics of the mothers, families and the immediate environments that the children are exposed to after birth.

5.1 Proportion of children exposed to risk factors for vulnerability at nine months

In the *Growing Up in New Zealand* cohort ten of the twelve risk factors measured in late pregnancy were measured again when the children were nine months of age (in infancy). The proportions of cohort children exposed to those same risk factors in infancy ranged between approximately 7% and 26% (Table 09).

Table 09: Proportion of children exposed to risk factors for vulnerability at nine months

Markers of vulnerability	Nine month	
	Yes n (%)	No n (%)
Maternal depression (EPDS ≥ 12)	686 (10.8)	5698 (89.3)
Maternal physical wellbeing (poor/fair)	613 (9.6)	5770 (90.4)
Maternal smoking (at nine months)	897 (14.1)	5486 (85.9)
Maternal age (<20)*	325 (4.8)	6434 (95.2)
Relationship status (no partner/single)	541 (8.5)	5843 (91.5)
Maternal education (no secondary school qualifications)*	479 (7.1)	6261 (92.9)
Financial stress (regular)	871 (14.5)	5119 (85.5)
Deprivation area (NZDep2006 9 & 10)	1673 (26.2)	4710 (73.8)
Unemployment (at nine months)	417 (6.2)	6343 (93.8)
Tenure - public rental	412 (7.0)	5444 (93.0)
Income tested benefit	1152 (18.1)	5230 (81.9)
Overcrowding (≥ 2 per bedroom)	1397 (21.9)	4987 (78.1)
Total mothers	6760	

Key:

- Decreased by more than 1% since the antenatal period
- No change since the antenatal period
- Increased by more than 1% since the antenatal period
- NA because variable was not a repeated measure

*These variables were not re-measured at the nine month mother interview as they were unlikely to have changed. Antenatal measures are repeated in cumulative analyses to denote continuing periods of exposure.

In comparison to in the antenatal period a greater proportion of mothers of the cohort children (greater than 1% increase) at nine months of age were: on an income tested benefit; living in a house with more than or equal to two people per bedroom; and were smoking. A reduced

proportion of mothers of the cohort children at this age (greater than 1% decrease) were: unemployed; living in an area of high deprivation (NZDep2006 deciles 9 and 10); experienced a high level of stress regarding family finances; and had symptoms indicating a depressive state.

5.2 Clustering of risk factors for vulnerability at nine months of age

5.2.1 Exploring clustering of risk factors at nine months using factor analysis

The risk factors for vulnerability from the infancy period also tended to cluster and overlap. The way in which these familial and environmental risk factors tended to cluster and the impact of exposure to multiple risk factors in infancy are explored in the following sections. Similar methods were applied as used in the antenatal exploration of vulnerability.

Table 10: Common clusters of risk factors for vulnerability at nine months

Risks 1-12	Factor 1	Risks 1-12	Factor 2	Risks 1-12	Factor 3
Income tested benefit	0.739	Overcrowding	0.722	Depression	0.670
Relationship status	0.707	Tenure	0.716	Financial stress	0.653
Age	0.590	Deprivation area	0.684	Physical wellbeing	0.571
Smoking	0.564	Education	0.242	Unemployment	0.387
Education	0.456	Income tested benefit	0.209	Smoking	0.187
Deprivation area	0.217	Smoking	0.171	Income tested benefit	0.148
Unemployment	0.167	Depression	0.101	Overcrowding	0.067
Tenure	0.135	Unemployment	0.045	Deprivation area	0.049
Financial stress	0.094	Physical wellbeing	0.015	Relationship status	0.033
Depression	0.005	Relationship status	-0.008	Tenure	0.029
Overcrowding	0.004	Financial stress	-0.015	Education	0.025
Physical wellbeing	-0.032	Age	-0.024	Age	-0.023

Note: The table above reports the results of an exploratory factor analysis which used a principal components extraction method. The use of both the Kaiser's criteria (eigenvalue > 1) test and scree test showed that a three Factor model was most likely for the nine month dataset. Risk factors considered to be most influential (using a cut-off of an eigenvalue ≥ 0.4 to avoid duplication of risk factors across the three clusters) are highlighted for each Factor.

The three Factor scores during infancy were plotted together to examine whether there was any patterning of exposure to these three Factors by maternal self-prioritised ethnicity (Figure 11). The average Factor score at nine months was also plotted by maternal self-prioritised ethnicity in Figure 12.

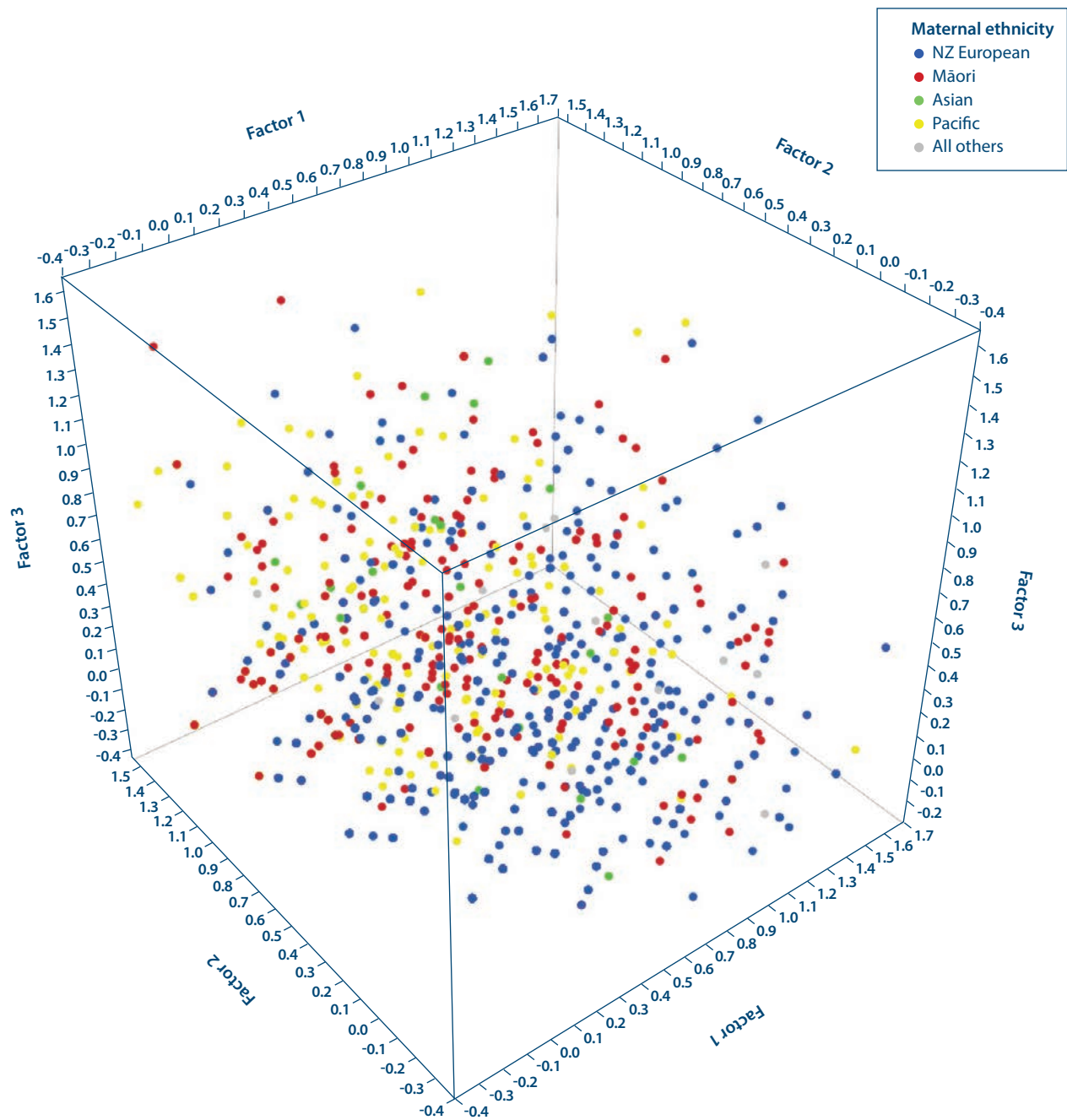


Figure 11: Individual nine-month Factor scores by maternal ethnicity

At nine months there was less obvious differences in the Factor scores by maternal ethnicity in comparison to those seen in the antenatal period, although Pacific and Māori mothers tended to have higher Factor 2 scores in comparison to mothers of other ethnicities (Figure 12). This indicates that children born to Pacific or Māori mothers are likely to experience greater vulnerability in relation to their home environments in the postnatal period (more likely to be living in rental accommodation in overcrowded conditions and in high deprivation areas) than children born to mothers identifying as Asian or New Zealand European ethnicities, although the heterogeneity is great.

