

Growing Up in New Zealand cohort alignment with all New Zealand births

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A country's future prosperity is closely linked to the health and social wellbeing of its population. Events and experiences during the critical early development period, including *in utero*, have lifelong influences on health and education and therefore societal wealth.¹ Identifying threats to positive health and development outcomes for children, and determining how these might be prevented, is crucial to developing policies that foster a healthier, wealthier and more equitable nation.

Longitudinal studies, which have a proven track record of providing relevant evidence for policy development,² are one tool at policy-makers' disposal. New Zealand (NZ) has benefited from such studies, with two birth cohorts established in Dunedin and Christchurch in the 1970s having provided much policy relevant information.^{3,4}

Consistent with the trend in many developed countries, the population of NZ has become more diverse in recent decades.⁵ The NZ population in 2011 was 4.4 million,⁶ of which 20% (n=893,000) were children under 15 years of age.⁷ Of this child population, an estimated 20% of children were Māori, 11% were Pacific Peoples and 8% were Asian. By 2026, it is predicted that the proportions of these three groups will increase to 22%, 14% and 14%, respectively, representing half the total child population.⁸

Migration is a key driver of the composition of the NZ population. In the 2006 Census, 23% of the population reported that they

Abstract

Objective: To compare the birth characteristics of the *Growing Up in New Zealand* cohort with those of all New Zealand (NZ) births over a similar time period, and to describe cohort alignment to current NZ births.

Method: The *Growing Up in New Zealand* longitudinal study recruited 6,846 children from before birth via their pregnant mothers who were residing in the greater Auckland and Waikato regions during 2009 and 2010. Data were collected from mothers antenatally and six weeks after their expected delivery date, and from routine perinatal health records. These data were compared to Ministry of Health data for all births in NZ between 2007 and 2010.

Results: The proportion of males and singleton births were not statistically different to national births. Compared to national births fewer of the cohort children were born low birth weight (4.9% vs. 6.1%, $p < 0.0001$) or preterm (6.4% vs. 7.4%, $p = 0.001$) and the cohort was expected to be more ethnically diverse than national births.

Conclusion: Birth parameters for the cohort were generally closely aligned to all NZ births in 2007–2010. Some statistically significant differences reflected small absolute differences, attributable in some part to cohort recruitment requiring survival to six weeks post expected delivery.

Implications: The explicit documentation of the alignment of the cohort to national data provides assurance that the study is well placed to deliver findings that can inform policy development relevant to the diversity of the contemporary NZ child population.

Key words: cohort studies, demography, longitudinal studies, New Zealand, policy

were born overseas, the highest proportion to report this since 1926.⁹ From the same census, Asian people made up 32% of NZ's overseas-born population, while only 3% of the NZ-born population.¹⁰

Recognising this changing demographic profile, a new longitudinal study of NZ children and families was commissioned by NZ government agencies in 2004. *Growing Up in New Zealand* commenced in 2008, after a significant design and evaluation phase,

with the over-arching objective of generating policy-relevant evidence to optimise children's developmental trajectories in multiple areas, including health, education and social and cognitive functioning.¹¹ Reflecting NZ's ethnic diversity, the study was explicitly designed to provide relevant evidence for Māori, Pacific and Asian children as well as the population as a whole.

Growing Up in New Zealand developed a strategy to recruit a cohort that could provide

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evidence that would be relevant for current NZ births. A non-probability-based sampling approach was taken to recruit the cohort participants. Probability-based sampling was not possible because there was no register of pregnant women, nor was there a timely register of NZ births from which to randomly sample around the time of delivery.

