Child injury in the preschool years

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Abbreviations

6w	6 week
9m	9 month
15m	15 month
2Y	2 year
4.5Y	4½ year
ACC	Accident Compensation Corporation
AN	Antenatal
AIPN	Australian Injury Prevention Network
B	Binary variable
C	Categorical variable (>2 levels)
CBQ-VSF	Child Behaviour Questionnaire Very Short Form
CI	Confidence interval
DCW	Data collection wave
ECE	Early Childhood Education
GP	General practitioner
GUiNZ	Growing Up in New Zealand
IPNANZ	Injury Prevention Network of Aotearoa NZ
k	1000
MELAA	Middle Eastern, Latin American, African
Med	Medium
NCEA	National Certification of Educational Achievement
NZ	New Zealand
NZD	New Zealand dollar
NZDep	New Zealand Deprivation Index
NS	Not statistically significant ($p<0.05$)
OR	Odds ratio
p	Level of statistical significance
S	Scale/continuous variable
SD	Standard deviation
SDQ	Strengths and Difficulties Questionnaire
US	United States
WCTOC	Well Child/Tamariki Ora checks
W/GA	Weight for gestational age
X^2	Chi-square

Executive summary

Injuries are a leading cause of child hospitalisation and death in Aotearoa New Zealand (NZ). This study focussed on preschool aged children and parent-reported injuries for which the child was taken to a doctor, dentist, health centre, or hospital for care. A life-course, epidemiological approach was used to build a comprehensive picture of the environments that surround preschool injury using data from the *Growing Up in New Zealand* (*GUiNZ)* study. The analytical approach was guided by previous *GUiNZ* analyses of early childhood vulnerability and safety.

Injury among preschool age children in the *GUiNZ* cohort

Mothers of the *GUiNZ* children were asked to report any injury requiring medical attention (including swallowing anything poisonous). Due to the manner in which the injury-related questions were asked in the *GUiNZ* questionnaires, it was not possible to distinguish between unintentional and intentional injuries. From birth to 4½ years of age, 48% of 6,114 *GUiNZ* children experienced at least one injury requiring medical attention. Among these children, 28% had one injury, 11% had two injuries, 5% had three injuries and 4% had four or more injuries. Five percent of children were admitted to hospital at least once due to injury. An injury index based on number of injuries and hospitalisation (a proxy for injury severity) was compiled for the study (Table 1).

Being in the *high injury risk* group (compared with being in a combined *no injury* or *low injury risk* group) was the key outcome for multivariable analyses that determined the strength of association between independent variables and injury outcome using odds ratios (OR). Sub-group analyses explored these relationships according to level of area deprivation, child sex, and maternal ethnicity.

Table 1: Injury index definitions used in the study

Index level	Definition	
No injury	No injuries	52%
Low injury risk group	1-3 injuries with no hospitalisation	39%
High injury risk group	1-3 injuries with a hospitalisation or ≥4 injuries	8%

Key findings

We found no associations between injury and the presence of home safety features (including working smoke alarms, driveway, pool and boundary fencing, safe power outlets, safe hot water temperature, securely stored potential poisons).

Five factors were significantly associated with injury outcome (see Table for OR and 95% Confidence Intervals), after adjusting for covariates*.

- Children in *high nurturing* environments were *less* likely to be in the high injury risk group than those in lower nurturing environments (significant across all maternal ethnicities except Asian).

These factors were associated with an *increased* likelihood of a child being in the high injury risk group:

- Living in a *high-need environment* (also significant for those in areas of high deprivation, children with Māori, Pacific and European mothers).
- High rate of *household risk factors.*
- High rate of *family risk factors* (also significant for children with Pacific or European mothers, and girls).
- Living in *high stress households* (also significant for those in areas of low/medium deprivation, and children with Pacific mothers).

Table 2: Factors (OR & CI) & variables associated with injury outcome

Factor	Variables
Reduced likelihood of being in the high injury risk group	
High nurturing environment OR*=0.5 (0.4 to 0.7)	Maternal warmth; Maternal discipline; Parenting programme use; Well Child/Tamariki Ora Checks (WCTOC); Primary care access
Increased likelihood of being in the high injury risk group	
High-need environment OR*=1.8 (1.4 to 2.3)	Single parent household; Income-tested benefit receipt; Social services contact; Parental conflict; Residential mobility; Smoking in pregnancy; Maternal employment/care arrangement; Maternal health
Household risk factors OR*=1.8 (1.4 to 2.4)	Household tenure; Material deprivation; Household income; Damp/mould/condensation; Use of public transport; Overcrowding
Family risk factors OR*=1.5 (1.4 to 2.4)	Siblings; Being a subsequent child; External support; Neighbourhood safety
High stress households OR*=1.4 (1.2 to 1.8)	Family stress; Postnatal anxiety; Antenatal stress

*adjusted for maternal ethnicity, child sex, behavioural difficulties, participation in activities, and temperament.

Three child characteristics were included as covariates in the study. Having a high level of behavioural difficulties, high levels of participation in activities and having a highly 'surgent' temperament (characterised by being highly active, intense pleasure seeking and impulsivity) were all associated with increased likelihood of being in the high injury risk group.

These analyses are an important first step in understanding patterns of childhood injury among a contemporary, diverse NZ cohort, and the environments associated with a child experiencing multiple and more severe injuries. Crucially, this work has allowed us to establish an evidence-base that future studies can build on to understand predictors of, and preventative measures for, childhood injuries, as well as later outcomes for children who experience them.

Data on circumstances immediately prior to injury events were not available. As such, we were unable to identify specific direct/proximal factors related to injury. Therefore, we focussed on the indirect or distal factors that may have played a role in increasing or decreasing the risk of child injury up to 4½ years of age.

While most injuries occurred in the home, the presence or absence of safety features in the home was not significantly associated with injury in this study. However, we were unable to explore their association with specific injury mechanisms due to limitations of the injury data.

Policy implications

The findings of this research reinforce the multifactorial nature of injury risk, and highlight the need for a multisector approach to preschool child injury prevention. A combination of child, demographic, socioeconomic, health and social factors appear to increase the likelihood of high injury risk. Policies should address factors that might prevent or reduce injury risk *and* improve the identification of children at higher risk of injury in order to better target interventions.

Preventing or reducing injury risk

Child-focussed health policy and practice could increase the uptake of Well Child/Tamariki Ora checks (WCTOC), and improve access to primary care, further ensuring that children are growing up in nurturing environments to prevent injury. Factors that place preschool children at increased risk of injury identified in this study include socio-economic disadvantage and household environments. This indicates that in addition to direct safety interventions, policies to reduce poverty and inequalities in socioeconomic status could impact injury risk.

Policy initiatives aimed at an overall improvement in child wellbeing provide opportunity to increase external support to families of pre-school children through family doctors, Plunket, care arrangements and Early Childhood Education (ECE) providers, parenting programmes, and information available through media and the Internet. Increased multi-agency support for pregnant women and mothers of preschool children could impact injury risk. Rates of injury could be reduced though family and parenting policy and practice focussed on reducing conflict, providing safe activity environments, coping with and managing difficult child behaviour, and ways of responding to children who have high levels of activity, high-intensity pleasure seeking and impulsivity.

Identifying children at higher risk of injury/targeted intervention

The sub-group analyses for the study suggest that different children or groups of children may require different approaches to intervention. For example, children of Pacific mothers are more at risk from injury when they live in a high stress household. Living in a high-need environment impacts children in areas of high deprivation. Children whose families received income-tested benefit, who had a history of social services contact, whose mothers attended parenting programmes, who accessed primary care that was not local to their homes, and those who regularly used public transport were more likely to be in the high injury risk group. These services could provide opportunities to identify children at risk of experiencing injury and deliver targeted evidence-informed interventions.

Though associated with injury risk, child activities are important elements of health and wellbeing, child growth and development. Since most injuries occur in the home, information provided to families could include advice on how to reduce injuries among highly active children. Continued efforts are required to improve and maintain safety standards in homes, ECE and care arrangements.

Policy initiatives

In our analyses, the presence or absence of safety features in the home was not significantly associated with injury outcome overall. However, we were unable to explore their association with specific injury mechanisms due to limitations of the injury mechanism data. This study shows that effective injury prevention needs to address a combination of factors, aimed at improving the wellbeing of all families and implemented antenatally and across the lifespan. As such, injury prevention policy requires multisectoral working to address a broader range of factors beyond current initiatives that have tended to focus on directly improving the safety of physical environments through information or advice to parents, regulation and improved infrastructure.

It appears that the factors identified by the study underlie previous findings of higher childhood injury risk among Māori and Pacific whānau. The following initiatives are recommended in order to lower the risk of injury among preschool children and reduce inequity in risk/protective factors:

- Multi-agency collaboration to provide nurturing environments for children at a societal level by improving access to primary care and well-child services.
- Improved identification of, and support for, families with a high level of need; those in contact with social services, mothers with poor health, children with mothers not in paid employment who use care arrangements, and children whose mothers return to paid employment but have no care arrangements.
- Improved living conditions for NZ families with a focus on housing and socioeconomic inequity.
- Increased and targeted multi-agency support for families that addresses their full range of health, social and economic and material needs
- Support to reduce psychosocial stressors among families and mothers. Including psychoeducational support for families who have children with behaviour problems, high levels of participation in activities and difficulties with impulsivity or self-control.
- Continued interagency monitoring of child injury patterns to identify emerging trends and evaluate the effectiveness of injury prevention efforts. This data must be made available at a national and regional level.

Understanding mediating factors between policy and child wellbeing outcomes (including injury), will allow agencies to work collaboratively through coordinated and sustained investment by public, government and private sectors to create a world where children can play, learn, grow up and live free from serious injury.

Introduction

Background

This study used data from the longitudinal *Growing Up in New Zealand* (*GUiNZ*) cohort (Morton et al., 2014; 2015a) to address three key issues or opportunities, as described below. The study focussed on improving our understanding of injury among preschool children (under five years of age) in New Zealand (NZ). Parents of the *GUiNZ* children were asked to report any injury their child sustained that required medical attention (including swallowing anything poisonous). Due to the manner in which the injury-related questions were asked in the *GUiNZ* questionnaires, it was not possible to distinguish between unintentional and intentional injuries.

The burden of preschool childhood injuries in NZ

Injuries are a leading cause of child hospitalisation and death in NZ (Bland et al., 2011; Injury Prevention Research Unit; Shepherd et al., 2013). On average, 2,600 children under the age of 5 years are admitted to hospital with an injury annually, and close to 50 die. In addition, injury among young children exacts a substantial cost on society. The Accident Compensation Corporation of NZ (ACC) accepts around 19,000 new claims annually for unintentional injury among this age group, with falls the leading mechanism of injury accounting for approximately 50% of claims (ACC, 2017). The annual ACC claim expenditure for unintentional child injuries is around $175M, and the total economic and social cost per child injury fatality $8.05M (2008 data - most recent available; O'Dea & Wren, 2012).

According to hospital discharge data, the NZ prevalence of injuries is highest in preschool children (NZ Injury Query System, 2020). At this younger age, injury patterns differ from those in older children and more frequently include burns (Sanyaolu, Javed, Eales, & Hemington-Gorse, 2017), poisonings (Schwebel et al., 2016), and ingestions (Davis, Casavant, Spiller, Chounthirath, & Smith, 2016; Ventura et al., 2017). The distribution of child injury varies by socioeconomic status (Growing Up in New Zealand, 2014) and ethnicity (Robson & Harris, 2007). Children living in areas of greater social disadvantage are over-represented in injury-related admissions to hospital (Simpson et al., 2017).

It has previously been reported that the burden of fatal and non-fatal injury is disproportionately higher among Māori children compared with their non-Māori counterparts (Safekids Aotearoa, 2015). For example, Māori children have higher rates of hospitalisations for pedestrian and vehicle occupant injuries than non-Māori, non-Pacific children (Simpson et al., 2017). These differences may be associated with broader socioeconomic determinants. Therefore, understanding influences on this disparity and what underlying environments produce such inequities is critical to improving the health and well-being of Māori Tamariki, including the prevention of injuries.

A broader, child-centred perspective on child injury prevention

Traditional approaches to understanding and preventing child injury in NZ have focused on short-term and proximal influences, such as playground surfacing (Chalmers et al., 1996), child/behavioural characteristics (McKinlay et al., 2010), and parental discipline (Langley, McGee, Silva, & Williams, 1983). While these factors are individually important predictors of injury, significant population-level improvements are difficult with approaches that only remedy single risk factors (Bland et al., 2011). Contemporary international research has explored a broader range of proximal *and* distal child injury-related factors including: neighbourhood influences (Kendrick, Mulvaney, Burton, & Watson, 2005; Reading, Jones, Haynes, Daras, & Emond, 2008); family and individual characteristics (Ekéus, Christensson, & Hjern, 2004; Kendrick, Mulvaney, et al., 2005; Kendrick, Watson, Mulvaney, & Burton, 2005; Reading et al., 2008); and safety practices (Kendrick, Mulvaney, et al., 2005; Kendrick, Watson, et al., 2005).

This study builds on previous NZ research on injuries in childhood during the 1970s as explored in the Dunedin (Caspi et al., 1995; Chalmers & Langley, 1990; Langley, Silva, & Williams, 1983; Langley, Silva, & Williams, 1987) and Christchurch cohorts (Beautrais, Fergusson, & Shannon, 1981, 1982; Fergusson & Horwood, 1984; Fergusson, Horwood, & Shannon, 1983), and other relevant studies (Keall et al., 2015; Roberts, Norton, & Jackson, 1995).

This study considered a breadth of influences that impact upon children and their environments. In addition, similar safety feature data to that explored by Kendrick et al. (2005) were analysed. The relationship between absence or presence of these features in a NZ cohort and preschool injury enabled comparisons with UK data from Kendrick et al., which found children from households lacking certain safety behaviours (e.g. storing sharp objects safely, fitted stair gates, working smoke alarms, etc.) were at increased risk of injury. Data from Safekids NZ, indicates that over 60% of injuries in preschool children happen in the home (Safekids Aotearoa, 2015), consistent with the 69% found in the *GUiNZ* cohort (2014). Suggesting that the identification of factors which place children at increased risk of injury in these settings has the potential to reduce a substantial burden of childhood injury.