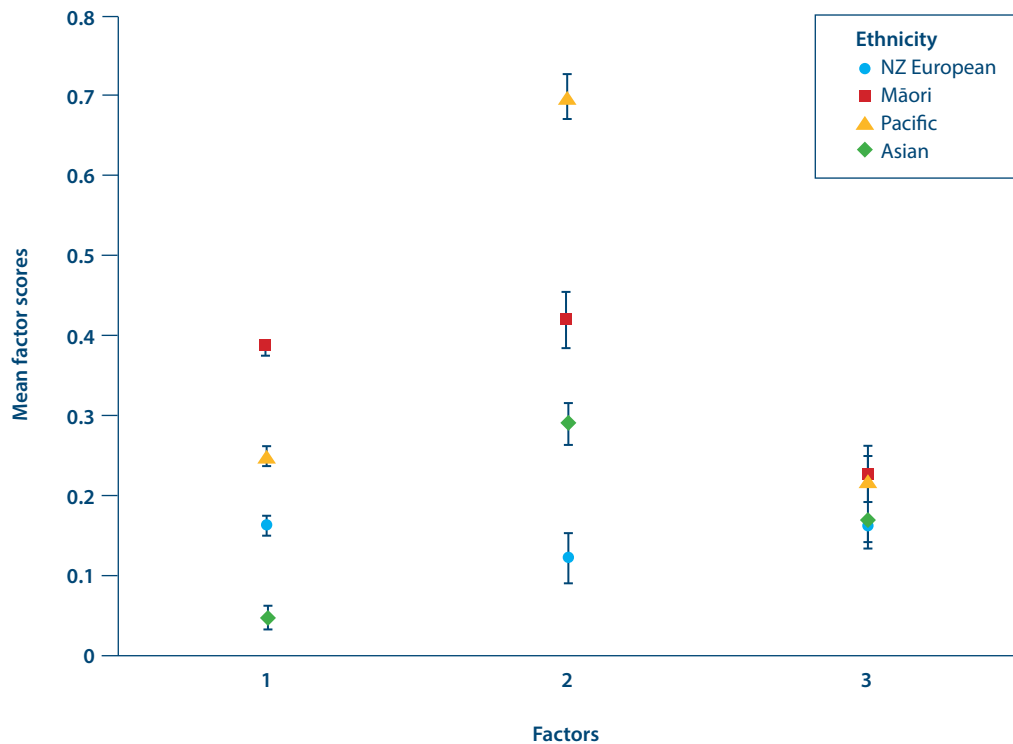


Figure 12: Average nine-month Factor scores by maternal ethnicity

At nine months the average Factor 2 score (home environment) for Pacific mothers remained higher than for other ethnic groups. Māori mothers tended to have higher scores for both Factor 1 (young, single mothers) and Factor 2 clusters in comparison to New Zealand European and Asian mothers. Average Factor 3 scores were similar across all ethnic groups (Figure 12).

When the distribution of Factor scores was compared for mothers born in New Zealand with mothers born elsewhere the pattern was also very similar to that seen during the antenatal period (Figure 13).

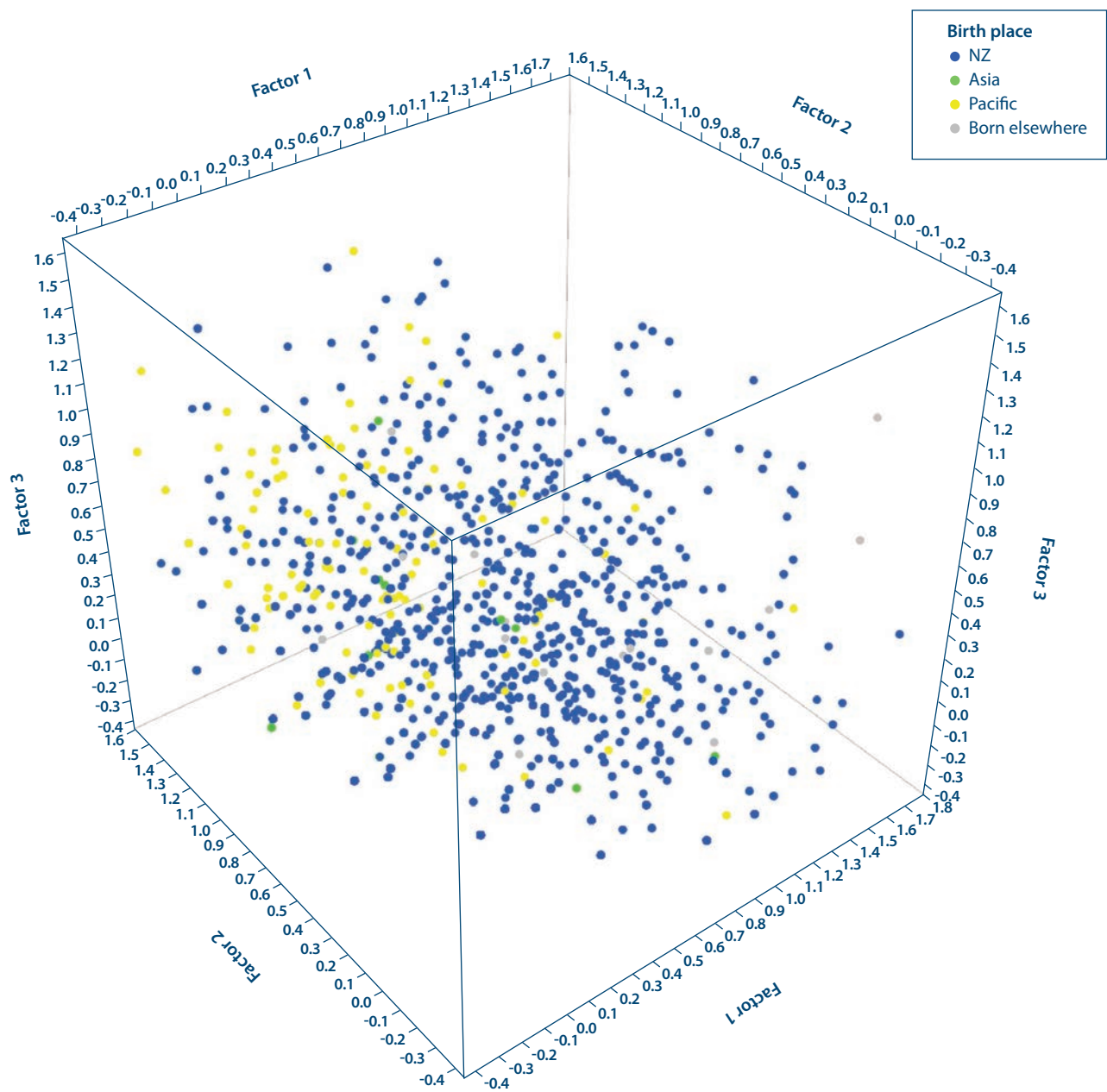


Figure 13: Individual nine-month Factor scores by mother's birth place

Children born to mothers born in the Pacific were the most likely to experience high Factor 2 scores, indicating greater exposure to more disadvantaged proximal home environments compared to the children of mothers who were born in New Zealand.

There was some indication that the pattern of postnatal exposure to clusters of risk factors for vulnerability varied according to maternal place of birth. In particular mothers who were born in the Pacific had the highest average Factor 2 scores (measures of a more disadvantaged home environment), whereas mothers born in New Zealand had the highest average Factor 1 scores (more likely to be young, poorly educated, reliant on a benefit for support and currently smoking). By contrast mothers born in Asia tended to have very low average Factor 1 scores (Figure 14).