Both probability and non-probability sampling methods have strengths and weaknesses in terms of their scientific merit, cost, complexity and the assumptions needed to generalise to the population of interest with respect to the relationships being measured in the study.¹² Probability sampling may still lead to a biased sample due to differences in rates of consent to participate and attrition within the sample.^{13,14}

The main advantages of non-probability sampling in terms of the *Growing Up in New Zealand* study were the engagement with the participants and their likely retention, as well as considerable cost and time savings. The associated potential scientific cost was that the generalisability to the population of interest might be limited. The population of interest in this case was current NZ births and considerable efforts were made during recruitment to diminish the potential limitations in the absence of an appropriate sampling frame.¹⁷ Within the context of longitudinal research, generalisability has been defined as, “the ability to extrapolate findings to the wider population, despite imperfect representativeness”¹⁵ and has been considered “more important than representativeness”,¹⁵ especially where the objective of the study is to understand developmental trajectories. Typical approaches to sampling to maximise generalisability of findings in longitudinal studies are use of smaller population frames, such as specific regions or cities, development of structured samples of convenience and selection of an explicitly biased sample.¹⁶ All three approaches were combined into this study’s regional recruitment strategy as previously described.¹⁷

A small number of other longitudinal studies have explored the generalisability of their findings, often by comparing outcome data for their sample to the wider study area and/or nationally according to the “population of interest”.^{15,18,19} However, there is a lack of consistency in the variables used and the age of the cohort at the time of these comparisons.^{15,18} Ideally, such comparisons would be performed throughout the study

– beginning early – and comparisons should consider a range of population variables.

Birth and ethnicity data are now available for the whole of NZ up to 2010, as well as for specific DHB regions. The characteristics of the cohort have been compared to the births restricted to the recruitment region and recruitment period elsewhere (www.growingup.co.nz). In this paper, we compare the birth characteristics and expected ethnicity of the *Growing Up in New Zealand* cohort with NZ births between 2007 and 2010 to assess how the cohort aligns with contemporary NZ births (the population of interest) to document both the strengths and limitations of the cohort’s generalisability. In addition, we describe a range of maternal and household characteristics of the cohort during the antenatal period to demonstrate the diversity within *Growing Up in New Zealand*.

Methods

Study

A profile of the cohort has been published.¹¹ Briefly, multiple recruitment strategies were used to invite all eligible pregnant women living within three District Health Board regions (Auckland, Counties-Manukau and Waikato) with an expected delivery date between April 2009 and March 2010. This region was chosen because it was deemed able to provide a diverse birth cohort that would be broadly applicable to the diversity of current NZ births, without the need for over-sampling or weighting, which become increasingly problematic in longitudinal analyses designed to consider trajectories or change over time.¹⁷ A record of the most recent NZ births (2003–2007) was used as a reference population to measure the success of the recruitment strategies throughout the recruitment period to ensure an appropriately diverse cohort was being recruited.

A total of 6,822 women agreed to their children’s participation in the *Growing Up in New Zealand* study for up to 21 years and completed an antenatal interview.

Ethical approval for the study was obtained from the Ministry of Health Northern Y Regional Ethics Committee.

Data

Growing Up in New Zealand Data

These data describe the *Growing Up in New Zealand* cohort around the time of their birth, their expected ethnicity and the maternal

and household characteristics during the antenatal period. Data were collected via: face-to-face antenatal interviews with expectant mothers (data source: a); telephone interviews with the child(ren)’s primary caregiver (usually their mother) about six weeks after their expected date of delivery (data source: b); and linkage to routinely collected perinatal health records (data source: c) with 98% of mothers consenting to this data being sourced from the Ministry of Health. The source of each data item (a, b and/or c) is noted below, with some data gathered from more than one source.

Birth information from the cohort included the child’s sex (b,c); birth weight (b,c); gestational age at delivery (a,b,c); whether they were part of a singleton or a multiple birth (b,c); and their mode of delivery (b,c).

The anticipated ethnicity of each child was recorded at the antenatal interview (a). Mothers were asked to describe which ethnic group(s) they expected their child to identify with, and to express identification with as many ethnicities as they deemed relevant. Data were recorded to the most detailed level possible, and for these analyses, coded into Level 1 categories (European, Māori, Pacific Peoples, Asian, Middle Eastern/Latin American/African, Other) following the Statistics NZ coding criteria.²⁰ The number of Level 1 ethnicities reported for each child (one, two, three or more) is reported here.