A life-course approach to injury prevention

This study used an epidemiological approach to build a comprehensive picture of the multiple factors that surround preschool injury. We hypothesised that situations in combination and the cumulative effect of separate events acting over time determine a child's risk of being injured during the preschool years. This study was designed to identify multiple potential interventions in line with life-course models of causation (Hosking, Ameratunga, Morton, & Blank, 2011). These models conceptualise spheres of influence that lead to adverse health outcomes; direct or proximal factors, indirect or distal factors that act via a number of intermediary causes, and societal or macro environments.

Due to the absence of data relating to the circumstances immediately prior to each injury event we were unable to determine which specific direct or proximal factors were related to injury, therefore this study focussed on the indirect or distal factors that may have played a role in increasing or decreasing the risk of children injury up to 4½ years of age.

Aims and objectives

The aim of this research was to understand how social and physical factors in combination, and over time, affect a preschool child's risk of experiencing injury.

The specific research objectives were:

1. To investigate how combinations of situations and multiple events act across the life-course to either protect a child or, alternatively place them at risk of isolated/repeated injuries requiring medical attention.
2. To determine how these life-course determinants of childhood injury vary between population subgroups in particular for Māori and Pacific children.

Multivariable analyses were used to explore life-course determinants of preschool child injury. The analytical approach was guided by previous *GUiNZ* analyses of early childhood vulnerability and safety (Morton et al., 2015b; Growing Up in New Zealand, 2014). The intention was to take important first steps in understanding patterns of childhood injuries among a contemporary, diverse NZ cohort, and the environments associated with an increased likelihood of a child experiencing multiple and more severe injuries. Crucially, this work was designed to establish an evidence-base that future studies can build on to understand predictors of childhood injuries, as well as outcomes for children who experience them. The findings allowed us to develop a range of evidence-based policy recommendations to reduce the incidence of preschool injury in NZ, in alignment with ACC, Safekids, Māori health providers, and key staff within the Ministry of Health.

Method

This study analysed data from the longitudinal *GUiNZ* cohort study. Access to external *GUiNZ* datasets described below was approved by the Data Access Committee in April 2019 (Reference: DA 18_1011). Data from the antenatal (AN), 6 week (6w), 9 month (9m), 2 year (2Y) and 4½ year (4.5Y) data collection waves (DCW) were included in this study as follows:

- Mother questionnaire (AN, 9m, 2Y & 4.5Y)
- Linkage to health data (6w)
- Child proxy (mother-completed) questionnaire (9m, 2Y & 4.5Y)
- Child observation (interviewer-completed) questionnaire (4.5Y)

Information about the methods of participant recruitment and data collection are detailed online[1] and in Morton et al (2014; 2015a).

Measures

Measures used by the *GUiNZ* study were selected for this analysis on the basis of existing evidence on associations with injury, current policy and practice, and advice from the Study Reference Group (see *Acknowledgements*

, page 2). Exploratory analysis of categorical variables with more than two levels (e.g. maternal education) was carried out to collapse/reclassify responses according to the pattern of the relationship between levels and injury outcomes. Scale variables were included initially as continuous data. See Additional data

To provide context to some of the findings, responses to questionnaire items that aimed to ascertain some of the reasons for participants' circumstances are reported in the Results (see Table 13,Table 14 andTable 15). For example, why a child was unable to see a doctor when they needed to. Further information on these items is provided in Appendix I (page 56).

Data analysis, page 16.

Injury measures

Injury* items from the 2Y and 4.5Y child proxy questionnaires included in this study are reported in Table 2. Mothers were asked to report any injury requiring medical attention (including swallowing anything poisonous) and describe the most serious injury including whether hospital admission was required.

Table 2: Injury items included in this study

DCW	Questionnaire item
2Y - all children	Has child ever had an 'accident' or injury for which he/she was taken to the doctor, health centre, or hospital?
4.5Y - all children	Since child was two, have they had an 'accident' or injury for which he/she was taken to the doctor, health centre, or hospital?

[1] www.growingup.co.nz/en/access-to-guinz-data/data-collection-waves-questionnaires-technical-documents.html

2Y & 4.5Y if *Yes* to 1st injury item	How many 'accidents' or injuries? Thinking about the most severe (or only) 'accident' or injury: Was child admitted to hospital as a result of this accident/injury? What sort of accident or injury was it? [See Table 7] Where did this accident or injury happen? [See Table 8] How old was child when this accident happened?

*The questionnaires referred to 'accidents' or injuries, however for the purpose of this report and in keeping with current injury prevention practice, the term 'injury' will be used throughout.

The 2Y and 4.5Y data were combined to provide overall injury data (any injury or no injury; number of injuries; and injury resulting in hospitalisation) from birth to 4.5Y (see *Injury outcomes*, page 20 for further information).

Socio-demographic measures

Child sex (male/female) was obtained from linked perinatal/6w health data. Data on ethnic identity were collected using the mother (AN) and child proxy (4.5Y) questionnaires. Participants were asked to name all the ethnic groups that they (or their child) belong to (all ethnicities). If more than one ethnicity was reported, which they considered to be their (or their child's) main ethnic group that they identify with most (prioritised ethnicity). In the *GUiNZ* external datasets, the all and main ethnicity data are classified at Statistics NZ Levels 3[2] and 1 (European; Māori; Pacific; Asian; Middle Eastern, Latin American or African (MELAA); Other; and New Zealander). Exploratory analyses were carried out to determine which set of ethnicity data should be used for the multivariable analyses for the study (see Ethnic identification, page 26).

Area-level deprivation (1 to 10; NZDep 2006 for AN, 9m, 2Y and NZDep 2013 for 4.5Y) was used to measure socio-economic status. Participants were grouped into areas of low (levels 1-3), medium (levels 4-7) and high (8-10) deprivation to provide categorical NZDep variables for each DCW. Household income data (collected at AN, 9m, and 2Y) were available at seven levels which were collapsed into low (≤70,000 NZD) and high (>70,000 NZD) categories.

Maternal age (in years) and education level were collected at the antenatal DCW. Exploratory analysis indicated that, due to the pattern of injury at different levels, the most suitable classification for use in the study was the binary variable: No degree (No secondary school qualification, Secondary school/NCEA 1-4 or Diploma/Trade certificate/NCEA 5-6) vs. Degree (Bachelor's or higher degree).

Explanatory measures

A list of the independent variables used in the analyses (plus details on their type, the corresponding DCW and their original sources) is reported in Table S1, Appendix I (page 56). In accordance with the study protocol, these variables were

[2] See https://www.stats.govt.nz/tools/aria

grouped into the following categories for analysis: antenatal; social and physical environment; child; socio-cultural and safety, as summarised in Table 3.

Explanatory variables comprised continuous, binary and categorical (>2 levels) data. Where possible and appropriate, published cut-offs were used to transform scale data into binary or categorical variables (see Data analysis, page 17). Exploratory analyses were used to collapse multi-level categorical variables into fewer levels or, if possible, into binary variables; based on associations with injury outcomes. The distribution of scale variables was explored to confirm that it was appropriate to use parametric analyses.

Table 3: Independent variables included in this study

Antenatal environment	Crowding; External support; Family cohesion; Family stress; Family structure; Housing tenure; Maternal alcohol intake; Maternal employment; Maternal health; Maternal stress; Maternal smoking; Parity; Rurality; Was pregnancy planned?
Physical and social childhood environments	Crowding; Damp, mould, or condensation; Dwelling condition; ECE arrangements; Family structure; Family Stress; Family Support; Household heating; Household income-tested benefit receipt; Housing tenure; Interaction with social services; Material deprivation; Material standard of living; Maternal discipline; Maternal employment; Maternal external support; Maternal health; Maternal neighbourhood belonging; Maternal parenting satisfaction; Maternal parenting values; Maternal social networks; Maternal warmth; Maternal work-life balance; Mother-child affiliation; Mother & partner involvement with child; Neighbourhood integration; Neighbourhood quality; Neighbourhood safety for children; Parental conflict; Parenting programmes; Primary care use and access; Residential mobility; Siblings; Transport; Well Child/Tamariki Ora checks
Child characteristics	Behaviour; Birth conditions; Birthweight; Body Mass Index; Cognitive functioning; Developmental milestones; Ear infections; General health; Gestational age; Health/developmental problems; Language; Level and type of participation in activities; Perinatal health; Temperament
Socio-cultural environment	Maternal cultural connectivity; Maternal experience of discrimination
Safety environment	Maternal sources of safety information; Safety features in the home

Additional data

To provide context to some of the findings, responses to questionnaire items that aimed to ascertain some of the reasons for participants' circumstances are reported in the Results (see Table 13,Table 14 andTable 15). For example, why a child was unable to see a doctor when they needed to. Further information on these items is provided in Appendix I (page 56).

Data analysis

The raw injury outcome data obtained at 2Y and 4.5Y were binary (at least one injury vs. no injury; at least one hospitalisation due to injury vs. no hospitalisation due to injury) and ordinal (number of injuries). Different combinations of derived injury variables were explored to determine the primary outcome variable for the study, see *Injury outcomes* (page 20). Analyses were carried out using SPSS and Stata. At both univariate and multivariable levels, significance was defined as $p<0.05$.

Missing data

The presence and impact of missing data were examined prior to carrying out multivariable analyses and developing the statistical models. It was important to determine the proportion of missing values among outcome, and independent variables, in order to prevent biased estimates. Given the relatively large sample size of the *GUiNZ* cohort, it was deemed reasonable to initially ignore small amounts of missing data – it has been suggested that missing rates of less than 5% for any variable can be considered inconsequential (Stewart et al., 2019).

Of the 6,469 NZ resident children in the *GUiNZ* cohort, 95% (N=6,114) provided injury data and were therefore included in the study. For 355 children, no injury data were available at either 2Y or 4.5Y. Since there were missing injury data for slightly more than 5% of the sample, this is not inconsequential. However, data that were missing due to non-participation in these DCW were not missing at random. Further, the injury data were binary or ordinal as opposed to normally distributed scale data. As such, techniques to adjust for missing injury data (such as using the overall mean) were not appropriate. Imputation of missing injury data for children who did not take part in at least one of these DCW was not possible. This is because there were no outcome data available for any of the relevant time points.

Missing data are present in the *GUiNZ* datasets, even with participation in a particular DCW. This is because many items include "*Don't know*" or "*Refuse to answer*"/"*Prefer not to say*" response options. Previous *GUiNZ* research (e.g. Walsh et al. (2019a, 2019b)) provided an indication of the likely level of missing values for variables, as well as guidance on the best ways to account for this in the analyses.

Exploration of missing values for individual exposure variables was carried out; this was generally low (<5%). When multiple variables were entered into statistical models, the overall level of missingness was more substantial. The simplest method of dealing with missing data is complete case analysis through listwise exclusion of participants with any missing data, such that multivariable models do not include any participant with one or more missing data points. However, this can lead to a considerable reduction in sample size/statistical power and introduce bias to the findings (Gontijo de Castro et al., 2019).

We mitigated this by applying the following steps, in turn, to test the impact on our models and sample size:

1. For categorical variables, the inclusion of "missing" as a response value (see Walsh et al., 2019b) if the level of missingness was above 15%,
2. For categorical variables, replacement of *"Don't know"* or *"Refuse to answer"* with the response most strongly associated with a positive injury outcome,
3. For scale variables, replacement of missing values with the overall mean value (initially 5-15% missingness and eventually all missing values).

Further details are provided in the Results Section (pages 21-42) and the Supplementary Table S20 in Appendix II (page 73).

Participants

There were 6,853 children in the initial *GUiNZ* cohort. Data were provided by mothers for 6,321 children at the 2Y DCW (92% of the cohort) and 6,160 (90%) at the 4.5Y DCW (see Figure 1, page 21). There are 6,495 children (95% of the cohort) for whom there were data at either the 2Y **or** 4.5Y DCW. There were 145 children (2%) at the 2Y DCW who were not living in NZ and 342 (6%) who were not living in NZ at 4.5Y; 381 children (6%) were not resident in NZ at some point up to 4.5Y. These participants were excluded from the analyses for this study since the aim was to provide evidence to inform NZ-focussed policy initiatives.

The mean age of the children at the time of interview for the 4.5Y DCW was 54 months (standard deviation: 1.6; range: 49-68 months). There is evidence of relationships between child age at the 4.5Y DCW and sociodemographic variables, as well as some developmental outcomes due to systematic selection bias; children who were older at the interview were more likely to be non-European and from areas of high deprivation. An inverse relationship between age at interview and motor and language skills has been demonstrated. Thus, if analyses find a significant relationship between an outcome and child age at the 4.5Y DCW, this should be taken into account in or the sample should include a narrower age range.

Inclusion criteria and included/excluded participants

Child participants were included in the initial analyses for this study if their mother provided data at 2Y **or** 4.5Y (N=6,495) **and** they were living in NZ at the time of these DCWs (N=6,114). The characteristics of included (89%; n=6114) and excluded (11%; n=739) children as well as the impact of missing one of the DCW were explored.

Missing 2Y and 4.5Y injury data

The sociodemographic characteristics of the 6,114 children eligible for inclusion in this study are reported in Table 4 along with data for the 739 *GUiNZ* children who were excluded from the analyses. There were further missing data on number of injuries for seven participants, including six whose parents answered *"Don't know"* or *"Prefer not to say"* and one participant who was excluded as an outlier (see

Footnote 3, Page 16). Chi-square (for categorical variables) and t-tests (for age) were used to determine whether differences between participants included or excluded in the study were statistically significant or not significant (NS; p>0.05).