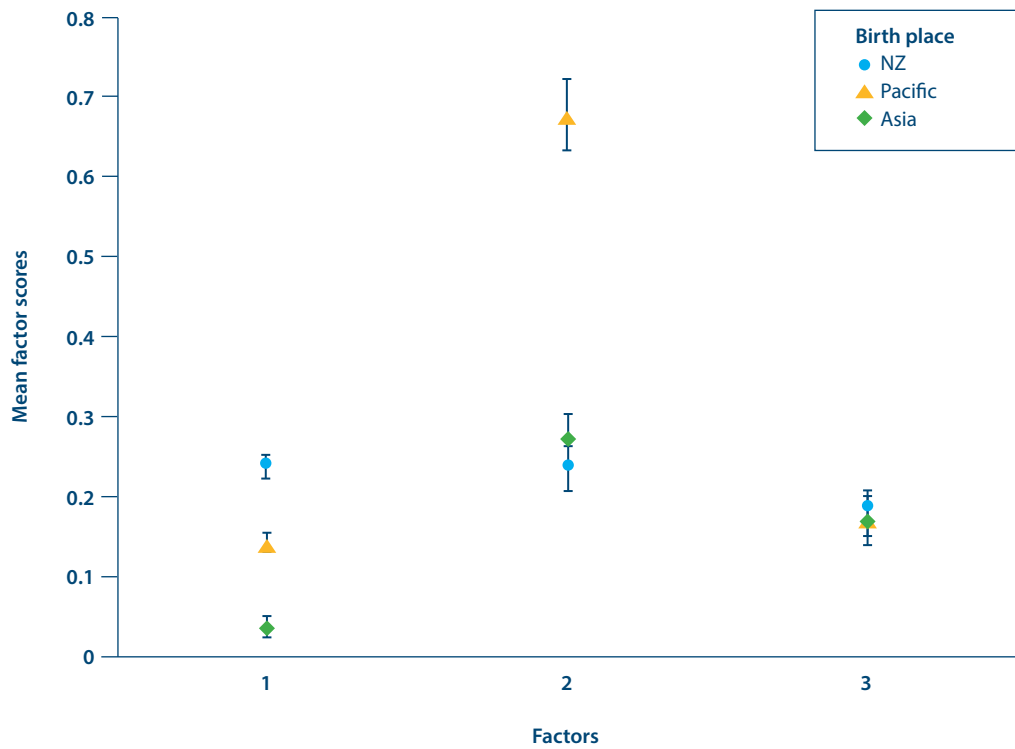


Figure 14: Average nine-month Factor scores by mother's birth place

6. Exposure to Risk Factors for Vulnerability During the Antenatal Period and at Nine Months of Age



6.1 Accumulation of exposure to vulnerability during the antenatal period and at nine months of age

Cumulative exposure to vulnerability over the period between late pregnancy and throughout infancy can also be explored by summing the absolute number of risk factors that children in cohort families are exposed to at both these time points. This means there are a total of 24 familial risk factors that children could potentially experience over the two time points.

The distribution of exposure to cumulative vulnerability using this additive approach is shown in Figure 15 for all the cohort families. Over three-quarters of all cohort families (76.5%) experienced four or less risks for vulnerability throughout the antenatal and infancy (postnatal) periods, and less than 5% experienced ten or more. No children were exposed to all 24 risk factors.

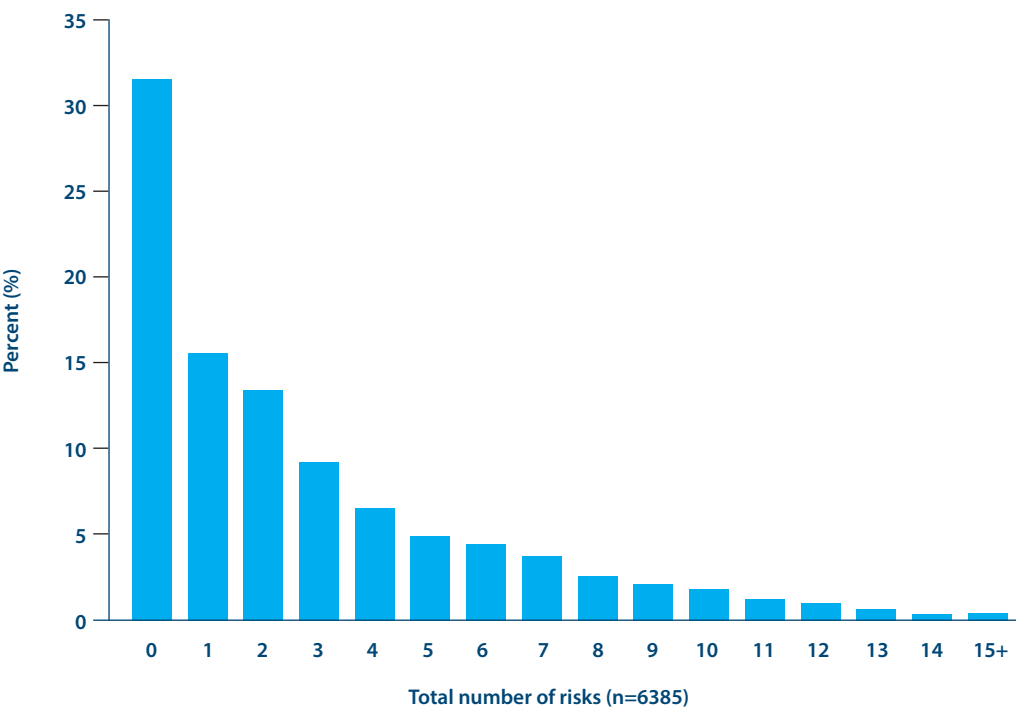


Figure 15: Cumulative vulnerability from before birth and throughout infancy

The pattern and amount of exposure to cumulative vulnerability varied according to maternal ethnicity, with children born to Māori and Pacific mothers tending to experience greater exposure to vulnerability over both time periods than those born to New Zealand European or Asian mothers (Figure 16).

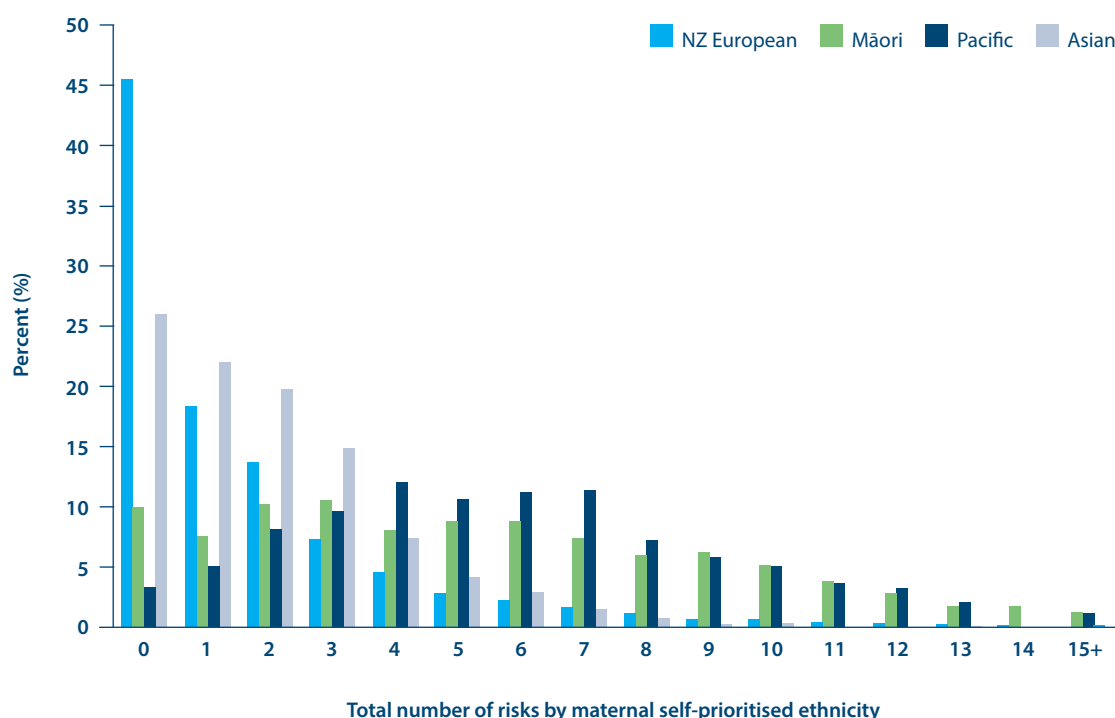


Figure 16: Cumulative vulnerability from before birth and throughout infancy by maternal ethnicity