Antenatal maternal and household characteristics described were: maternal age, ethnicity, education (highest completed), relationship status and place of birth (NZ, elsewhere and living in NZ for five years or more or less than five years); household composition (people residing in the household); home tenure and household mobility (number of moves in the previous five years); language usually spoken at home; urban/rural domicile and area-level deprivation (divided into quintiles). Domicile and area-level deprivation (NZDep 2006) variables were determined by geo-coding from address data according to Statistics NZ categories.^{21,22}

New Zealand National Birth Data

Information relating to all births in NZ for the years ending December 2007 to 2010 were extracted from the Ministry of Health’s Maternity Snapshot,²³ drawn from hospital discharge information in the National Minimum Dataset.

As the cohort recruitment period did not take place during a single calendar year, comparison of the exact recruitment time frame with national data was not possible.

Further, the intention of recruitment was not to recruit a representative sample of births during the 11-month recruitment period but to recruit a cohort broadly generalisable to current NZ births. Therefore, comparisons are provided for multiple years, which include the recruitment period.

The ethnicity of national live births during the same time period were extracted from Statistics NZ's Demographic Trends: 2011.⁶ These data were drawn from birth registration information, which is provided by parents

postnatally and permits multiple ethnicities to be identified.

Analysis

Chi-square tests were used to compare birth characteristics and number of ethnicities of the achieved *Growing Up in New Zealand* cohort to annual births in NZ for each year between 2007 and 2010.

Results

The *Growing Up in New Zealand* cohort consisted of 6,846 children who survived to at least six weeks after their expected delivery date (EDD). This cohort represented about

one-third of births born in the recruitment area and about 11% of all births in NZ born during the recruitment period.

Table 1 compares birth information from the *Growing Up in New Zealand* cohort, and the 6,752 mothers with complete antenatal information, to that of all births in NZ for the years 2007 to 2010. The proportions of the cohort that were a singleton versus a multiple birth and male versus female were not statistically significantly different from the national data. Mode of delivery of the cohort differed from that for all NZ births in 2009 but not in 2007, 2008 or 2010. A smaller proportion of children in the *Growing Up in New Zealand* cohort were of low birth

Table 1: Birth characteristics of the Growing Up in New Zealand cohort (2009/10) compared to all births in New Zealand in the period 2007-10.

	Growing Up in New Zealand Cohort ^a		Births in New Zealand ^b							
			2007		2008		2009		2010	
	Mothers		Unique hospital deliveries (number of mothers) ^c							
	n	%	n	%	n	%	n	%	n	%
Mode of Delivery										
Spontaneous vaginal delivery (incl. spontaneous breech)	4,463	66.7	40,116	66.3	40,629	66.8	39,455	65.7	39,462	65.5
Caesarean (Planned or emergency)	1,590	23.8	14,835	24.5	14,883	24.4	15,169	25.3	15,145	25.1
Other Assisted Birth (incl. assisted breech)	637	9.5	5,596	9.2	5,351	8.8	5,407	9.0	5,681	9.4
P-value*			0.363		0.091		0.018		0.052	
Singleton/Multiple Birth										
Singleton	6,662	98.7	59,833	98.4	60,041	98.5	59,503	98.5	–	–
Twins / Triplets	91	1.3	992	1.6	945	1.5	908	1.5	–	–
P-value*			0.079		0.199		0.317		–	–
	Children		n	%	n	%	n	%	n	%
Sex of child										
Male	3,526	51.5	31,851	51.4	31,951	51.5	31,720	51.5	31,901	51.4
Female	3,320	48.5	30,133	48.6	30,064	48.5	29,928	48.5	30,193	48.6
P-value*			0.852		0.979		0.936		0.839	
Birth Weight (grams)										
Less than 1500	48	0.7	650	1.1	652	1.1	652	1.1	655	1.1
1500-1999	67	1.0	760	1.2	785	1.2	735	1.2	751	1.2
2000-2499	221	3.2	2,321	3.8	2,313	3.7	2,308	3.8	2,312	3.8
2500-4499	6,292	92.0	56,473	91.1	56,448	91.1	55,569	91.2	55,960	91.4
4500 or more	214	3.1	1,765	2.8	1,779	2.9	1,646	2.7	1,563	2.5
P-value*			0.002		0.001		0.0004		<0.0001	
Gestational Age at Delivery (weeks)										
<37 (PreTerm)	436	6.4	4,387	7.2	4,487	7.5	4,517	7.5	4,434	7.4
37-41 (Term)	6,234	91.2	54,527	90.1	53,698	89.9	54,362	90.2	53,816	90.3
42+ (PostTerm)	166	2.4	1,647	2.7	1,542	2.6	1,408	2.3	1,365	2.3
P-value*			0.01		0.002		0.004		0.005	