There were significant differences between the *GUiNZ* children who could be included in the analyses for this study and the 379 children who were excluded (see Table 4). Specifically, excluded children: were less likely to have mothers who prioritised their ethnicity as European; more likely to be from an area of high deprivation; and had mothers who were younger when the child was born.

The latter variables are known risk factors for injury, therefore the injury rates reported for this study may be underestimates, particularly for groups that are over-represented among those with missing data. Because no injury data are available at either 2Y or 4.5Y, imputation of missing data was not possible.

Table 4: Characteristics of included & excluded participants

Variable	Level	N=6114 (%)	Excluded (n=739) (%)	Results of statistical analysis
Child sex (N=6847)	Female	2956 (48)	363 (49.5)	NS
	Male	3158 (52)	370 (50.5)	
Mother ethnicity* (N=6740)	European	3351 (56)	235 (32.5)	$X^2(5)=157.7$, $p<0.001$
	Māori	813 (13.5)	126 (17)	
	Pacific Island	818 (14)	168 (23)	
	Asian	835 (14)	157 (22)	
	Other	124 (2)	32 (4)	
	New Zealander	76 (1)	<10 (<1)	
NZDep 2006* (N=6757)	Low	1534 (25)	150 (21)	$X^2(2)=30.7$, $p<0.001$
	Medium	2243 (37)	226 (31)	
	High	2257 (37)	347 (48)	
Mother's age* (N=6759)	Mean (SD)	30.2 (6)	28.7 (6)	$t(6757)=-6.6$, $p<0.001$

* at antenatal interview

Missing 2Y or 4.5Y injury data

For 133 children, there were no 2Y data but there were 4.5Y data and for 343 children there were 2Y data but no 4.5Y data (thus in total 476 children had one missing injury data point). Table 5 and Figure 1 (page 21) show the number of children with and without injuries for those who had no data at one of the DCW and how these data were included in the analyses that follow.

Table 5: Injury for children who participated in either the 2Y or 4Y DCW

	2Y data available but no 4.5Y data (n=343)	4.5Y data available but no 2Y data (n=133)	Result	Outcome
Injury in either DCW	91	35	At least 1 injury from 2Y to 4.5Y	Included in Injury category (n=126)
No injury	252	98	Unclear if injured at missing DCW	Included in No injury category (350)

There were missing 4.5Y data for 5% of children who experienced an injury between birth and 2Y and 6% of children with no injures at 0-2Y. There were missing 2Y injury data for 2% of children who experienced an injury between 2 and 4.5Y and 3% of those with no injuries at 2-4.5Y. Neither of these differences was statistically significant. Thus, it does not appear that children with or without injuries were more or less likely to have participated in the 2Y or 4.5Y DCW.

To deal with the issue of unclear outcome data, we explored the method used by Walsh et al. (2019a) in their analysis of adverse experiences among the *GUiNZ* cohort. In line with this, the 350 children with unclear 0-4.5Y injury data were *included* in the No Injury group. This likely resulted in a slight **underestimation** of injury rates because some of those children were likely to have experienced an injury that was not reported to the *GUiNZ* study due to non-participation in a DCW.

We were able to quantify this underestimation as follows:

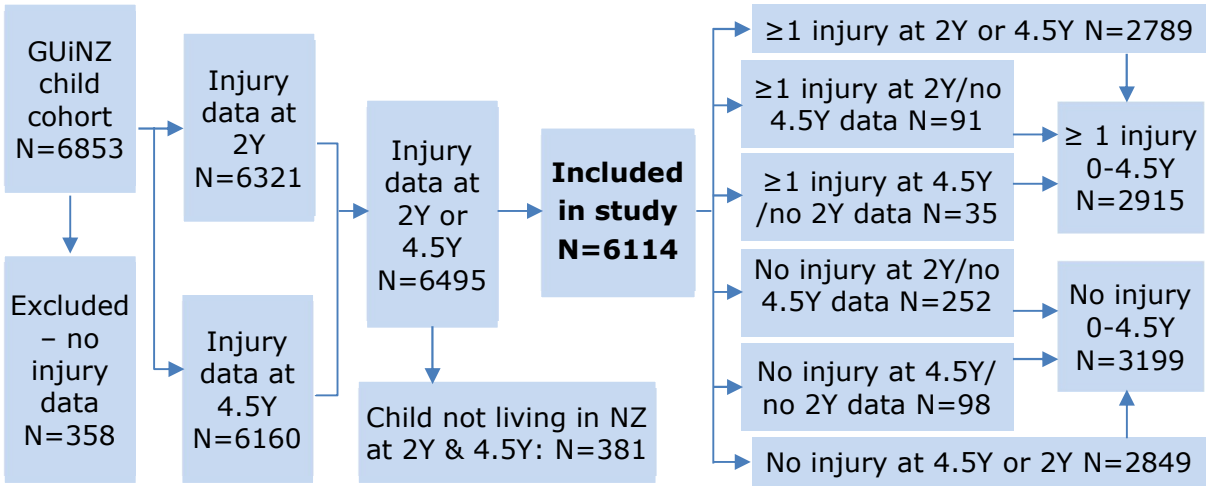
- the odds of having an injury at 4.5Y if a child had no injury at 2Y were 0.4,
- the odds of having an injury at 2Y if a child had no injury at 4.5Y were 0.3.
- Thus, among the 350 children for whom injury data is unclear (see Table 5), there are likely to be around 136 (39%) who actually did have an injury at 0-4.5Y (4% of the sample with no injuries).

The likelihood of a child experiencing an injury was not random and was likely to be dependent on a range of factors. Therefore, it was not possible to determine which children in the cohort were among the approximately 136 who may have been misallocated to the 'no injury' category.

An alternative strategy of excluding the 350 children without injury data from the study was explored. Excluding these children would have resulted in a slight **overestimation** of injury rates and a 6% reduction in sample size. This approach was rejected to maintain a higher sample size and reduce bias since those with missing data had different characteristics to those who included in the study.

For the main data analyses, the 350 children with unclear 0-4.5Y injury data were included in the *No Injury* category (see Table 5), unless specified. Thus, the sample size was 6,114. As mentioned above, this is likely to have resulted in a slight **underestimation** of injury rates.

Figure 1: Flowchart of participants



Results

In this section the overall injury rates are described, including injuries resulting in admission to hospital. Following this, associations between injury and selected independent variables are reported. See Method (pages 14-21) for details on the selection and derivation of these variables. Full results are reported in Appendix 2: supplementary results tables, starting on page 63.

Injury outcomes

Injury rates

Up to age 2Y, 1,679 children (27.5%; N=5,987) experienced an injury, and between the ages of 2Y and 4.5Y, 1961 children (32%; N=5,780) experienced an injury. Among those injured, the mean number of injuries up to age 2Y was 1.4 (SD: 0.9; range: 1-10[3]) and from age 2Y to 4.5Y was 1.5 (SD: 1.1; range: 1-10[4]).

From birth to 4.5Y, 2,915 children (48%) experienced at least one injury (see

Figure ***2***). As such, most children (52%, n=3,199) had no injuries with 27.5% of children (n=1,679) experiencing their first injury before they were aged 2 with 20% (n=1,236) first injured between the ages of 2Y and 4.5Y (see Figure 3).

Figure 3 shows the distribution of the number of injuries experienced by children up to 4.5Y. Overall, 28% of children (n=1,791) had one injury, 11% (n=725) had two injuries, 5% (n=294) had three injuries, 2% (n=130) had four injuries and 2% (n=126) had five or more injuries. Among those injured, the mean number of injuries was 1.8 (n=3,066; SD: 1.4; range: 1-15) and the median was one.

Figure 2: Injury up to 4.5Y (and time of 1st reported injury)

[3] One child with a considerably higher number of injuries at 2Y than other children or their own number of injuries at 4.5Y, was excluded as an outlier from these analyses.
[4] At 4.5Y, the maximum number of injuries provided was 10.

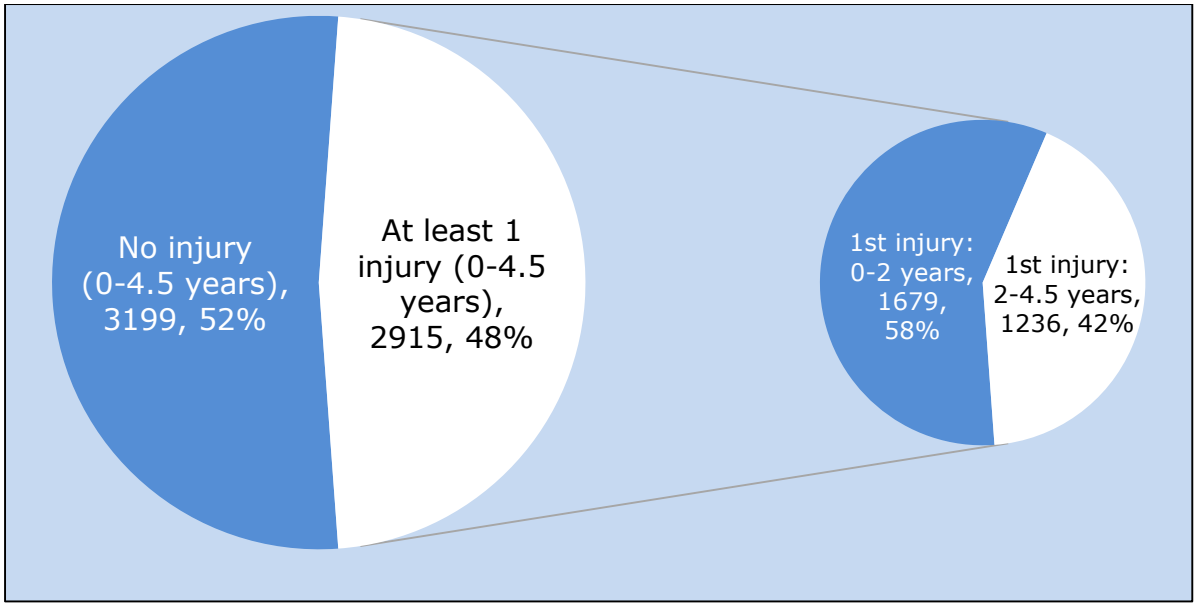
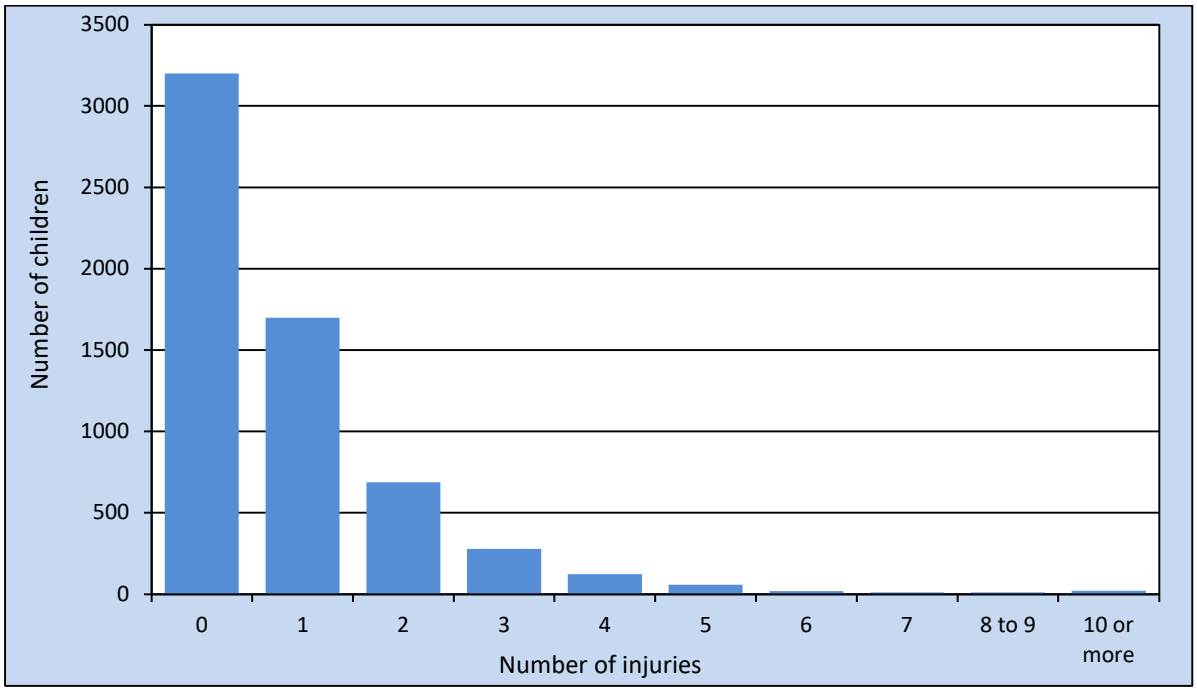


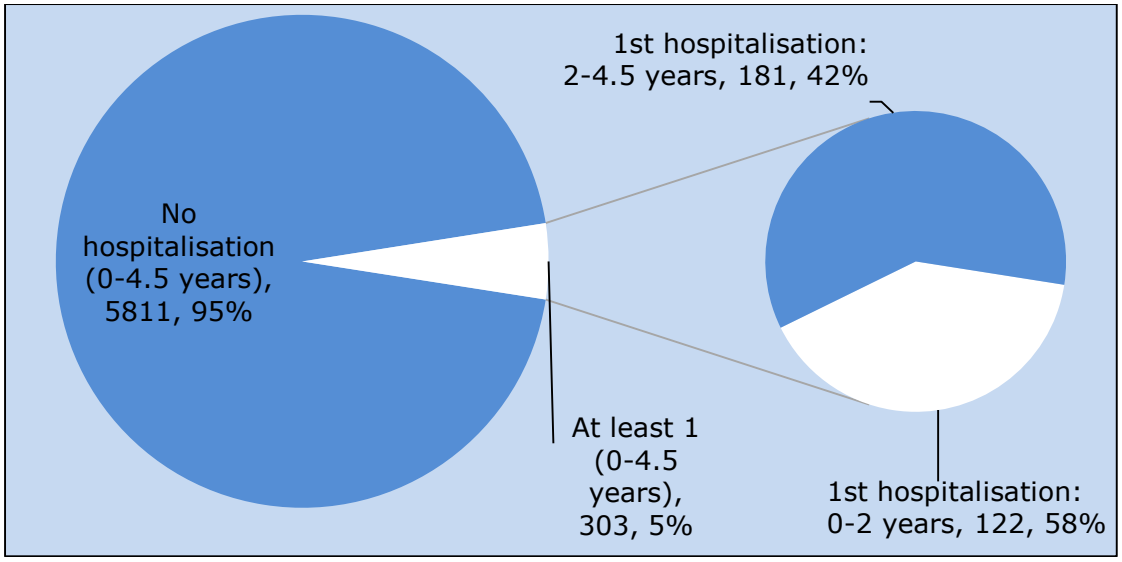
Figure 3: Distribution of the number of injuries



Hospitalisation due to injury

Up to age 2Y, 122 children (2%; N=5,981) were admitted to hospital due to an injury, and between the ages of 2Y and 4.5Y, 205 children (3%; N=5,765) were hospitalised due to an injury. From birth to around 4.5Y, 303 children (5%; N=6,114) were hospitalised at least once due to an injury (see *Figure 4*). With 2% of children (n=122) experiencing their first hospitalisation before they were aged 2Y and 3% (n=181) first hospitalised between the ages of 2Y and 4.5Y.