6.2 Association between cumulative exposure to vulnerability risk factors and wellbeing outcomes at two years

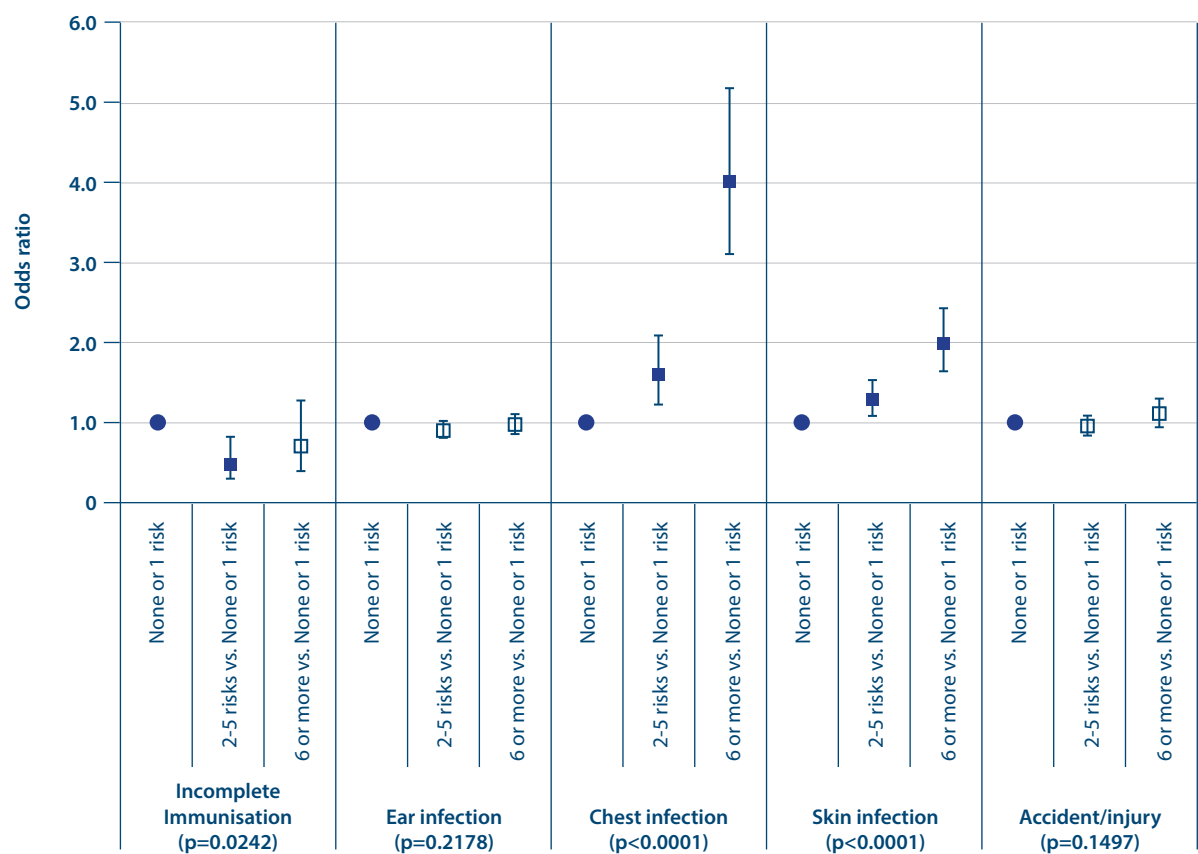
The comprehensive two-year Data Collection Wave of *Growing Up in New Zealand* provides an opportunity to explore the impact of cumulative exposure to risk factors for vulnerability in the antenatal period and at nine months of age on outcomes for health and development up to the age of two years. The relationship between cumulative exposures to vulnerability risk factors in early life was explored with respect to the following specific health outcomes for cohort children at two years of age: complete immunisations; maternal report of doctor-diagnosed ear infections and skin infections; chest infections requiring hospital admission; and accidents or injuries requiring medical attention (Figure 17).

At two years of age, immunisation coverage was very high across the cohort (98-99%) and incomplete immunisation was rare. The association that had been present between exposure to vulnerability risk and incomplete immunisations in infancy had disappeared by the age of two years. The relationship between cumulative exposure and doctor diagnosed ear infections also no longer held at two years of age. That is fewer children exposed to cumulative vulnerability had doctor-diagnosed ear infections between nine months and two years of age (Table 12). This is in contrast to the association seen between antenatal vulnerability exposure and ear infections in the first nine months of life. The possibility that this flattening of the relationship between vulnerability and doctor-diagnosed ear infections was confounded by more vulnerable children not accessing medical care (for diagnosis or treatment) will be

further explored with linkage to health service data and analysis of *Growing Up in New Zealand* information such as the pre-school Data Collection Wave and the hearing assessment from the ‘Before School Check.’

The association between greater exposure to vulnerability and the likelihood of experiencing more than one accident or injury that required medical treatment between the age of nine months and two years was also less pronounced compared to the analyses from earlier in life (Table 11). Linkage to routine hospital records will allow a further assessment of this relationship over time.

The graded association between exposure to greater cumulative vulnerability and an increased likelihood of adverse health outcomes between nine months and two years of age remained strong however for respiratory illness requiring hospital admission and for doctor-diagnosed skin infections.



Key: ■ Denotes significantly different from the reference group
□ Denotes not significantly different from the reference group
● Reference group

Note: Error bars represent 95% confidence intervals.

Figure 17: Exposure to cumulative vulnerability and health-related outcomes up to two years of age

Table 11: Health related outcomes at two years of age by category of exposure to cumulative vulnerability

	Illness outcome on or before two year					Logistic Regression		
	No		Yes		Total	Pr > ChiSq	OR	95% CI
	n	row %	n	row %	n			
a) Incomplete immunisation						0.0242		
None or 1 risk	2742	98.0	57	2.0	2799		Ref	
2-5 vs. None or 1 risk	1939	99.0	20	1.0	1959		0.496	0.297 0.829
6 or more vs. None or 1 risk	1004	98.5	15	1.5	1019		0.719	0.405 1.275
Total	5685		92		5777			
b) Any ear infection that saw a doctor						0.2178		
None or 1 risk	1556	51.3	1421	47.7	2977		Ref	
2-5 vs. None or 1 risk	1147	54.7	949	45.3	2096		0.906	0.81 1.014
6 or more vs. None or 1 risk	571	52.8	510	47.2	1081		0.978	0.851 1.124
Total	3274		2880		6154			
c) Any chest infection etc. admitted to hospital						<0.0001		
None or 1 risk	2865	96.2	114	3.8	2979		Ref	
2-5 vs. None or 1 risk	1969	94.0	126	6.0	2095		1.608	1.24 2.085
6 or more vs. None or 1 risk	932	86.2	149	13.8	1081		4.018	3.114 5.184
Total	5766		389		6155			
d) Any skin infection that saw a doctor						<0.0001		
None or 1 risk	2673	89.7	308	10.3	2981		Ref	
2-5 vs. None or 1 risk	1826	87.1	271	12.9	2097		1.288	1.083 1.532
6 or more vs. None or 1 risk	880	81.3	203	18.7	1083		2.002	1.651 2.428
Total	5379		782		6161			
e) Any accident/injury that required medical assistance						0.1497		
None or 1 risk	2142	71.9	838	28.1	2980		Ref	
2-5 vs. None or 1 risk	1528	72.9	568	27.1	2096		0.95	0.838 1.077
6 or more vs. None or 1 risk	754	69.6	329	30.4	1083		1.115	0.958 1.299
Total	4424		1735		6159			

7. Exposure to Risk Factors for Vulnerability in the First 1000 Days



Many of the parental, familial and environmental risk factors for vulnerability were measured again in the *Growing Up in New Zealand* study when the children were two years of age. Therefore this study provides longitudinal measures of exposure to vulnerability at three time points over the first thousand days of the cohort children's development, from conception to age two years.

7.1 Accumulation of exposure to vulnerability from before birth throughout infancy and to two years of age

The same 12 risk factors were considered for the cohort when they were two years of age, resulting in 36 potential risk factors that cohort children could be exposed to over time. Where measures of the familial and environmental risk factors had not been explicitly collected at the two year data collection it was assumed that presence of these risks at nine months of age was continued to two years of age. This was premised on the expectation prior to data collection that the changes in the distribution of the family level risk factors at a population level between nine months and two years was likely to be very small or negligible. The distribution of exposure to risk factors for vulnerability over the three time points is shown below (Table 12).

Table 12: Total number of vulnerability risks experienced at antenatal, nine months and two years of age

Total number of risks experienced	n	%	Cumulative n	Cumulative %
0 or 1	2390	39.3	2390	39.3
2-5	1961	32.3	4351	71.6
6-10	993	16.3	5344	87.9
11+	735	12.1	6079*	100

*Complete data across all three Data Collection Waves.

Approximately half of the *Growing Up in New Zealand* cohort children were exposed to three or less of the total 36 risk factors across their first thousand days, an average of one or less at each time point (Table 12). The distribution of cumulative vulnerability risk factors for all cohort children according to family level risk factors is shown in Figure 18.