* Assessing the null hypothesis that there is no difference in distributions between *Growing Up in New Zealand* and births in New Zealand for each year; chi-square test.

^a Enrolment in the *Growing Up in New Zealand* cohort required survival to 6 weeks of age.

^b Live babies born in, or admitted to, hospital; is unique to hospital deliveries, and does not include still born babies.

^c Singleton/multiple birth and mode of delivery are unique to hospital deliveries and includes still births. *Growing Up in New Zealand* mothers who had multiple births involving more than one delivery mode are categorized by the greatest level of intervention received.

weight (<2,500 grams), or were born preterm (before 37 weeks) compared to all births in 2007–2010.

The distribution of anticipated child ethnicity for the cohort and all registered NZ births in 2007–2010 is shown in Table 2. Multiple ethnicities were reported more frequently in the cohort children. Mothers anticipated that 28% and 5% of the cohort would have two and three or more ethnicities, respectively, compared to approximately 22% and 3% for the national data.

About two-thirds of the cohort children were expected to identify as European, 24% as Māori, 21% as Pacific Peoples and 16% as Asian. Compared to NZ births, the cohort had larger proportions expected to identify as Pacific Peoples or Asian, and slightly smaller proportions as European or Māori.

A descriptive summary of a range of maternal and household characteristics of the cohort in the third trimester of pregnancy is presented in Table 3 for the 6,752 mothers of the cohort children who had complete antenatal information. Where comparative statistics are available from routine sources these are provided in bracketed text below, however, not as much detail about family characteristics is available from routine birth data. The median maternal age of cohort mothers was 31 years (as for current NZ births). When reporting all of their ethnicities (multiple ethnicity), 62% of mothers identified

as European (66% for current NZ births); 19% as Māori (22% for current NZ births); 17% as Pacific Peoples (12% for current NZ births); and 16% as Asian (11% for current NZ births). Sixty-nine per cent had completed education beyond secondary school. Sixty-three per cent were in a committed relationship as defined by being married, in a civil union or co-habiting. Two-thirds lived with their partner with no other adults in the house.

Sixty-four per cent of the mothers were born in NZ. Of the 2,404 women born elsewhere, 836 (35%) had lived in NZ for less than five years. About half the mothers (53%) lived in a house owned by their family, and a quarter (26%) had moved house more than three times in the preceding five years. The majority (93%) of expectant mothers lived in urban areas. Twenty-eight per cent of respondents lived in households that were in the most deprived quintile of areas (the same percentage as for all current births).

English was the language usually spoken in most households (80%). Each of the other languages were usually spoken in less than 5% of households, including Samoan (3%); Hindi (3%); Tongan (3%) and Mandarin (2%). Māori was the usual language spoken in 20 households (<1%), while 5% of women stated they could have a conversation in Māori.