Figure 4: Number of children with at least one hospitalisation up to 4.5Y (and time of 1st hospitalisation for those with at least 1 hospitalisation)



Injury index

Exploratory data analysis found that injuries varied among population groups according to key sociodemographic characteristics. There were statistically significant relationships ($p<0.05$) between injuries and area level deprivation (NZDep 2006), mothers' education, mother and child prioritised ethnicity and child sex. The pattern of these differences appeared to be dependent on which injury outcome variables were used. For example, when the dichotomous variable of injury versus no injury was used, European children had a higher injury rate than other groups. However, European children were less likely to have three or more injuries than Māori or Pacific children and they had a lower number of injuries (among those with ≥1 injury). Similarly, children with European mothers were less likely to have been hospitalised due to an injury than Māori or Pacific. This pattern was similar for NZ Dep 2006, mother's education and ethnicity data.

As such, an index was derived from the different types of injury data: number of injuries (zero or above) and whether the child was hospitalised due to an injury up to the age of 4.5Y. The index is shown in Table 6 with the majority of children in the no injury category and fewest in the 'high' injury category.

Table 6: Injury index definitions & number (proportions) at each level among the 6114 children

Index level	Definition	n (%)
No injury (0)	No injuries up to 4.5Y (or injury data at one DCW was unclear)	3199 (52%)
Low injury (1)	1-3 injuries with no hospitalisation	2410 (39%)
High injury (2)	1-3 injuries with a hospitalisation or ≥4 injuries	505 (8%)

There were no statistically significant differences between the mean ages of the children in each injury group at the time of the 4.5Y DCW (No injury: 54 months, Low injury 53.9 months, High injury 54 months). Therefore, it was not necessary

to use age at the 4.5Y DCW as a covariates nor exclude children who were interviewed early or late in the 4.5 DCW.

The results tables (Supplement Table S2 toTable S19, pages 63 to 72) show the rate of each injury level among each group for a specific variable. In accordance with the study analysis plan, variables are grouped into: sociodemographic characteristics; social and physical environments, including family, home, community, neighbourhood, health and social service support; and child characteristics. Where variables were measured at more than one DCW (e.g. NZDep), the strength of the relationships between the variables and injury outcome at each time point and longitudinal relationships were examined (see Longitudinal analyses (page 31, Results section) and Appendix I, pages 60-58.

Location and type of injury

Table 7 andTable 8 show the parent-reported type and location for the most severe injury, among the 2,915 children who experienced an injury from birth to 2Y and 2Y-4.5Y. The most common types of injuries were those to the head without being knocked out at 2Y, and a broken bone, fracture or dislocation at 4.5Y. Unsurprisingly, children who experienced a loss of conciousnes or a cut needing stitches or glue were more likely to be in the high injury risk group.

Table 7: Type of injury for child's most severe injury

	2Y			4.5Y		
Injury category	**Overall %**	**Low**	**High**	**Overall %**	**Low**	**High**
Loss of consciousness/knocked out	2	2	5	2	2	5
Injury to head (not knocked out)	38	38	39	19	19	19
Broken bone, fracture or dislocation	10	10	10	20	18.5	26
Cut needing stitches or glue	11	10	14	16	16	14
Cut not needing stitches or glue	3	3	2	N/A	N/A	N/A
Injury to mouth or tooth	11	10	13	12.5	14	6
Burn or scald	8	8	7	3	3	2
Swallowed household cleaner/other poison/pills	2	2	4	2	1	3
Swallowed object	2	3	2	2	1	4
Fall	*	*	*	8	8	6

* Category not included in the 2Y questionnaire

Most injuries occurred in the home. At 4.5Y, there was an increase in injuries occurring at care arrangements and a decrease in injuries at home. There was no significant difference in the location of injuries for those in the low or high risk injury groups at either 2Y or 4.5Y.

Table 8: Where the child's most severe injury occurred

	2Y			4.5Y		
Injury category	**Overall %**	**Low**	**High**	**Overall %**	**Low**	**High**
Own home	70	69.5	71	54	53	56
Someone else's home	12	12	11.5	12	12	13.5

ECE or care arrangement	7	8	5.5	18	18	16
Playground or park	4	4	4	6.5	7	5
Public swimming pool/beach/river/etc.	<1	<1	1	2	2	1.5
Road as pedestrian/in buggy/on trike	1	1	1	2	1	2
Road as passenger in vehicle	1	1	1	1	1	1
Other	5	5	4	5	5	5

Multivariable analysis were conducted, once significant associations between independent variables and injury outcome had been identified, to explore which factors were associated with injuries at home (see Location and type of injury, Final analysis models, page 40).

Sociodemographic characteristics

Table 9 shows injury outcomes for key sociodemographic characteristics. At univariate level, there were statistically significant relationships ($p<0.05$) between the injury index and area level deprivation (NZDep 2006), mothers' education, child sex and household income.

Table 9: Sociodemographic characteristics & injury index level

Variable		No injury	Low	High	Chi-square results
NZDep 2006* (N=6034)	High	54%	36%	10%	$X^2(2)=21.4$, $p<0.001$
	Low to Medium	51%	41.5%	7.5%	
Mother's qualifications * (N=6017)	No degree	54%	37%	9.5%	$X^2(2)=37.2$, $p<0.001$
	Bachelor or higher degree	50%	44%	6%	
Child sex (N=6114)	Male	49%	41.5%	9%	$X^2(2)=26.1$, $p<0.001$
	Female	56%	37%	7%	
Household income* (N=6035)	Missing (n=1336)	53%	38%	9%	$X^2(6)=60.1$, $p<0.001$
	Low (≤$30 000)	58%	29%	12%	
	Medium (>$30k-≤$70k)	55%	36%	9%	
	High (>70k)	49.5%	44%	7%	

* based on information provided at the antenatal interview

In addition, there was a significant age difference between mothers of children at each level of the injury index with mothers of those in the high risk group being significantly younger (mean=29, SD=6) than mothers of children with no injury (mean=30, SD=6) and mothers of children in the low risk group (mean=31, SD=6; $m^2(2)=385.7$, $p<0.001$). As shown in Table 9, there were a considerable amount of missing data for household income; 22% of the study sample. In accordance with the study analysis plan (see Methods, page 17), a 'missing' category was included as a level for the household income variable.

Ethnic identification

Ethnic identification of the *GUiNZ* cohort can be measured in several ways, according to whose ethnicity is being explored (Mother or Child), whether identification was prioritised or included multiple responses and whether one ethnicity variable (of several levels) or multiple binary ethnicity variables are used.

In general, children of Pacific Island mothers were more likely to be in the high injury risk group, while those of Asian mothers were less likely to be in the high injury risk group; compared with children of European mothers (Table 10). Children of European/New Zealander mothers were more likely to be in the low injury risk group but less likely to be in the no injury group. Children of Asian mothers were most likely to be in the no injury group, compared with all other ethnicities.

Table 10: Ethnic identification & injury index (% in each index group)

Variable	Level	No injury	Low	High	Chi-square results
Mother Main ethnicity – binary (N= 6017)	European (n=3602 vs. all others)	48	44	8	$X^2(2)=78.9$, $p<0.001$
	Māori (n=813 vs. all others)	55.5	35	10	$X^2(2)=9.3$, $p=0.009$
	Pacific (n=835 vs. all others)	57	30	13	$X^2(2)=46.4$, $p<0.001$
	Asian (n=842 vs. all others)	63	33	4	$X^2(2)=52.6$, $p<0.001$
Mother any ethnicity* (N= 6027)	European (n=3944 vs. all others)	48	44	8.5	$X^2(2)=99.4$, $p<0.001$
	Māori (n=1086 vs. all others)	53	37	10	$X^2(2)=5.1$, $p=0.077$
	Pacific (n=961 vs. all others)	56.5	31	12	$X^2(2)=45.6$, $p<0.001$
	Asian (n=913 vs. all others)	63	33	4	$X^2(2)=57.9$, $p<0.001$
Mother self-prioritised ethnicity* (N= 6017)	European/New Zealander (n=3427)	47.5	44	8	$X^2(8)=135.7$, $p<0.001$
	Māori (n=813)	55.5	35	10	
	Pacific (n=818)	57	30	13	
	Asian (n=835)	63	33	4	
	Other (n=124)	56	42	2	
Child main ethnicity – binary (N=5691)	European (n=3210 vs. all others)	47	44	8	$X^2(2)= 49.5$, $p<0.001$
	Māori (n=763 vs. all others)	52	38	10	$X^2(2)= 4.1$, $p=0.128$
	Pacific (n=830 vs. all others)	54	34	12.5	$X^2(2)= 30.7$, $p<0.001$
	Asian (n=690 vs. all others)	63	33	4	$X^2(2)= 51.3$, $p<0.001$
	New Zealander (n=574 vs. all others)	50.5	41	8.5	$X^2(2)= 0.1$, $p=0.953$
	European (n=3923 vs. all others)	47	44	8.5	$X^2(2)= 75.8$, $p<0.001$

Child any ethnicity (N=5778)	Māori (n=1419 all others)	50	40	10	$X^2(2)= 3.3$, p=0.197
	Pacific (n=118 vs. all others)	54	34.5	12	$X^2(2)= 34.6$, p<0.001
	Asian (n=939 vs. all others)	60	35	5	$X^2(2)= 42.0$, p<0.001
	New Zealander (n=799 vs. all others)	49	42	9	$X^2(2)= 1.5$, p=0.481
Child 'self-prioritised' ethnicity# (N=5691)	European (n=3068)	48	44	8	$X^2(10)=$ 106.1, p<0.001
	Māori (n=771)	51	38.5	10	
	Pacific (n=776)	54	33	13	
	Asian (n=707)	63	33	4	
	Other (n=81)	54	43	2.5	
	New Zealander (n=288)	51	41	9	

* based on information provided at the AN interview # New Zealander reprioritised to 2nd ethnic group if New Zealander & one other group were reported for all ethnicities.

With regards to the children's ethnic identification, a similar pattern was found. Māori and Pacific Island children were more likely to be in the high injury risk group and Asian children were least likely to be in the high injury risk group. European children were less likely to be in the no injury group and Asian children were more likely to be in the no injury group.

For multivariable analyses, grouping children according to whether their mothers' self-prioritised ethnicity was: European/New Zealander; Māori; Pacific Island; Asian, MELAA or other; best fit the pattern of the data and differences between groups. There were fewer missing data for mothers' ethnicity (n=97; 1.6%) compared with child ethnicity (n=423; 7%) and mother's ethnicity had a stronger association with the injury index.

Data were collected on whether participants' mothers were born in NZ or overseas (n=6,028). Compared with children of mothers born overseas, those *with* NZ born mothers were more likely to be in the high injury risk group (9% vs. 7%) ($X^2(2)=30.4$, p<0.001). There was a significant association between ethnicity and being born in NZ. Notably, 95% of Asian mothers were not born in NZ (compared with 19% of European/New Zealander mothers and 33% of Māori, Pacific Islanders, MELAA or others; $X^2(2)=1739.6$, p<0.001).

At the antenatal interview, 81% of mothers (n=4,941) reported that they usually spoke English (80.5%) or Te Reo Māori (<1%) at home. Other languages spoken by more than 1% of mothers were: Hindi (3%); Tongan (3%); Samoan (2.5%); Northern Chinese (2%); and Indo-Aryan (2%). The children of mothers who usually spoke English or Te Reo Māori at home were more likely to be in the high injury risk group than the children of those who usually spoke other languages at home (9% vs. 6%; $X^2(2)=7.9$, p=0.005). It is likely that this reflects the association between ethnicity and the injury outcome; the majority of mothers who usually spoke other languages at home were Asian (57%).

Multivariable analyses

Multivariable analyses were carried out with a binary outcome variable (no/low injury risk vs. high injury risk). As such, adjusted odds ratios (OR) and 95% confidence intervals (CI) are reported for this binary outcome.

Analyses were carried out using binary logistic regression, reference categories were those with the lowest proportion of participants in the high injury risk group. Except for maternal ethnicity, where the reference category was European/New Zealander. For variables with lower levels of missing data (5-15%), IBM SPSS Statistics was used to replace missing values with the series mean for the entire study sample. A summary of missing data is reported in the Supplemental Information (Table S20, page 67). Household income was the only variable with more than 15% missing data and as such was retained as a four level variable with a missing data category.