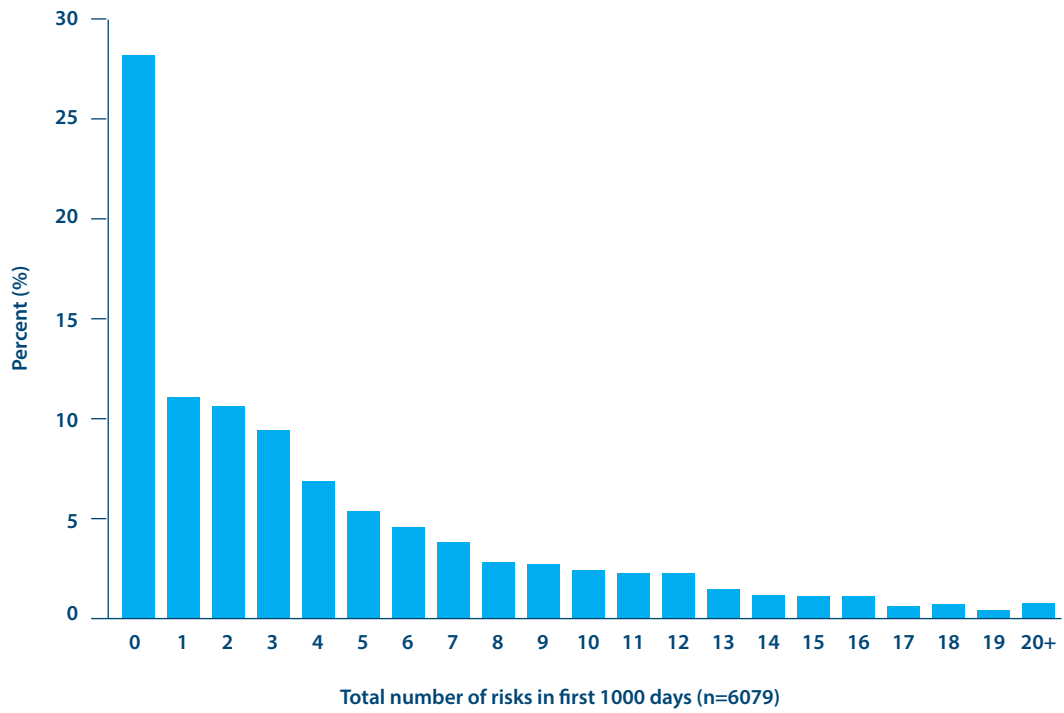


Figure 18: Distribution of cumulative exposure to vulnerability up to two years of age

The distribution of cumulative exposure to vulnerability across the first thousand days continued to differ according to maternal self-prioritised ethnicity. *Growing Up in New Zealand* children born to Māori and Pacific mothers experienced the greatest cumulative exposure to vulnerability over the first 1000 days of their development (Figure 19).

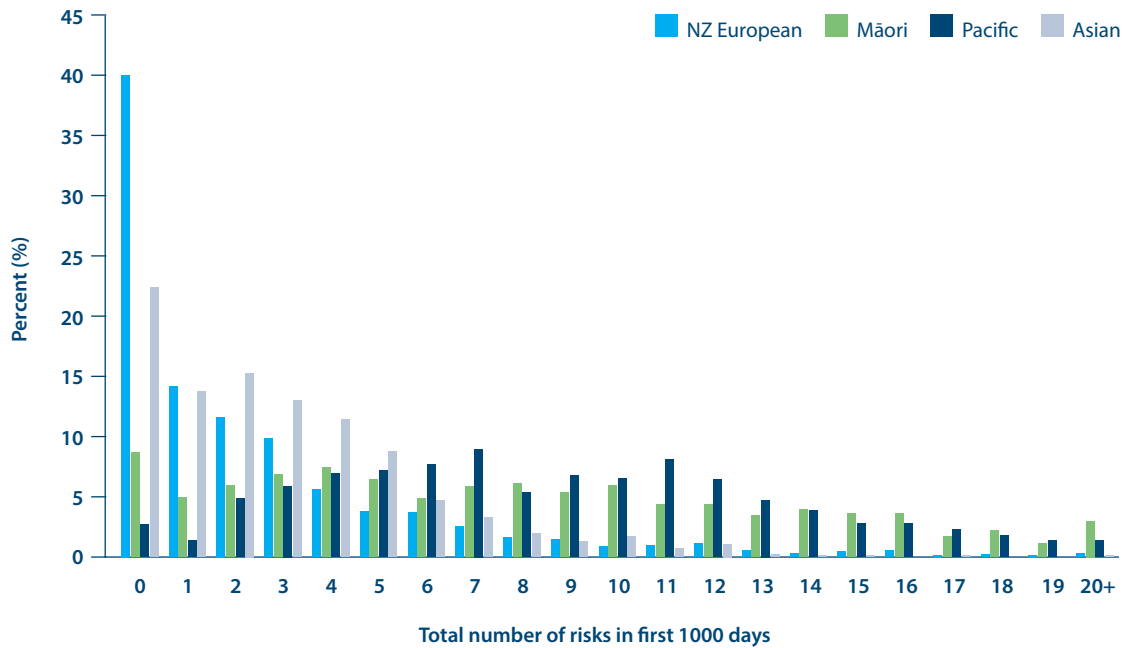


Figure 19: Distribution of cumulative exposure to vulnerability up to two years of age by maternal ethnicity

The association between cumulative vulnerability and maternal place of birth was also similar to that found earlier in life. Children born to mothers who were born in the Pacific experienced more cumulative exposure to vulnerability during their first thousand days of life compared to children born to mothers who were born in New Zealand or elsewhere (Figure 20).

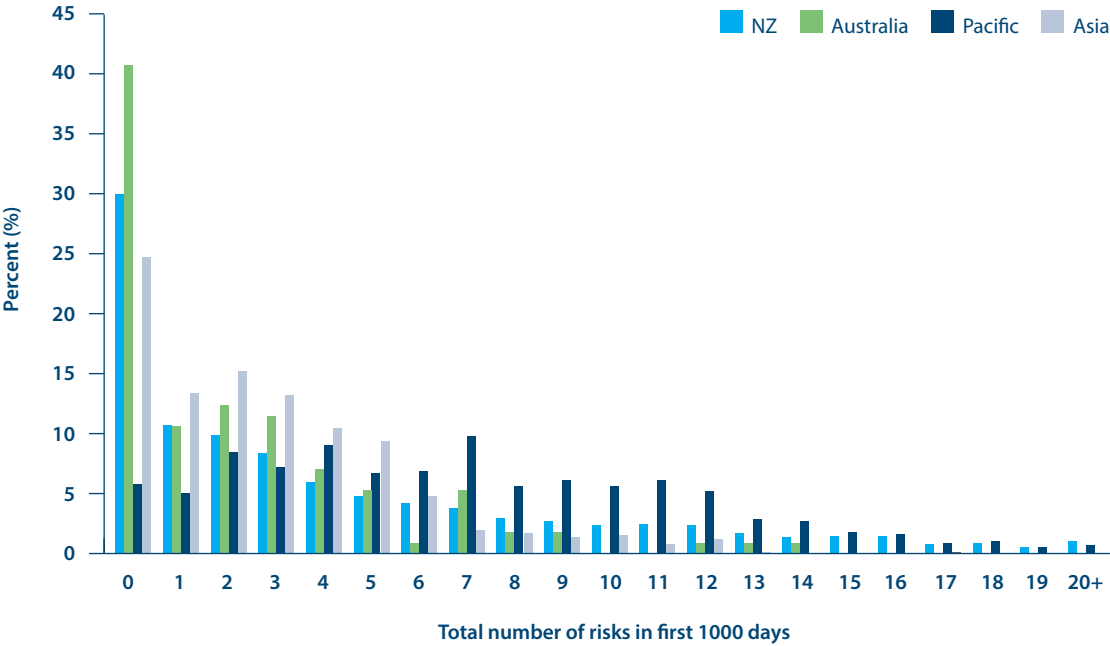


Figure 20: Distribution of cumulative exposure to vulnerability up to two years of age by mother's birth place

The pattern of exposure to cumulative vulnerability was also considered with respect to the urban or rural residence of families. Those cohort children living in families in urban areas had slightly greater chances of being exposed to more cumulative vulnerability in their first thousand days than those living in rural areas (Figure 21).