Discussion

The overall objective in establishing this longitudinal study was to recruit a cohort that would be able to provide population-relevant information to inform policy development in the context of the growing diversity of the NZ birth population, especially with respect to ethnicity and family socioeconomic status. A sample that includes a wide range of individual differences on the variables of interest enables generalisability to the wider population.¹⁶ Our comparison with contemporary national data indicates that this is what has been achieved. Only small differences were evident in comparisons of the cohort with contemporary national birth data from 2007 to 2010 and these are unlikely to limit the external validity of findings to the wider NZ population. The large size of the cohort means that small variations in percentages (<1%) between the cohort and national births reached statistical significance.²⁴ Despite this statistical difference, the variation is unlikely to be of public health or clinical relevance.

The requirement of survival to six weeks of age to become part of the cohort provides some explanation for the smaller proportion of the cohort that were either born with low birth weight or pre-term compared with national births from 2007 to 2010. Thirty-one women who completed an antenatal interview in *Growing Up in New Zealand*

Table 2: Expected child ethnicity of the Growing Up in New Zealand cohort (2009/10) compared to that of all births in New Zealand in the period 2007–10.

	Growing Up in New Zealand Cohort		Births in New Zealand ⁶							
	(6,195 ^a)		2007 (63,983)		2008 (64,285)		2009 (62,499)		2010 (63,868)	
	n	%	n	%	n	%	n	%	n	%
Number of ethnicities^b										
One	4,135	66.8	48,194	75.3	48,292	75.1	46,742	74.8	47,389	74.2
Two	1,737	28.0	13,668	21.4	13,880	21.6	13,586	21.7	14,151	22.2
Three or more	323	5.2	2,121	3.3	2,113	3.3	2,171	3.5	2,328	3.6
p-value*			<0.0001		<0.0001		<0.0001		<0.0001	
Child Multiple Ethnicity^{b,c}										
European	4,174	67.4	44,680	69.8	44,543	69.3	43,292	69.3	43,965	68.8
Māori	1,489	24.0	18,717	29.3	18,844	29.3	18,027	28.8	18,458	28.9
Pacific Peoples	1,312	21.2	9,788	15.3	10,122	15.7	10,068	16.1	10,407	16.3
Asian	994	16.1	7,076	11.1	7,263	11.3	7,492	12.0	8,208	12.9
MELAA ^d	183	3.0	1,044	1.6	1,166	1.8	1,179	1.9	1,245	1.9
Other (including New Zealander)	450	7.3	690	1.1	562	0.9	491	0.8	502	0.8

* Assessing the null hypothesis that there is no difference in distributions between Growing Up in New Zealand and births in New Zealand for each year; chi-square test.

a Anticipated ethnicity not reported antenatally for 651 children; ethnicity information will continue to be collected throughout the study.

b According to Statistics New Zealand "Level 1" categories.

c Mothers could provide as many responses as deemed relevant so the total is more than the number of children. Percentage is calculated for all respondents.

d Middle Eastern, Latin American or African.

experienced a perinatal death.²⁵ Of all NZ births in 2009, the rate of stillbirths and neonatal deaths was greatest for babies born with low birth weight or premature gestation.²⁶

In comparison with national birth registration data, a larger proportion of the *Growing Up in New Zealand* cohort was expected by their mother to have more than one ethnicity. The diversity of expected ethnicity within the cohort was greater than that described by birth registration data. The mode and timing of data collection is likely to have contributed to these differences.²⁷ *Growing Up in New Zealand* data were collected during a face-to-face interview with the mothers in late pregnancy, while the NZ data came from a self-complete form completed by a parent at the time of birth registration, which could be several weeks after delivery. In addition, the areas in which the *Growing Up in New Zealand* cohort were recruited were explicitly chosen to maximise recruitment of an ethnically diverse cohort. This meant exact alignment with all NZ births was never likely. The recruitment of a large, ethnically diverse cohort does enable the consideration of the determinants of developmental trajectories for children within each of Māori, Pacific Peoples, and Asian ethnicities, as well as the exploration of multiple ethnicities in the current NZ population.