Sociodemographic variables

Maternal education, ethnicity and age; mother born in NZ; English or Te Reo Māori usually spoken at home by mother; NZDep2006; household income; and child sex were entered into a multivariable analysis. In combination, **ethnicity, household income** and **child sex** were significantly associated with injury index outcome ($p<0.05$). As such, in the supplemental results tables for this report (Appendix II, pages 63-66), OR and CI adjusted for these variables are reported.

Maternal education, age, born in NZ, language usually spoken at home and NZDep2006, were not significantly associated with injury when mother's ethnicity, household income and child sex were taken into account, therefore they were not included in regression analyses. Table 11 shows the OR and 95% CI for the sociodemographic variables that all further analyses were adjusted for.

Table 11: Associations between sociodemographics & injury index

Variable	Level	OR & CI (95%) for high injury risk group	
		Unadjusted	Adjusted
Child sex (N=6114)	Male	1.3 (1.1 to 1.6)	1.3 (1.1 to 1.6)
	Female		
Mother self-prioritised* (N=6017)	Asian, MELAA or other	0.4 (0.3 to 0.6)	0.4 (0.3 to 0.5)
	Māori	1.2 (0.9 to 1.6)	1.0 (0.8 to 1.4)
	Pacific	1.6 (1.3 to 2.1)	1.4 (1.1 to 1.8)
	European or New Zealander		
Household income* (N=6035)	Missing (n=1336)	1.3 (1.0 to 1.7)	1.3 (1.0 to 1.7)
	Low (≤$30 000)	1.9 (1.4 to 2.6)	1.9 (1.4 to 2.6)
	Medium (>$30k to ≤$70k)	1.4 (1.1 to 1.8)	1.4 (1.1 to 1.8)
	High (>$70k)		

* based on information provided at the antenatal interview

Antenatal variables

Rurality was not significantly associated with injury at a univariate level ($X^2(1)=4.2$, $p=0.12$) and was very strongly associated with ethnicity, therefore it was not included in further analyses (see Table S2). When significant antenatal and sociodemographic variables were entered into a regression analysis, **smoking during pregnancy, high family stress** and **low external support** were significantly associated with being in the high injury risk group (see Table 12).

Table 12: Variables significantly associated with injury at each stage of the multivariable analyses

	Socio-demographic	Antenatal environment	Home environment	Family environment	ECE & care arrangement	Neighbourhood characteristics	Primary care access	Services & support	Child characteristics
Socio-demographic covariates	Child sex; Maternal ethnicity; Household income	Child sex; Maternal ethnicity; Household income	Child sex; Maternal ethnicity;	Child sex; Maternal ethnicity;	Child sex; Maternal ethnicity;	Child sex; Maternal ethnicity;	Child sex; Maternal ethnicity;	Child sex; Maternal ethnicity;	Maternal ethnicity
Antenatal environment		External support; Family stress; Smoking;	External support; Family stress;	External support	External support	External support	External support	External support	External support
Childhood social and physical environment			Damp/mould/ condensation; Material deprivation	Damp/mould/ condensation; Material deprivation Maternal health; Maternal employment	Material deprivation Maternal health; Maternal employment Looked after by individual/ relative (other than parent) at 2Y	Material deprivation Maternal health Employment/ care arrangement Use of public transport	Material deprivation Maternal health Employment / care arrangement Use of public transport Primary care risk factors	Maternal health Employment / care arrangement Use of public transport Primary care risk factors; Interaction with social services; Parenting programmes	Maternal health Employment/ care arrangement Use of public transport WCTOC 15m Primary care risk factors; Interaction with social services; Parenting programmes;
Child characteristics									Behaviour; Level of participation in activities; Temperament

Longitudinal analyses

Longitudinal socioeconomic variables

Initial analyses explored whether socioeconomic status during childhood were associated with being in the high injury risk group, after taking sociodemographic variables into account (see Appendix I, page 60). There were no significant relationships between longitudinal measures of NZDep and injury. **High family stress** was significantly associated with being in the high injury risk group for the high NZDep group (N=2,257). For the low/medium NZDep group (N=3,777), **smoking during pregnancy** was significantly associated with being in the high injury risk group.

Further analyses explored whether household income during childhood were associated with being in the high injury risk group, after taking sociodemographic variables into account (see Appendix I, page 60). There were no significant relationships between longitudinal measures of change in household income and injury outcome. As such, multivariable analyses continued to adjust for household income as measured at the antenatal DCW.

Longitudinal social and physical variables

There were no significant univariate relationships between longitudinal measures of rurality and being in the high injury risk group (see Appendix I, page 60). The strongest relationship between being in the high injury group and other variables were for children who met the following criteria:

- moved from private rental to public rental at some time between birth & 4.5Y
- moved twice or more between birth and 4Y
- lived in a single parent family for at least one DCW
- were 2Y when their mother went from being not being in paid employment to being employed.
- had siblings born between 16m and 4.5Y
- experienced a change from overcrowding to not being overcrowded
- mother was in poor to fair health for at least one DCW

The multivariable analyses that follow include the longitudinal variables (above) for household tenure, residential mobility, family structure, maternal employment, overcrowding and maternal health (instead of the antenatal measures).

Childhood social and physical environments

Social and physical variables were measured from 9m to 4.5Y, for these analyses, some antenatal variables were replaced with childhood cross-sectional or longitudinal variables, depending on which variable was more strongly associated with being in the high injury risk group (see Longitudinal social and physical variables, page 31).

Childhood home and family variables

Associations between (longitudinal and cross-sectional) measures of childhood variables and injury were explored. First, significant childhood home physical and social environment variables (Table S3), then significant childhood family home environment (see

Table S4), antenatal and sociodemographic variables were entered into a regression analysis (see Table 12).

For children of mothers in paid employment at 2Y, there were no significant associations at univariate level between injury outcome and hours worked each week or working at weekends. There was a significant relationship between injury and maternal hours worked each week at 4.5Y and working at weekends, at univariate level but not when sociodemographic variables were taken into account. Children of employed mothers at 2Y who worked a regular daytime schedule were more likely to be in the no/low risk injury group after taking sociodemographic variables into account (7% vs. 10%; OR=1.4, 95% CI=1 to 1.8)

Childhood care and neighhourhood variables

Next, associations between (longitudinal and cross-sectional) measures of early childhood care arrangement variables and injury were explored (see Table S5). There were significant relationships between injury outcome, being in any early childhood care arrangement at 2Y and type of care arrangement at 2Y. There were no significant relationships between injury and care arrangements at 9m or 4.5Y. For children in a care arrangement at 2Y, there was no significant relationship between hours spent in their main care arrangement per week and injury outcome at the univariate level.

The most significant type of care arrangement associated with injury was children who were looked after by an individual or relative (other than their parents) at 2Y. That variable, other childhood, antenatal and sociodemographic variables were entered into a regression analysis (see Table 12).

There were significant relationships between regular childcare arrangements and maternal employment. In the following results, 'unemployment' refers to mothers who were not in paid employment. Children who experienced the following were particularly more likely to be in the high injury risk group:

- Maternal unemployment from 0 to 4.5Y and being in a care arrangement at 2Y,
- Maternal unemployment to paid employment at 2Y and not being in any care arrangement at 2Y

These groups were combined and compared with a combination of employment and care arrangement (i.e. maternal unemployment from 0 to 4.5Y and being in a care arrangement at 2Y **or** maternal unemployment to paid employment at 2Y and not being in any care arrangement at 2Y). Then the employment/care

arrangement variable, other childhood, antenatal and sociodemographic variables were entered into a regression analysis (see Table 12).

Children who experienced maternal unemployment from 0 to 4.5Y and were being looked after by relatives at 2Y were more likely to be in the high injury risk group (n=30; 17% in high injury risk group).

Next, neighbourhood childhood variables (see Table S6), the employment/care arrangement variable, other childhood, antenatal and sociodemographic variables were entered into a regression analysis (see Table 12).

During the 2Y DCW, mothers were asked about the reasons why their child was or was not in a regular childcare arrangement and why they were not in paid employment. Table 13 shows the main reasons given by different groups for children with high-level injuries and for the cohort as a whole.

Table 13: Reasons for care arrangements & employment/unemployment

		High injury risk group	Whole cohort
Reasons for no childcare arrangement	Child does not need it	69%	58%
	Transport difficulties	8%	12%
	Don't want child cared for by strangers	8%	12%
	No spaces	15%	6%
Unemployed to employed at 2Y & Not in a care arrangement at 2Y	Prefer to look after own children	82%	87%
	Too busy with family	18%	33%
	Partner earns enough to support family	36%	32%
	No jobs available	0%	1%
	No jobs with suitable flexibility	27%	11%
Reasons for unemployment given at 9m	No suitable child care	10%	7%
	Childcare costs	46%	28%
	Studying	10%	15%
Reasons for childcare arrangement	Because of other commitments/activities	28%	33.5%
	To give mother a break/alone time	24%	22%
	Good for child's development	24%	30.5%
	To mix with other children	16%	8%
Unemployed 0 to 4.5Y & In a care arrangement at 2Y	To establish relationships with Grandparents	8%	2%
	Prefer to look after own children	76%	65%
	Too busy with family	14%	22%
	Partner earns enough to support family	5%	22%
	No jobs available	14%	9%
	No jobs with suitable flexibility	29%	19%
Reasons for unemployment given at 2Y	No suitable child care	14%	5%
	Childcare costs	33%	17%
	Studying	28%	36%

Childhood services and support

NZ children under five years of age are eligible for free Well Child/Tamariki Ora checks (WCTOC). Analyses were carried out on whether individual checks were completed (according to mother report) (see Table S7). Exploratory analysis also

included composite variables of how many WCTOC were completed from 0 to 4.5Y and whether all or none were completed. The strongest association with being in the high injury risk group was those who did not complete the 15m WCTOC.

A high number of General Practitioner (GP) visits at either the 2Y or 4.5Y DCW and being unable to access GP services at either DCW were significantly associated with being in the high injury risk group. Attending a primary care service that was *not* local to the participant was protective against being in the high injury risk group. These items were closely related to each other and as such could not all be entered into multivariable regression (see Table S8). Thus, a primary care risk factor index was compiled. Having two or more risk factors was significantly associated with being in the high injury risk group (OR= 1.9; 95% CI: 1.6 to 2.3). This variable (≥2 primary care risk factors vs. <2 risk factors) was included in further analyses.

Table 14 shows the reasons given by mothers for not being able to access GP services for their child at the 2Y and the 4.5Y DCW. Numbers were too small to carry out statistical testing but there were differences for children with in the high injury risk group for many of the reasons given.

Table 14: Reasons for being unable to access GP services for the child

	High injury risk group	Whole cohort
Main reason for not having a regular GP practice at 2Y		
Didn't need one	25%	29%
Too far away/unable to get there	6%	16%
Changed address	12.5%	4%
Unhappy with previous treatment	0%	4%
Too expensive	6%	2%
Reasons endorsed for not being able to see a GP at 2Y (multiple responses):		
Couldn't get an appointment soon enough/at a suitable time	44%	49%
It was after hours	22%	22%
No transport	26%	15%
Couldn't get in touch with the doctor	11%	3.5%
Couldn't spare the time	7%	6%
Cost	4%	5%
Main reason at 4.5Y (single response):		
Couldn't get an appointment soon enough/at suitable time	55%	54%
It was after hours	24%	23%
No transport	9.5%	5%
Couldn't spare the time	5%	5%

A range of other services and support were explored: receipt of income-tested benefits; interaction with social services (Child, Youth and Family; Whanau Ora; other social service agencies, support services or professionals); sources of external support; early parenting support programmes and social networks (see

Table S9). Table 15 shows the reasons for contact with social support services for children in the high injury risk group and the cohort as a whole. In particular, there were differences for child-related reasons and parent problems for those in the high injury risk group compared with the entire cohort.

Table 15: Reasons for social support services contact for the child

	High injury risk group	Whole cohort
Child-related reasons	29%	37%
Problems between parents	27%	19%
Financial help	14.5%	14%
Family consultant	11%	16%
Family counselling/family workshop	22%	15%
Maternal support	18%	14%
Legal issue/requirement	6.5%	4%

Other services and support, the primary care risk factor variable, WCTOC at 15m, employment/care arrangement, childhood, antenatal and sociodemographic variables were entered into a regression analysis. External support at 9m was not significantly associated with injury, therefore external support measured at the antenatal DCW was retained in further analyses (see Table 12).

Child variables

Three types of child characteristics were explored: health and development; participation in activities; and temperament.

Child health and development variables

Health and development characteristics were grouped into birth variables (Table S10 to Table S12), early health and development (0 to 2Y; Table S13) and later health and development (4.5Y; Table S14). The 2Y and 4.5Y DCW measured child behaviour using the Strengths and Difficulties Questionnaire (SDQ); a standardised scale that provides a total difficulties score and subscale scores for emotional symptoms, hyperactivity problems, conduct and peer problems.

When significant early development and birth variables plus sociodemographics were entered into a regression analysis, **birth conditions, general health** and **ear infections** were associated with being in the high injury risk group.

Very few children had a birth condition, or poor to fair health at 9m or at 2Y (<3% for each variable). Therefore, two composite variables were created for: any birth condition or health/developmental problem at 9m or 2Y; and general health at 9m

or 2Y. When these variables were entered in the analysis along with significant antenatal, social and physical environmental variables, none of the early developmental variables were associated with being in the high injury risk group.

When later developmental variables were entered into a regression analysis, **growth/physical development** and **SDQ emotional symptoms** were significantly associated with being in the high injury risk group (Table S14). Fewer than 3% of participants had fair to poor health, or a growth/physical development problem. Therefore, composite variables were compiled for general health 9m-4.5Y, and health or development condition from birth to 4.5Y (all health/development problems at 4.5Y, including speech, growth/physical development and behaviour problems). When these variables were combined with sociodemographic variables, all were significantly associated with being in the high injury risk group. However, when antenatal, and social/physical childhood variables were included in the analysis, the only later developmental variables associated with being in the high-risk group were **SDQ hyperactivity problems** and **total SDQ difficulties score**.