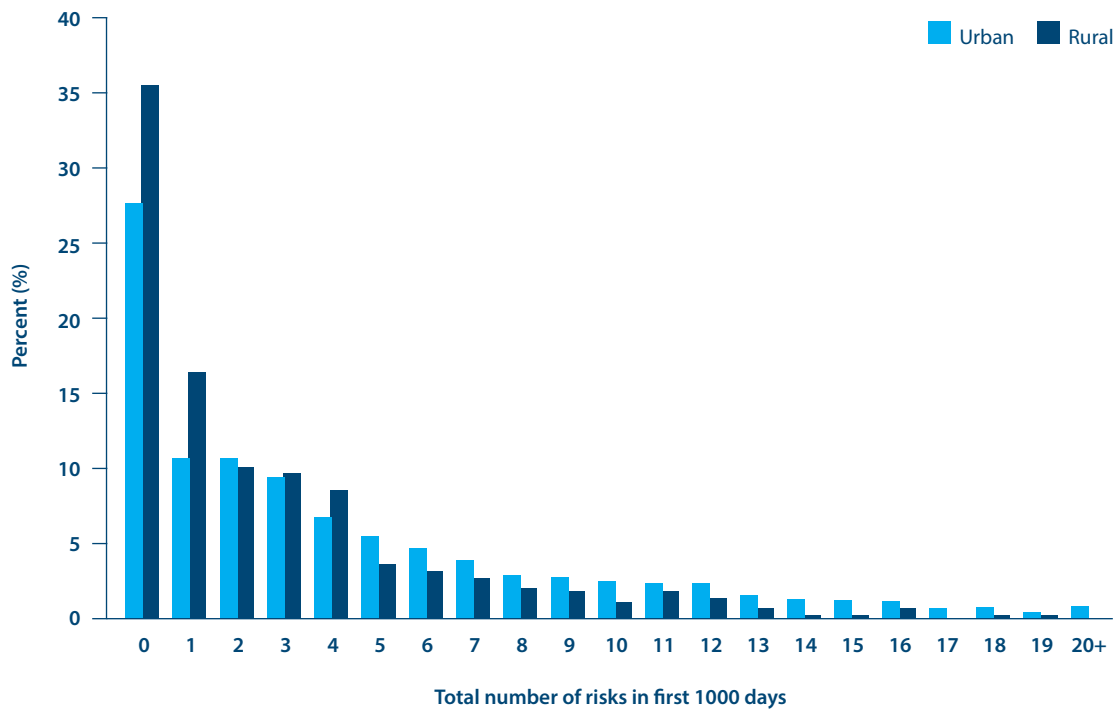


Figure 21: Distribution of cumulative exposure to vulnerability up to two years of age by geographic location (urban vs. rural)

8. Transitions in Exposure to Vulnerability Risk Factors in the First 1000 Days



The longitudinal data of *Growing Up in New Zealand* can also be used to understand which groups of children are likely to experience significant changes in their exposure to vulnerability risk factors over time and importantly what family and environmental characteristics are associated with these changes. In ‘*Exploring the definition of vulnerability*’ the proportion of children experiencing different levels of relative vulnerability between antenatal and postnatal life is explored. Further analyses on the contextual influences of these transitions and the impact of these transitions on developmental outcomes for children will be described in the next report of this ‘Vulnerability and Resilience’ series using the *Growing Up in New Zealand* cohort.

8.1 Transitions in vulnerability risk exposure between the antenatal period and nine months of age

Over half of the families of the *Growing Up in New Zealand* children (57.2%) were exposed to either one or no risk factors for vulnerability across both the late pregnancy and nine month time points. Approximately one in seven families of cohort children (14.5%) decreased their exposure to vulnerability between the two time points and less than one in ten (8.8%) experienced the same number of risks for vulnerability at both time points. Almost a fifth (19.6%) of the cohort families experienced an increase in exposure to risk factors for vulnerability between the antenatal and nine month time points (Table 13).

Table 13: Shifts in exposure to multiple risks between the antenatal and nine-month periods

Antenatal (AN)	Nine months (9M)						Total
	None	1	2	3	4	5+	
0	2017	570	137	45	9	5	2783
1	426	637	302	116	51	34	1566
2	85	230	237	125	51	44	772
3	13	56	109	151	108	59	496
4	2	26	51	82	70	87	318
5+	1	8	21	58	85	277	450
Total	2544	1527	857	577	374	506	6385

Key: ■ Zero or one risk at both AN and 9M
■ Number of risks decreased from AN to 9M
■ Same number of risks both AN, 9M
■ Number of risks increased from AN to 9M
■ Those with 5+ risks are distributed into the above three (green, yellow and orange) categories

Importantly the overall change in the proportion of children exposed to absolute numbers of vulnerability risk factors over time conceals the extent of change in exposure to specific risk factors for individual children between the antenatal period and infancy. For many of the vulnerability risk factors explored here, the longitudinal data from *Growing Up in New Zealand* describes significant movement in and out of individual risk exposure categories between Data Collection Waves. The longitudinal data can provide detailed information about

that movement, which may be especially important during this critical period of early child development.

Examples of this transition are shown for maternal depression in Figure 22. The proportion of mothers of cohort children experiencing symptoms indicating likely maternal depression had reduced from 16% during late pregnancy to 11% postnatally (measured when the children were nine months of age), however this was not equivalent to 5% of the mothers recovering in that time and 11% continuing to experience similar depressive symptoms. Rather the number of women with this vulnerability risk factor at both time periods was only 272, representing less than one third of those mothers with likely depression in pregnancy. There were 637 women who were likely to be depressed in late pregnancy who were no longer classified as depressed when their children were nine months old. There were a further 336 women who were newly classified as likely to be experiencing depression when their children were nine months old (Figure 22). The longitudinal information available from *Growing Up in New Zealand* means it is possible to measure changes in exposure to risk factors for vulnerability at the individual level as well as being able to explore what specific family and environmental factors might be associated with both new exposure to vulnerability risks and with movement of children into a state which is likely to be less vulnerable and potentially more supportive of positive child development. Further analysis of these vulnerability transitions and their impact on child development will be increasingly important with further longitudinal developmental data and will be on-going in this report series.

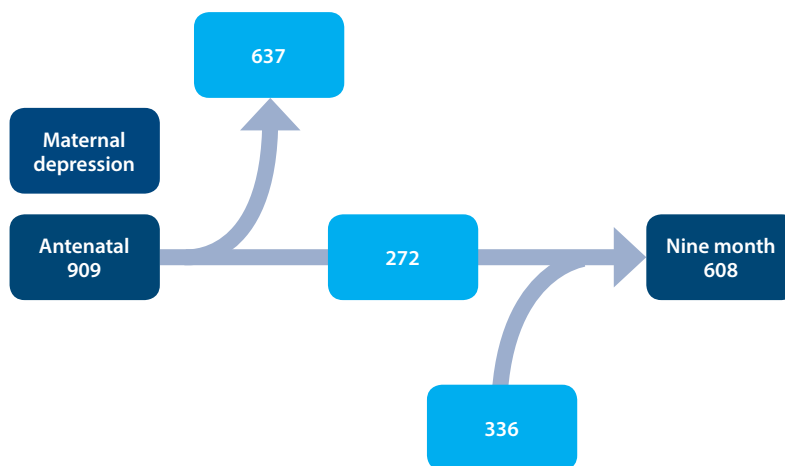


Figure 22: Change in exposure to symptoms of maternal depression between pregnancy and when their child was nine months old

Note: Exit arrows indicate those women who no longer had symptoms of depression between Data Collection Waves, and entry arrows indicate those women who developed new symptoms of depression between Data Collection Waves.

8.2 Transitions in vulnerability risk exposure between nine months and two years of age

Change in exposure to individual risk factors for vulnerability can also be explored for the children between the ages of nine months and two years. The total number of children exposed to each risk factor category at both time points is relatively stable; however this apparent stability hides considerable movement in and out of risk for many individuals. For example there were 17.3% of the households of the cohort children in receipt of an income tested benefit (including unemployment benefit, sickness benefit, domestic purposes benefit and invalids benefit) at the nine month measurement point and 15.9% at the two year point. However, only 63% of those households where cohort children were growing up were in receipt of an income tested benefit at both the nine month and two years data collection points. There were 389 households who were receiving an income tested benefit at nine months but no longer receiving this when the cohort child was two years of age, and 307 households who were not receiving an income tested benefit at nine months but now receiving it when the cohort child was two (Figure 23). This illustrates further the importance of longitudinal data collected at suitable intervals at the individual level for understanding the dynamic nature of the family and environmental contexts within which early child development occurs.