As ethnic diversity in NZ is expected to continue to increase, having a more ethnically diverse sample at recruitment provides some protection to the cohort's ability to continue to inform national policy in a population-relevant manner. As it becomes possible to collect self-identified ethnicity from the cohort children themselves, the development of ethnic identity and mobility of self-identified ethnicity can be examined,²⁸ and ethnic distribution reassessed. Retention of this diverse sample will continue to be a priority as the study progresses. So far, strategies to maximise retention across the diversity of participants have been successful.¹⁷

The comparison of birth data reported here is just one example of how the cohort can be compared to routine national statistics. To date, data collection has been completed when the cohort children were aged nine months, 16 months, two years and 31 months. The study has continued to collect a broad range of information that will provide opportunities for further comparisons to national data for specific

Table 3: Maternal and household characteristics of the *Growing Up in New Zealand* cohort^a in the last trimester of pregnancy (2009/10).

Characteristic	n	%
Maternal age (years) (6,749)		
<20	323	4.8
20-29	2,629	38.9
30-34	2,099	31.1
35+	1,698	25.2
Maternal multiple ethnicity (6,746)		
European	4,183	62.0
Māori	1,244	18.5
Pacific	1,141	16.9
Asian	1,080	16.0
Middle Eastern/Latin American/African	166	2.5
Other (including New Zealander)	140	2.1
Maternal education (highest completed) (6,733)		
Higher degree(s)	1,058	15.7
Bachelor degree	1,526	22.6
Diploma/NCEA 5 or 6	2,065	30.7
Secondary school	1,607	23.9
<Secondary school	477	7.1
Maternal relationship status (6,097)		
Married/civil union	3,812	62.5
Co-habiting	1,705	28.0
Dating but not co-habiting	253	4.1
No relationship	327	5.4
Maternal place of birth (6,745)		
Born in New Zealand	4,335	64.3
Born elsewhere ^b	2,410	35.7
In New Zealand ≥5 years	1,568	65.2
In New Zealand <5 years	836	34.8
Household composition (6,745)		
Mother living alone	233	3.5
Two parents living alone	4,430	65.7
Parent(s) living with extended family	1,723	25.5
Parent(s) living with non-kin	359	5.3
Tenure of household (6,061)		
Individual / family ownership	3,183	52.5
Private rental	2,403	39.7
Public rental	475	7.8
Household mobility (number of moves in the previous five years) (6,730)		
0	1,035	15.4
1	1,469	21.8
2	1,300	19.3
3	1,151	17.1
>3	1,775	26.4
Language usually spoken at home (6,752)		
English	5,417	80.2
Samoan	197	2.9
Hindi	193	2.9
Tongan	185	2.7
Northern Chinese	154	2.3
Other	606	9.0
Urban / rural domicile (6,752)		
Urban	6,289	93.1
Rural	463	6.9
New Zealand deprivation index level (6,750)		
NZDepQ1 (least deprived)	1,092	16.2
NZDepQ2	1,229	18.2
NZDepQ3	1,159	17.2
NZDepQ4	1,414	20.9
NZDepQ5 (most deprived)	1,856	27.5

a 6,752 women completed an antenatal interview and confirmed the birth of a child and subsequent survival to six weeks of age. Therefore the maximum denominator for each response is 6752. Any difference represents missing data or refusal to answer the question.

b 6 women born elsewhere did not describe length of time in New Zealand

health and development outcomes, such as that collected from the Ministry of Health's national B4 School Check.²⁹

The ethnic and socio-demographic diversity of the *Growing Up in New Zealand* cohort means it is well placed to be able to describe developmental pathways for important population subgroups and to identify resilience and risk factors specific to them. It enables the study to have a strong focus on health equity and the social determinants of child health.³⁰ Ideally, this will enable a better understanding of the structures and processes that differentially affect children's chances to be healthy in NZ, and identification of strategies that can address the large inequities in health and social opportunity that currently exist in NZ.^{31,32}

The alignment of the birth characteristics of the cohort to all NZ births over the 2007–2010 period presented here indicate that the study is well-placed to deliver on its stated objective. The large size of the cohort, as well as its ethnic and socio-demographic diversity, will help to improve policy decision making by providing data collected from families comparable to those to whom the policy will be directly applicable.

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