It was not possible to include both the SDQ hyperactivity subscale and total difficulties score into further analysis, since subcale scores are included in the total. The total score was chosen because the effect size of the impact on injury outcome was higher, once all other variables had been taken into account. When earlier and later health and developmental variables were included in a regression analysis, only total SDQ difficulties at 4.5Y was significantly associated with injury.

Child participation in activities

There were no significant univariate associations between being in the high injury risk group and going to the following places or activities: park; beach; swimming lessons; playgroup; organised physical activity; or aquatic/outdoor activity. There was no obvious patterns as to whether specific types of activity at 2Y were associated with injury that could inform sub-factor activity analyses. Therefore, an overall count of number of activities at 2Y was compiled.

At 4.5Y, the following were significantly associated with injury: climbing trees; enjoying physical activity; choosing active things to do. There were no significant associations with being in the high injury risk group for: being able to ride a bicycle; playing with a ball; or chasing/running. Again, because there was no clear pattern among types of activity and their associations with being in the high injury risk group, an overall 4.5Y physical activity score was compiled. There were no significant association between injury outcome and hours spent outdoors at 2Y or 4.5Y (

Table S15). Since activities at 2Y and physical activity at 4.5Y were strongly correlated, a total score for child participation in activities was compiled.

Child temperament

Temperament was measured at 4.5Y using the Child Behaviour Questionnaire (Very Short Form; CBQ-VSF).

Table S16 shows the mean scores for each injury index group for the two factors of the CBQ-VSF that were significantly associated with being in the high injury risk group. The Negative Affect subscale was not significantly associated with injury when other variables were taken into account. A high Surgency subscale score was associated with being in the high injury risk group when other variables were taken into account. High surgency is characterised by being highly active, intense pleasure seeking and impulsivity.

When all child variables were included in the regression model, Surgency, SDQ total, and participation in activities were significantly associated with being in the high risk injury group. Therefore, Surgency, SDQ total, participation in activities score, services and support, primary care access risk factors, WCTOC at 15m, the employment/care arrangement variable, other childhood, antenatal and socio-demographic variables were entered into a regression analysis (see Table 12).

Socio-cultural variables

Table S17 There was no association between sociocultural variables and injury risk group once child, services and support, primary care access, WCTOC, social and physical childhood variables, employment/care arrangements, antenatal and socio-demographic variables were taken into account (see Table S17).

Safety variables

Caregivers reported that safety information came mainly from 'informal' sources such as family, friends, the Internet, other media and their own knowledge or experience. Less than 40% of mothers reported that their main source of support was a healthcare provider or their Well Child Book. Sources of safety information were not significantly associated with being in the high injury risk group when sociodemographic variables were taken into account (see Table S18).

There was no association with safety features in the home at 2Y and 4.5Y and being in the high injury risk group once other significant variables were taken into account (see Table S19). Further analysis explored the number of safety features in the home, low vs. high number of safety features, and all safety features present vs. at least one safety feature not used. None of these variables were significantly associated with being in the high injury risk group.

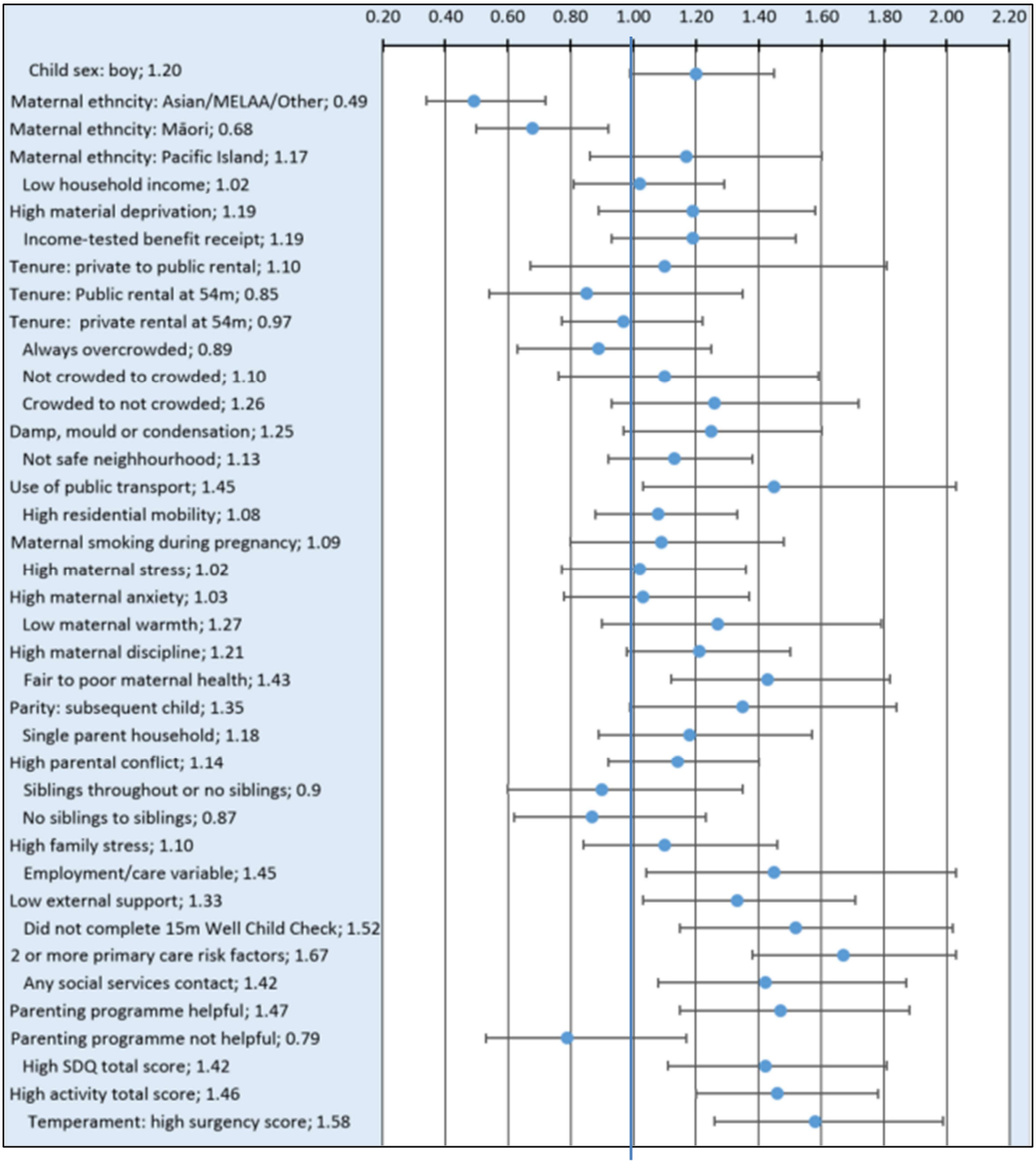
Final analysis models

The final model included 30 independent variables (see Table S2 to Table S16). Further analyses to refine the regression model were carried out, as described in Appendix II, page 74. The final regression model included binary variables with all missing data replaced (see *Figure 5*). Finally, the differential impacts of the

variables and factors on specific population groups (by ethnicity, NZDep and child sex) and a range of alternative outcomes (hospitalisation, no injury vs. any injury, location and type of injury) were explored (see Appendix II, Table S20, page 73).

For the final multivariable model, **maternal ethnicity, low external support, fair to poor maternal health, employment/care arrangements**, **use of public transport, 15m WCTOC**, **primary care risk factors, interactions with social support services, use of parenting programmes at 9m, high SDQ total, high participation in activities** and **high Surgency** were associated with being in the high-risk group.

Figure 5: Adjusted odds ratios for binary variables in the final model



[Reference categories for the variables included in the final model were: ethnicity – European/NZ; housing tenure – owner at 4.5Y; crowding – never overcrowded; maternal health – good to excellent; siblings – no siblings; parenting programmes – not available or not used; employment/care variable – children **not** meeting the following criteria: Maternal unemployment from 0 to 4.5Y *and* being in a care arrangement at 2Y **or** Maternal unemployment to employment at 2Y and *not* being in a care arrangement at 2Y.]

Factor model

A factor analysis of the 26 independent variables included in the final multivariable model was carried out (see Appendix II, Factor analysis method, page 75). The variables in each factor are reported in Table 16.

Table 16: Factors & variables included in the final model

Factor	Variables
Family	Siblings; Being a subsequent child; External support*; Neighbourhood safety
Household	Household tenure; Material deprivation; Household income; Damp/mould/condensation; Use of public transport*; Overcrowding;
Need	Single parent household; Income-tested benefit receipt; Social services contact*; Parental conflict; Residential mobility; Smoking in pregnancy; Maternal employment/care arrangement*; Maternal health*
Nurturing	Maternal warmth; Maternal discipline; Parenting programme use*; WCTOC at 15m*; Primary care access*;
Stress	Family stress; postnatal anxiety; antenatal stress

*significant in the final multivariable model

All five factors were significantly associated with ($p<0.05$) being in the high injury risk group. Odds ratios and 95% CI are reported in Table 17 and Figure 6.

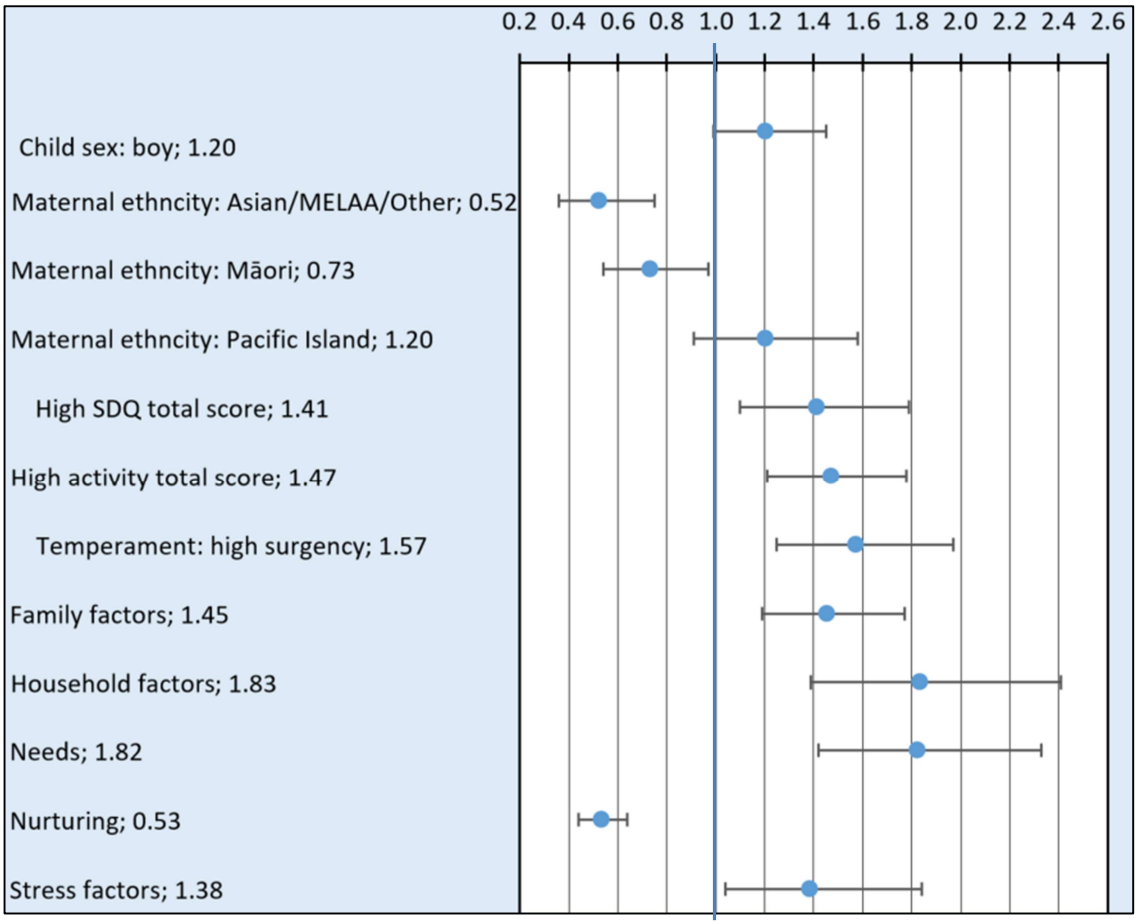
Table 17: OR (95% CI) for the 5 factors among different groups & for alternative outcomes

	Family	Household	Need	Nurturing	Stress
Unadjusted	1.5 (1.2-1.8)	1.9 (1.5-2.3)	1.8 (1.4-2.3)	0.5 (0.6-0.4)	1.4 (1.0-1.9)
Adjusted*	**1.5 (1.2-1.8)**	**1.8 (1.4-2.4)**	**1.8 (1.4-2.3)**	**0.5 (0.6-0.4)**	**1.4 (1.0-1.8)**
Subgroup analyses					
High NZ Dep	1.5 (1.1-1.9)	2.0 (1.2-3.2)	2.5 (1.7-3.5)	0.6 (0.8-0.5)	NS
Low/Med NZDep	1.5 (1.1-2.0)	1.9 (1.3-2.6)	NS	0.4 (0.6-0.3)	1.5 (1.0-2.2)
Asian	NS	2.7 (1.1-6.7)	NS	NS	NS
Māori	NS	1.9 (1.1-3.3)	1.9 (1.1-3.2)	0.5 (0.9-0.3)	NS
Pacific	1.7 (1.1-2.6)	1.6 (1.0-2.5)	1.8 (1.1-3.4)	0.5 (0.8-0.3)	1.8 (1.1-3.0)
European	1.5 (1.1-1.9)	2.1 (1.2-3.5)	1.8 (1.3-2.6)	0.5 (0.6-0.4)	NS
Boys	NS	1.9 (1.3-2.9)	1.7 (1.1-2.4)	0.5 (0.7-0.4)	NS
Girls	1.6 (1.2-2.1)	1.8 (1.2-2.6)	2 (1.4-2.7)	0.6 (0.7-0.4)	NS
Alternative outcomes					

Hospitalis-ation (any)	1.3 (1.0-1.7)	1.7 (1.2-2.3)	1.7 (1.2-2.3)	0.7 (0.9-0.6)	NS
Any injury 0-4.5Y	NS	NS	NS	0.8 (0.8-0.7)	NS
Any injury 2Y	NS	NS	NS	0.7 (0.8-0.7)	NS
Any injury 4.5Y	1.2 (1.0-1.3)	NS	1.2 (1.0-1.5)	0.9 (1.0-0.8)	NS
Low vs high injury	1.4 (1.1-1.8)	2.0 (1.4-2.7)	1.8 (1.4-2.4)	0.6 (0.7-0.5)	NS

*adjusted for Maternal ethnicity; child sex; SDQ total; activity participation; Surgency

Figure 6: Odds ratios for binary factors in the final model



*adjusted for Maternal ethnicity; child sex; SDQ total; activity participation; Surgency

Location and type of injury

At 2Y, none of the independent variables included in the final model for the injury outcomes were significantly associated with a child experiencing their most severe injury in their home. At 4.5Y, **living in a high income household** and **high maternal stress** were significantly associated with a child experiencing their most severe injury in their home. With regards to the final models, only **level of participation in activities** was significantly associated with the most severe injury occurring in the home at for both the 2Y and the 4.5Y DCW.