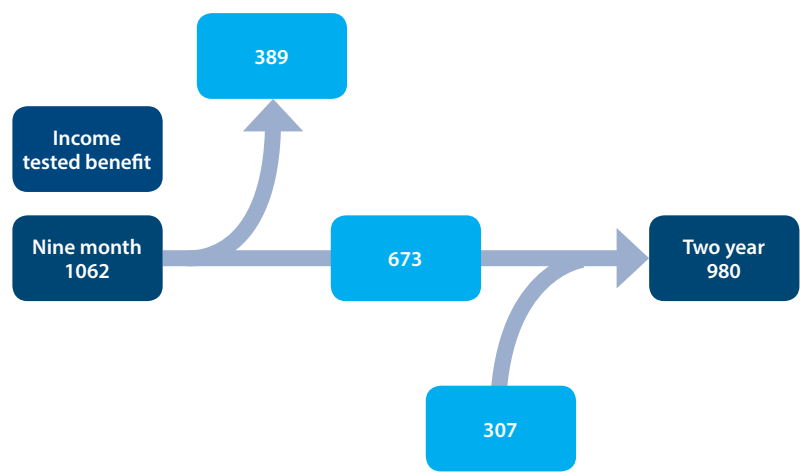


Figure 23: Change in exposure to income tested benefit receipt between nine months and two years

Note: Exit arrows indicate households who stopped receiving an income tested benefit between Data Collection Waves, and entry arrows indicate households who started receiving an income tested benefit between Data Collection Waves.

8.3 Transitions in vulnerability risk exposure across the first 1000 days

As there were three data collection points during the first thousand days of the children's development it is possible to utilise the *Growing Up in New Zealand* information to explore transitions in and out of states of vulnerability across more than two time points. This is demonstrated for sole mother households as an example of one important risk factor for early life vulnerability (Figure 24).

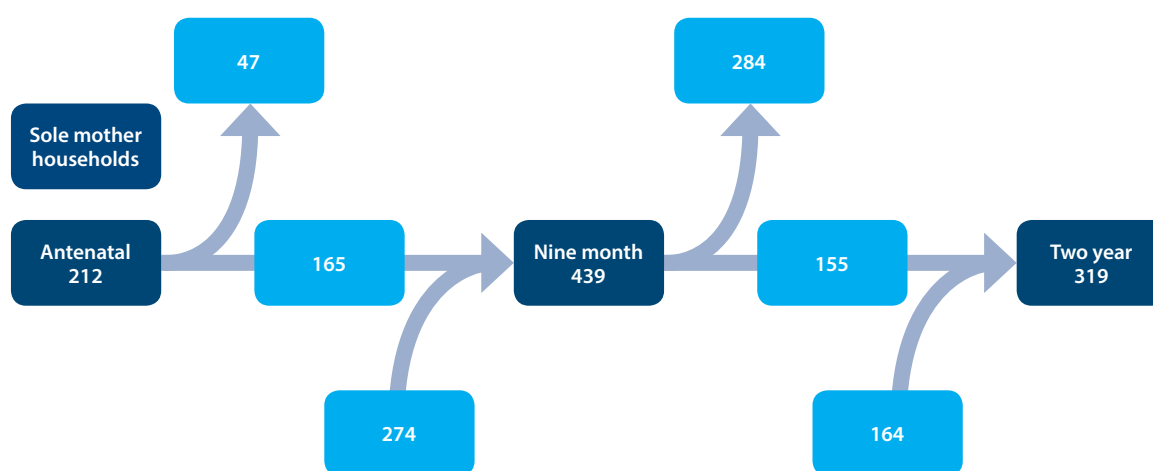


Figure 24: Change in number of sole mother households between pregnancy, nine months and two years of age

Note: Exit arrows indicate those who left sole mother household status between Data Collection Waves, and entry arrows indicate those who entered sole mother household status between Data Collection Waves.

This longitudinal exploration of sole mother household status highlights the dynamic nature of exposure to risk factors for vulnerability over this critical period of early child development. In the approximately 12 months between the antenatal and nine month data collection points a significant number of sole mother households had changed. In particular 274 mothers who were not living alone during pregnancy were now living alone (with no other adults) at nine months (a greater number than the total number of sole mother households during pregnancy). Between the children being nine months and two years of age only 155 sole mother households who were alone at nine months remained alone at two years. During this approximate 15 month period a greater number of sole mother households changed their household structure type (n=284), or became newly living alone by the time their children were two years old (n=164). These dynamic changes in household structure (with potential for impacting on child development in the first thousand days of life) cannot be fully determined from routine or cross-sectional surveys or studies.

The capacity to track movement in and out of multiple risk factor categories for individual children and families over time is a key strength of longitudinal cohort studies. Being able to consider when being exposed to vulnerability has the greatest impact and what contribution duration of exposure makes to outcomes will be possible using the information from the *Growing Up in New Zealand* families as further longitudinal data becomes available. This information will be extremely important for understanding how best to support families of children who are vulnerable during their earliest years.

9. Insights from Exploring Early Vulnerability



Identifying children who are vulnerable is a current policy focus for New Zealand. There is particular focus on enabling the appropriate targeting of interventions as early in life as possible, to reduce the impact of exposure to a disadvantaged (or vulnerable) early environment, and to limit accumulated exposure to vulnerability over time.

To date, descriptions of the proportion of children who are likely to be vulnerable in the New Zealand population have relied on estimates of the number of children likely to be at risk, such as the use of a threshold, for example 15% of all children (New Zealand Government 2011a; Statistics New Zealand 2012). Until now, there has been limited opportunity to explore the proportion of children exposed to specific risk factors that increase the likelihood of being more vulnerable to poor developmental outcomes over time, nor has there been the chance to consider how these risk factors may or may not prospectively impact on developmental outcomes for groups of New Zealand children.

In this report we have utilised population relevant longitudinal information collected over the first thousand days from the children and their families in the *Growing Up in New Zealand* cohort to explore how vulnerability might be defined for the diverse range of families with young children living in a contemporary New Zealand environment.

9.1 Vulnerability within Growing Up in New Zealand

Previous evidence has shown that single risk factors such as being a teenage mother, or income-based measures, have not been sufficient as a target for intervention strategies to reduce the burden of outcomes that result from early vulnerability (Chittleborough et al. 2011). Therefore, this report sought to determine whether a set of risk factors likely to be associated with disadvantage could be used to define vulnerability. A set of fourteen risk factors previously shown to be significantly associated with a range of poor developmental outcomes, usually in retrospective studies for European populations, were initially selected for their potential to define vulnerability in New Zealand families and children.

These fourteen familial and environmental risk factors had been measured in the *Growing Up in New Zealand* cohort at multiple time points, including during the antenatal period and during infancy. An initial evaluation of the utility of these fourteen risk factors demonstrated that twelve of these risk factors were consistently associated with disadvantage in the New Zealand context. In contrast to international studies, family mobility and maternal alcohol intake were not consistently associated with disadvantage and were subsequently excluded from the defining set of factors. High residential mobility (the subject of focus of a *Growing Up in New Zealand* report to be released later in 2014) was observed for a diverse range of families in the *Growing Up in New Zealand* cohort irrespective of socioeconomic indices. Alcohol consumption was associated with greater advantage, rather than disadvantage.

The proportions of children within *Growing Up in New Zealand* exposed to each of the 12 risk factors from before their birth varied between approximately 5% (who were born to teenage mothers) and 28% (who were born to families living in areas of greatest deprivation - NZDep2006 deciles 9 and 10). The *Growing Up in New Zealand* cohort is broadly generalisable to the current New Zealand population (Morton et al. 2014c), so similar proportions of children exposed to each of the risk factors across all current births are likely at a population level.

9.2 Implications of the clustering of risk factors for vulnerability

The twelve risk factors used to define vulnerability in the New Zealand context are not independent, rather they tend to cluster. In the *Growing Up in New Zealand* cohort they cluster in three common ways, during both the antenatal period and in infancy. The most common cluster of risk factors describes young, single mothers without formal educational qualifications, who are likely to continue smoking in pregnancy and be in receipt of an income-tested benefit. The second most common cluster defines mothers who are living in areas of high deprivation, in over-crowded, rental housing. The third common cluster describes mothers experiencing high levels of physical, emotional and or financial stress during late pregnancy or during the postnatal period. The way in which the risk factors tended to cluster was relatively consistent between the antenatal and nine month time points, as were the proportions of children who were exposed to each cluster, although the individuals experiencing each specific risk factor were highly likely to have changed.