Subgroup analyses

The OR for the combination of factors above (1.4 to 1.9) were higher than the OR for the combination of individual variables (see 1 to 1.7; Figure 5 and 6). Table 17 demonstrates that different factors impact different population groups and there are different results across different types of outcome measure. For children of Asian mothers, who were less likely to be in the high risk injury group, the *household* factor was the only factor associated with increased injury risk. While children of Pacific mothers were impacted by all of the factors identified. Overall, in this model, children of Māori mothers were less likely to be in the high injury risk group than those of European mothers but were adversely affected by experiencing high levels of need, and adverse household conditions.

The protective nurturing factor had the strongest assocation with injury, overall, and was the strongest among the five factors for those in low/medium areas of deprivation, children of Pacific mothers and boys. It was the factor most consistently associated with injury across groups and outcome measures.

The impact of ethnicity on injury risk changed as variables were added to the regression model. At the univariate and initial adjusted levels, children of Asian mothers were less likely to be in the high injury risk group, while those of Pacific mothers were more likely to be in this group (compared with children of European mothers). When all other factors were added (at the individual variable and combined level) this remained the case for children of Asian mothers. However, children of Pacific mothers were no longer more likely to be in the high injury risk group, while children of Māori mothers were less likely to be in this group.

Final models conclusion

In conclusion, the following were identified as child characteristics significantly associated with increased likelihood of a *GUiNZ* participant being in the high injury risk group: having a high SDQ total difficulties score, high level of participation in activities, and having a high level of Surgency (a facet of temperament). Children of Asian or Māori mothers were significantly less likely to be in the high injury risk group than those with European/New Zealander mothers.

After adjustment for these covariates, we found the following significant results:

- Children in *high nurturing* environments were **half** (95% CI 0.4 to 0.7) as likely to be in the high injury risk group than those in lower nurturing environments (significant for those in both deprivation groups; across all maternal ethnicities except Asian and for both boys and girls).
- Children in *high-need environments* were **1.8** times (95% CI 1.4 to 2.3) more likely to be in the high injury risk group than those with low-needs (subgroup analyses found this factor was significant for those in areas of high deprivation, children with Māori, Pacific and European mothers and both girls and boys).

- Children in *more difficult household circumstances* were **1.8** times (95% CI 1.4 to 2.4) more likely to be in the high injury risk group than those in less difficult households (significant for all subgroups).
- Children with a *high rate of family risk factors* were **1.5** times (95% CI 1.2 to 1.8) more likely to be in the high injury risk group than those with a low rate of family risk factors (significant for those in both NZDep groups; children with Pacific Island or European mothers and girls).
- Children in *high stress households* were **1.4** times (95% CI 1.0 to 1.8) more likely to be in the high injury risk group than those in low stress households (significant for those in areas of low/medium NZDep; children with Pacific Island mothers).

Discussion

The aim of this study was to understand how multiple factors in combination, and over time, affect a preschool child's risk of experiencing injury. A life-course epidemiological approach was taken to explore the longitudinal environments that surround preschool injury. Unlike conceptual models, that apply principles of public health to specific injuries, this study was designed to identify covariates and factors that are associated with an increased risk of any or multiple injuries across childhood from birth to 4½ years of age. A key aspect of the study's approach was affirmation that parent-related variables alone do not account for all early childhood injuries. Also, that previous reports of differences in injury rates according to ethnic identity are likely to be associated with broader socioeconomic determinants. There are multiple child, social and environmental factors, beyond parental control, that might contribute to additional risk for, or protection from injury. The study sought to approach the analyses and interpretation of findings using a strengths-based framework, acknowledging that many 'at risk' pre-school children remain injury-free.

By age 4.5Y, 48% of children in the *GUiNZ* cohort had experienced at least one injury requiring medical attention. Most of these children (28%) had experienced only one such injury. However, a condsiderable proportion of children (8%) were classified as being in a 'high injury risk group'. These were children who, by age 4.5Y, had experienced up to three injuries (at least one of which required hospital admission) or four or more injuries (with or without hospitalisation).

The use of an injury outcome variable that combined the prevalence of any injury, number of injuries and a proxy for injury severity (hospitalisation) allowed us to account for statistical issues around a lack of normal distribution and small numbers at the high end of the injury rate (most children had no injuries with very few (1%) experiencing more than five injuries) plus the distinct patterns that we found for children who were reported to have not been injured from birth to 4.5Y. Children with no reported injuries, tended to be more similar to those in the high

injury risk group (higher deprivation, lower maternal education and lower household income).

After adjusting for covariates (maternal ethnicity, child sex, behaviour, participation in activities, and surgent temperament), a protective nurturing factor was associated with *reduced* odds of being in the high risk injury group (OR: 0.5, 95% CI: 0.4 to 0.7). While the following factors were associated with *increased* odds of being in the high risk injury category: living in a need-environment (OR: 1.8, 95% CI: 1.4 to 2.3), higher level of household risk factors (OR: 1.8, 95% CI: 1.4 to 2.4), higher level of family risk factors (OR 1.5, 95% CI: 1.2 to 1.8), and higher family stress factors (OR: 1.4, 95% CI: 1.0 to 1.8).

At the individual variable level, analyses found that maternal ethnicity, low external support, fair to poor maternal health, employment/care arrangements, use of public transport, 15m WCTOC, primary care risk factors, interactions with social support services, use of parenting programmes at 9m, high SDQ total, high level of participation in activities and high Surgency (temperament) were associated with being in the high injury risk group. The OR for the combination of variables into the factors described above were higher than any of the individual variable ORs.

The findings contribute to the limited body of knowledge regarding the lifecourse determinants that lead to injury among NZ preschoolers. The identification of factors and clusters of factors has helped to inform the development of a prioritised range of evidence-based policy initiatives (including those that address socio-political factors). The longitudinal perspective offers novel and critically needed contemporary population and context relevant evidence to determine timely points for the delivery of effective interventions. By deepening our understanding of why inequities in injury outcomes by ethnicity and socioeconomic status exist for NZ children, we are able to inform policies and interventions to reduce the frequency and impact of injury in these vulnerable populations.

The findings highlight the importance of multi-sectoral and multi-level approaches to optimise injury prevention and control efforts to reduce the impact of injuries. Previous NZ studies have tended to focus on specific types of child injury (e.g. as a result of road traffic accidents), at one time point, across all age groups. Whereas, we were able to analyse longitudinal information (for both injury and independent variables), specifically for preschool children, on all injuries requiring medical attention. Our findings on child characteristics highlight the importance of taking gender, in particular, into account when identifying injury risk (Langley et al., 1987). In line with existing evidence, we found that socioeconomic variables were less important than the physical, psychosocial and support environments within which children were living (Langley, Silva, et al., 1983).

Many of the individual variables that we found to be associated with childhood injury (behavioural difficulties, external support, maternal employment, maternal stress and health, overcrowding, parental conflict, residential mobility, single

parent household, smoking during pregnancy, social services contact and housing tenure) have been previously identified as indicators of vulnerability among the *GUiNZ* cohort that impacted child health outcomes up to 2Y, see Morton et al. (2015b). Like previous research we found that high levels of maternal discipline were associated with an increased risk of injury (Langley, McGee, et al., 1983; McKinlay et al., 2010).

A programme of prenatal and infancy home visitation in the US to improve health-related behaviours, reduced the rates of child abuse and neglect, maternal welfare dependence, and a subsequent reduction in the child's criminal and antisocial behaviour (Olds et al., 1998). We found that children who did not complete their 15m Well Child/Tamariki Ora check (WCTOC) were more likely to be in the high injury group. The focus of the 15m WCTOC is *"How well is the home environment supporting wellbeing or are there concerns about dysfunction?"*[5]. Appendix II (page 75) details the content of the check at 15m and the WCTO *My Health Book* with regards to child safety. Care givers who do not take part in the 15m WCTOC may not be directed to or look up relevant sections of the *My Health Book.*

We did not find that any one home safety feature or combination of features was significantly associated with injury outcome, once other child, social and physical environment variables were taken into account. This, despite our finding that most injuries from birth to 2Y and 2Y to 4.5Y occurred in the home. That said, the relatively low rates (<70%) of fenced off driveways, covered electrical outlets and stair safety reported by parents indicate that there is room for improvement in the installation and uptake of safety features in the homes of preschool children (see Table S19). Building on the model for minimum standards of insulation in public and private rental homes, consideration should be given to expanding this initiative to include requirements for home safety features.

The findings have provided Māori-specific data to inform the prioritisation of relevant injury prevention activities. We found that at the univariate level, Māori maternal and child ethnicity was associated with the high injury risk group, with 10% of children being in this group compared with 8-8.5% for European. However, once all other variables were taken into account, Māori maternal ethnicity was signficantly associated with being in the low injury risk group.

In sub-analyses of individual variables, we found that injury risk for children of Māori mothers was increased for those with high levels of participation in activities and fair to poor maternal health; a narrower range of independent variables than we found for the entire sample. It was the needs and household risk factors that were associated with being in the high risk injury group for children of Māori mothers. A systematic review of interventions to reduce injuries among indigenous populations, acknowledged the need for more evaluation of interventions to assess their appropriateness for Tamariki Māori (Margeson & Gray, 2017). Our findings highlight the importance of underlying, intergenerational difficulties for Māori that

[5] www.wellchild.org.nz/sites/default/files/wcto-practitioner-handbook-october-2015-updates-with%20contents%20page_clean.pdf

help to explain why inequities in injury by ethnicity and socioeconomic status persist.

Policy implications

Many of the variables identified as being significantly associated with injury are potentially modifiable through general policy and practice initiatives, others indicate that a more direct approach is required. Some variables are not modifiable in terms of their relationship to injury outcome but provide opportunities for identifying children at high risk of experiencing injury and providing targeted intervention.

Preventing or reducing injury risk

Policies to reduce poverty and inequalities in socio-economic status could directly impact household income, and material deprivation and potentially indirectly improve maternal stress, anxiety and health, family stress and parental conflict. Housing policy and practice could directly reduce the impact of household tenure, overcrowding, damp/mould/condensation and residential mobility. Child-focussed health policy and practice could increase the uptake of WCTOC, improve access to primary care and optimise parental responses to behavioural difficulties.

These general policies could potentially, indirectly, improve maternal stress, anxiety and health, family stress and parental conflict. These areas also provide opportunities to increase external support to families of pre-school children through family doctors, Plunket, pre-school care arrangements and ECEs, parenting programmes and information available through media and the Internet. They would also help to reduce the impact of family stress through improvements in family health, housing difficulties, work-life balance, financial difficulties, family conflict and child behaviour.

Increased multi-agency support for pregnant women and mothers of pre-school children could decrease smoking during pregnancy, reduce maternal stress and anxiety, and increase maternal health and warmth. Targeted maternal policy and practice could also reduce the impact on child injury of being in a single parent household, being a subsequent child and employment/care arrangements. Rates of injury could be reduced though family and parenting policy and practice focussed on reducing conflict, providing safe activity environments, coping with and managing difficult child behaviour, and ways of responding to children who have characteristics of a surgent temperament: high levels of activity, high-intensity pleasure seeking and impulsivity.

Identification of children at higher risk of injury and targeted intervention

The sub-group analyses for the study suggest that different groups/children may require different approaches to intervention. For example, children of Asian mothers were particularly vulnerable to the *household* risk factors.

Children whose families received income-tested benefit, who had a history of social services contact, whose mothers attended parenting programmes, who accessed primary care that was not local to their homes, and those who regularly used public transport were more likely to be in the high injury risk group. These services could provide opportunities to identify children at risk of experiencing injury and deliver targeted intervention.

Reducing levels of childhood participation in activities would not be desirable as they are important elements of maintaining good health and wellbeing, and child growth and development. Since most injuries occur in the home, policy and practice could be geared towards providing families with information and intervention that allows for better safety for highly active children. Work could also be carried out to improve the safety of ECE and care arrangements for 2 to 5 year old children.

Cross sector implications

Our aim was to explore both immediate, close and distant influences on preschool child injury. By including household *and* neighbourhood variables, our findings are likely to require cross-sector solutions. The study aligns with key national and international strategy documents and therefore the findings will be useful in engaging with government agencies to inform the development of policy that can help reduce the harm resulting from preschool child injury. These include the NZ Health Strategy (2016) He Korowai Oranga (the Māori Health Strategy) (2002), 'Ala Mo'ui: Pathways to Pacific Health and Wellbeing (2014), and the United Nations Convention on the Rights of the Child (UN General Assembly, 1989). Representatives from key NZ policy partners (ACC, Hāpai Te Hauora Māori Public Health, Ministry of Health, Plunket, Safekids Aotearoa) were involved in the development of policy initiatives arising from the findings.