In general, children born to mothers who identified with a Pacific ethnicity were more likely to be living in overcrowded rental accommodation in deprived areas than those children whose mothers identified with any other ethnic group. Those children whose mothers were born in the Pacific (compared to children whose mothers were born in New Zealand or elsewhere) were the most likely to experience a disadvantaged proximal home environment. Children of Māori mothers also tended to experience greater exposure to each of the three clusters of risk factor than children born to New Zealand European or Asian mothers.

This analysis suggests that it may be possible to use clusters of risk factors to identify where to provide additional support to families of children who will potentially be exposed to vulnerability from before their birth and during their early childhood. Such support would be aimed at reducing the long-term effects of early exposure to vulnerability. The use of such clusters of risk factors, instead of single, independently-considered risk factors, has considerable advantage. For example, not all children born to teenage mothers experience the same level of risk of poor developmental outcomes. The additional consideration of other risk factors that commonly cluster with young maternal age (such as maternal relationship status, education level, smoking during pregnancy and receipt of an income-tested benefit) may help to stratify the potential risks for children and better identify those mothers in need of the greatest support from before their children are born. It is important to note however that the three clusters of risk factors identified here explained less than half of the total variation in the distribution of the 12 risk factors for vulnerability across this population either at the antenatal or postnatal time points. Thus interventions targeted specifically at mothers and children exposed to identified clusters of these risk factors, although expected to be more effective than interventions targeted at single risk factors, could not be expected to reach all vulnerable mothers and children.

An alternative method used here to define relative exposure to vulnerability was to determine the total number of risk factors that children were exposed to at both the antenatal and postnatal time points separately and cumulatively. In agreement with the method that identified clusters of risk factors, different patterns of relative exposure to vulnerability were seen for children according to their mother's self-identified ethnicity. In particular, children born to Māori or Pacific mothers were more likely to be exposed to a greater number of risk factors

for vulnerability during both the antenatal period and infancy than those born to New Zealand European or Asian mothers. This differential exposure to vulnerability may help begin to explain the origins of early inequalities seen in child outcomes within New Zealand.

The impact of being exposed to vulnerability during the antenatal period was evident early in perinatal life. For example, there tended to be a higher rate of low birth weight children (less than 2500 grams), a lower rate of exclusive breastfeeding beyond the first month of life, and a lower completion of immunisations at nine months of age, for infants born to mothers who were exposed to greater vulnerability during the antenatal period. Further, exposure to multiple risks during the antenatal period was associated with a higher likelihood of a child growing up in a home environment that was damp or where there was exposure to cigarette smoke, and a higher likelihood of the child experiencing poor health (with respect to infectious disease and more serious illness requiring hospitalisation) during infancy.

Cumulative exposure to risk factors for vulnerability during both the antenatal and postnatal time periods was similarly associated with an increased likelihood of poor child health outcomes, particularly for serious illness, between the ages of nine months and two years. However, the effects of cumulative exposure to vulnerability on the number of doctor-diagnosed ear infections, as well as repeated accidents and injuries requiring medical attention, were less distinct during the second year of the children's lives than they were in the first nine months of development. This may suggest that early infancy is a more sensitive period for exposure to vulnerability, with adverse consequences more likely to occur than after the first nine months. Alternatively, it may suggest that children who are in the most at risk situations (that is most vulnerable) are also less likely to be taken to the doctor when they are either hurt or unwell. The reasons for these changing associations between exposure to vulnerability and developmental outcomes will be the subject of further detailed analyses as the longitudinal information from the *Growing Up in New Zealand* cohort accumulates. These analyses will also be greatly enhanced by the on-going linkage to routine health records to add value to the information from both sources.

Although the impact of exposure to multiple vulnerability risk factors differed between the nine month and two year time points, the data demonstrates that exposure to multiple risk factors for vulnerability at any one time point, as well as over time, increases the likelihood of poor health outcomes. Given that the specific risk factors experienced often differed between individuals that were exposed to the same total number of risk factors, strategies to target effective interventions to children who are most vulnerable might consider a 'check-list' approach, rather than an approach that uses a set of fixed risk factors to determine which families and children may require the most support. For example, additional support could be provided to children of families that experience more than three of the 12 risk factors used here to define vulnerability, regardless of which risk factors they experienced. Although it would be possible to define additional risk factors for vulnerability, the advantage of the 12 risk factors used in this report to explore the definition of vulnerability is that they are criteria that are already routinely assessed and recorded by health professionals during the antenatal period. This means that it would potentially be possible to identify and support families using such metrics from the time of the children's birth.

It is also salient to note that for each of the health-related infancy and early childhood outcomes investigated in '*Exploring the definition of vulnerability*' there are a significant number of children who are exposed to multiple risk factors who do not experience any poor health outcomes. In addition, there are a significant proportion of 'low-risk' children who are

not exposed to any of the risk factors, but who still experience poor health outcomes (and who may therefore be considered vulnerable). These groups of children are important when considering the potential impact of intervention strategies designed to target children who have experienced exposure to vulnerability early in their lives, especially with regards to expectations about how much of the childhood illness burden can be realistically reduced using such strategies.

Further exploration of the family and societal supports for these children who are resilient in the face of exposure to vulnerability, as well as those children whose needs are not considered using this definition of vulnerability, is underway using data from the *Growing Up in New Zealand* cohort.

9.3 Added value from the longitudinal information

The proportion of children in the *Growing Up in New Zealand* cohort exposed to each of the 12 risk factors for vulnerability during the antenatal and postnatal periods were similar. However, this overall similarity in cross-sectional exposure hides considerable movement of individual families and children in and out of vulnerability risk factor categories over time. This means that when risk factors are measured via routine data collections that capture exposure to risk at only one point in time they may rapidly be out of date at the individual level. An understanding of dynamic change in exposure to vulnerability is only possible when longitudinal information is collected from the same children and their families over time. The longitudinal information collected directly from the families participating in *Growing Up in New Zealand* provides the depth and detail required to investigate the consequence of changes in exposure to vulnerability for individual children.

9.4 Future directions

Understanding what family and environmental characteristics are likely to be associated either with the stability of exposure to vulnerability risk factors or the transitions in and out of vulnerability will be the focus of future reports in the 'Vulnerability and Resilience' series from *Growing Up in New Zealand*. The timing and duration of exposure to risk factors for vulnerability will be examined in relation to other important health outcomes as well as for other developmental outcomes such as those in relation to cognition, education, socialisation and behaviour. In particular, other measures of parental relationships, informal and formal sources of support, neighbourhood and community characteristics, availability and access to services, and residential mobility will be able to be explored to determine how these proximal family and distal environmental factors might either mitigate or exacerbate the effects of being exposed to vulnerability. It will be possible to explore prospectively whether exposure to multiple risk factors impacts similarly or differently on a range of child outcomes for all children as well as important subgroups (particularly by ethnicity). It is not possible to obtain this depth of information from routine or administrative child data. Such data tends to lack the required detailed information about the broader family and home environment (and cross-sectoral service delivery), require an acknowledged poor child outcome to have occurred before data is collected about a child and their family, and/or be available only from one time point in the life-course.

Further prospective analyses will also consider what relative contribution the poor developmental outcomes arising from children who are classified as vulnerable makes to the overall burden of poor child outcomes across the population. This will contribute important evidence to better determine how much resource to allocate to identified groups (assuming identification is possible) if the target is to reduce overall population rates of poor developmental outcomes.

While the focus of this report is vulnerability, further analyses will also consider resilience, and what factors contribute to resilience in the face of exposure to vulnerability. It will also consider what family or environmental factors have mitigated the effect of exposure to vulnerability over time. This will draw on the ability of *Growing Up in New Zealand* to identify what works as well as what leads to poor outcomes.

9.5 Looking ahead

The information presented here from the first thousand days of the *Growing Up in New Zealand* provides an introduction to the capacity of the longitudinal information collected to date to inform the important issue of how to appropriately define vulnerability in early life for children born in New Zealand today. Such evidence, from children who identify as Māori, Pacific and Asian as well as those who identify as New Zealand European, provides a unique opportunity to understand childhood vulnerability in the context of the contemporary New Zealand family structure and the wider social and political environment.

As further longitudinal information is collected from the *Growing Up in New Zealand* children and their families it will be possible to consider how early exposure to vulnerability is linked to developmental outcomes across multiple domains throughout the life-course. This will help address the important question of ‘vulnerable to what?’ a question that is often poorly addressed in attempts to categorise or define children as ‘vulnerable.’ These future analyses using longitudinal information collected beyond the first thousand days of life will assist with a better understanding of the optimum time for intervening to reduce the impact and costs of exposure to early life vulnerability to help fulfil the aspiration that all New Zealand children born today should be enabled to achieve, thrive and belong.

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