Policy intiatives

While most injuries occurred in the home, the presence or absence of safety features in the home was not significantly associated with injury in this study. However, we were unable to explore their association with specific injury mechanisms due to limitations of the injury data.

This study shows that effective injury prevention needs to address a combination of proximal and distal socio-economic, psychosocial and health factors, aimed at improving the wellbeing of all families and implemented antenatally and across the lifespan. As such, injury prevention policy requires multisectoral working to address a broader range of factors beyond current initiatives that have tended to focus on directly improving the safety of physical environments through information/advice to parents, regulation and improved infrastructure. It appears that the factors identified by the study underlie previous findings of higher childhood injury risk among Māori and Pacific whānau.

The authors, policy partner (Safekids Aotearoa) and study reference group recommend the following policy and practice initiatives in order to lower the risk of injury among preschool children and reduce inequity in risk/protective factors.

- Agencies should work together to provide a nurturing environment for children at a macro or societal level by improving access to primary care, well-child services and parenting support.
- Improved identification of and support for families with a high level of need, particularly those in contact with social services, mothers with poor health, those with children whose mothers are not in paid employment and use care arrangements, and those with children whose mothers return to paid employment but have no care arrangements.
- Improved living conditions for NZ families with a focus on housing and socioeconomic inequity.
- Increased and targeted multi-agency support for families that addresses their full range of health, social and economic or material needs
- Support to reduce psychosocial stressors among families and mothers.
    - Psychoeducational support for families who have children with behaviour problems, high levels of participation in activities and difficulties with impulsivity or self-control.

In addition, continued interagency efforts are required to monitor trends in child injury rates to assist with the identification of emerging trends and monitor the effectiveness of injury prevention efforts. This data needs to be made available at a national and regional level. By understanding mediating factors between government policy and child wellbeing outcomes (including injury), agencies can work more collaboratively through coordinated and sustained investment by public, government and private sectors to create a world where children can play, learn, grow up and live free from serious injury.

Limitations and future directions

Study strengths and limitations

The key strengths of this study are its contemporary nature, longitudinal design, and the size and diversity of the sample, which is broadly generalisable to the current NZ population (Morton, Ramke, et al., 2015a). The breadth of exposure measures has enabled analysis of multiple child, caregiver, and environmental characteristics in conjunction with self-reported measures of household safety.

The use of multivariable models enabled consideration of a wide range of factors. We demonstrated that in some cases, it is the combination of specific variables that affects injury risk. For example, the interaction of maternal employment with childhood care arrangements. In other areas, changes over time appeared to be more important than cross-sectional measures – e.g. housing tenure. Maternal

ethnicity was an important covariate for the study and there was sufficient diversity among the sample to explore associations between explanatory factors and injury for specific subgroups; Asian, Māori, Pacific and European. It is important to note that there is substantial heterogeneity within these groups that could not be addressed by this study, including narrower ethnicity categories, whether parents were migrants to NZ and their experiences of migration or discrimination.

The study findings need to be considered in light of further limitations. As is the case with any cohort study, the exposure variables are reliant on participant recall and the desire for participants to respond honestly. Our analyses relied on information collected from and about the mothers of the GUiNZ cohort, thus we were unable to take potentially relevant paternal sociodemographic, psychosocial and health variables into account. Partner (father) data have been collected by the *GUiNZ* study but the sample size for these participants is smaller (N=4,401) than the mother sample (N=6,822), not representative of the wider *GUiNZ* cohort and less generalisable to the general population of preschool children (Pryor, Morton, Bandara, Robinson, & Grant, 2015).

An injury index was compiled for the study, based on exploratory data analyses. Hospital admission was used as a proxy for injury severity and mothers were only asked to report whether their child's most severe injury resulted in hospitalisation. Thus, a key assumption was made that if a child had been admitted to hospital due to injury, that parents would consider this the most severe injury to have occurred. It is possible that rates of hospitalisation were under-reported in our results because while a hospital admission occurred, it was not related to what a mother perceived was their child's most severe injury.

The way injury questions were asked did not allow for a distinction to be made between intentional and unintentional injury. In addition, as mentioned above, injury-related questions did not capture the details of all injuries and some questions only related to the 'most severe injury'. The latter is a subjective caregiver perception and may not correlate with a clinical determination.

While there was limited data on the types of injuries sustained, it was not possible to identify the mechanism of injury associated with the specific events (for example, whether a head injury resulted from a fall). The available data allowed us to paint a broad picture of the socioeconomic, household, family, and external care environments in which the *GUiNZ* children were living antenatally, at 9m, 2Y and 4.5Y of age. However, it was not possible to directly link proximal or distal factors to specific injury events, including type of injury and where it occurred.

An objective household safety assessment was not available, and therefore the this data were limited to self-report. Previous NZ research found that people perceive their houses to be in better condition than they are following independent assessment (Buckett, Jones, & Marston, 2011). This suggests that caregivers in the present study may have overestimated the presence of household safety

measures in their homes. However, a US study validating self-reported home safety practices among culturally diverse caregivers of pre-schoolers, found the use of safety practices and devices reported in face-to-face interviews were generally reliable (Hatfield et al., 2006). In addition, we were unable to specifically take parental supervision into account as this was not measured in any of the *GUiNZ* DCW. That said, a range of other measures of parental involvement that we included were not associated with injury outcome.

There were some missing data both in terms of injury outcomes and exposure variables, as detailed in the methods and results sections. Since there were missing data on whether a child did not experience an injury between birth and 2Y and 2Y-4.5Y (N=350), the estimate for the number of children in each of the injury index group (low injury risk and high injury risk) may have been an overestimate. Household income had the highest level of missing data among the exposure variables (22% of the study sample) and injury outcome for this group was significantly different from the reference group (high household income). This may have impacted the validity of the findings based on the household factor.

Finally, the use of some "forward variables" (i.e. covariates that may have been collected after injury occurred) may mean that measured risk factors and odds ratios are not correct and there is a risk of reverse causality. For example, we found no association between child injuries and safety features in the home, however, it is possible that child injury before age 4.5 leads to safety features being improved in the home afterwards. Future analyses, could restrict analyses to covariates measured at birth or 2 years.

Future directions for research, policy and practice

The present study relied on caregiver reports of exposures and outcomes. Data on hospitalisation, type and location of injury were restricted to the 'most severe injury' as determined by the child's caregiver. Children with no reported injuries had different characteristics to those in the low-injury group, suggesting a number of possibilities: under-reporting of injuries by parents; some children experienced injuries that went unrecognised by their parents or injuries occurred without medical attention being sought. The degree to which this could be explored along with other potential avenues of investigation was constrained by the time and resources available to the study. However, the findings provide a sound basis for future analyses of the data. Consideration should be given to conducting studies that link *GUiNZ* data to routinely collected data (ACC and hospital discharge data) in order to establish a more complete picture of the burden of injury in this cohort and to validate parental self-report of injury.

Our findings suggest potential areas for further research (using GUiNZ data or other study designs). For example, the increased injury risk found for children who were looked after by an individual or relative (other than their parents) at 2Y. As well as associations found for working patterns among those in paid employment, particularly children whose mothers do not work to a regular daytime schedule. It

is unlikely that there is a direct relationship between using public transport and injury events among pre-school children. Few of the injuries reported in this study occurred outside of the home or ECE/care environment. Discouraging the use of public transport to prevent injuries would not be desirable. As such, our finding that use of public transport increased injury risk needs further investigation to identify the socioeconomic and environmental determinants that underpin this association. The same applies to our findings of associations between injury and income-tested benefit receipt, social services contact, and parenting programme attendance. We related these variables to an indication of a high level of need but acknowledge that previous research has demonstrated that those who access social services are not always those most vulnerable or at risk, and that many vulnerable or at risk families do not have contact with social services (Growing Up in New Zealand, 2014).

Key to the future direction of policy and practice are a multi-sectorial approach, improved advocacy for injury prevention and child safety, improved support for and recognition of Safekids Aotearoa, and dissemination/uptake of new evidence and developments in policy initiatives such as those described in this report.

From 2003 to 2013, NZ had a National Injury Prevention Strategy (NZIPS) (Dyson, 2003). Multiple government agencies were involved in leading implementation of the Strategy and its priority areas (falls, drowning, suicide/self-harm, work-based, road, and assault) – note there was no specific child injury focus. The strategy was collectively owned by members of the Chief Executives Forum and supported by the NZIPS Secretariat. NZIPS was an expression of the Government's commitment to working with organisations and groups in the wider community to improve NZ injury prevention efforts. A key focus of NZIPS was to strengthen and enhance the infrastructure that supports injury prevention activity to improve safety performance. Since the plan expired in 2013, it has not been replaced and there has been a gap in a coordinated national strategic focus for injury prevention in NZ. There are siloed activity (e.g. Work Safe, road safety, drowning) but no national coordinated approach that prioritises child safety.

The Australian Government is in the process of developing their National Injury Strategy 2020-2030[6] which will focus on preventing injury across all age groups. The evidence-informed plan will have a strong emphasis on those most at risk, including young children, with recognition that injury prevention requires co-ordinated multi-sector action. In addition to actions to prevent specific types of injury, the draft strategy includes objectives on determinants of injury. For children, these focus on access to culturally appropriate programmes and support services for families, antenatally and across the pre-school years. The draft emphasises the need to deliver strengths-based, family-centred approaches to provide culturally-safe and supportive home environment for families and children.

[6] https://www.health.gov.au/initiatives-and-programs/national-injury-prevention-strategy-2020-2030

From an injury advocacy perspective, historically NZ had an association that advocated for injury prevention (Injury Prevention Network of Aotearoa NZ). IPNANZ advocated at a government level, held annual conferences, ran a foundation certificate in injury prevention, held regular workshops to discuss and debate key injury issues etc. At its peak IPNANZ had 400 members and was supported by funding from the Ministry of Health and ACC. The organisation was disbanded in 2016. In 2017, the Australian Injury Prevention Network (AIPN) broadened their focus to include NZ and became the *Australasian* IPN. The network's activities include conferences, publications, events, advocacy activities and research. The Network benefits from its high profile, influential membership base of leading injury prevention researchers, and those working to reduce the incidence of injury and harm throughout Australasia. AIPN has a strong child injury prevention focus and provide an opportunity for people in NZ working in child injury prevention to network, share resources etc. An opportunity exists to increase awareness of the networks activity among agencies involved in child injury prevention in NZ.

Safekids Aotearoa was set up in the early 1990s by Paediatricians at Starship Children's Hospital to help reduce rates of unintentional injury to children. They provide technical, evidence-based advice to ensure that legislation, policies and guidelines consider steps to protect children from unintentional injury. Safekids partners with a national network of community providers to share information, provide support and training on how to keep children safe. It also designs, delivers and evaluates practical programmes that seek to reduce injury risks in children. As a member of Safekids Worldwide, a network of 32 countries, Safekids provides input to international best practice on injury prevention for children.

Safekids is committed to ensuring that the gaps between groups, particularly those that exist between outcomes for Māori and Pacific children and European children, are eliminated. This equity-focused practice requires a broader, systems-based efforts to address inequitable community environments – places in which the surrounding conditions make injury inevitable. This includes advocating for changes in the decisions, decision-makers, policies, and practices that are responsible for these conditions. Safekids is committed to working with Māori to identify and support pae ora (Māori health aspirations) for injury prevention and child and whānau wellbeing. An opportunity exists to increase awareness of Safekids' equity approach to injury prevention among agencies involved in child injury prevention in Aotearoa.

The multi-dimensional nature of the policy partner involved in this study provides a pathway for knowledge transfer that will be used to inform stake-holders of the recommendations for policy and practice to highlight opportunities for injury prevention. This will be also be achieved, in part, through the study's policy brief, media release and manuscripts that will be submitted to peer-reviewed journals.

Concluding comments

The findings of this research have helped to provide evidence needed to inform the design and application of targeted and effective policies and interventions to reduce the prevalence and impact of childhood injury. In addition to achieving a primary outcome of health benefit, the study has identified opportunities to reduce preschool child injury morbidity and mortality in NZ, and thereby the associated direct and indirect costs of those injuries. A review of safety measures in NZ estimated that if our child injury mortality rate was reduced to that of The Netherlands (one of Europe's safest countries), then approximately 130 lives per year could be saved (60% of all child and adolescent injury deaths) (Bland et al., 2011). This provides added impetus for increased prioritisation of child injury prevention in NZ and uptake of the policy initiatives developed for this study.

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Appendix 1: included variables

Table S1: Independent variables included in the study analyses

	Variable	Type	DCW	Original source	Adaptation for this study
Socio-demographic characteristics	Child sex	B	6w	Linked health data	None
	Child ethnicity	C	4.5Y	Statistics NZ classifications	5 level variable created
	Maternal ethnicity	C	AN	Statistics NZ classifications	4 level variable created
	Household income	C	AN, 9m, 2Y	Statistics NZ classifications	Binary variable created
	Maternal education	C	AN	Statistics NZ classifications	Binary variable created
	Maternal age	S	AN	*GUiNZ* item	None
Antenatal environment	Crowding	C	AN	No. of Bedrooms & people in house	≥2 people per bedroom
	External support	S	AN	Family Support Scale [a]	Sum score calculated
	Family cohesion	S	AN	Family Adaptation & Cohesion [b]	Sum score calculated
	Family stress	S	AN	*GUiNZ* items	Sum score calculated
	Family structure	C	AN	Statistics NZ classifications	Binary variable created
	Housing tenure	C	AN	Statistics NZ classifications	3 level variable created
	Maternal alcohol intake	C	AN	Number of drinks per day in pregnancy (0, <1, 1-3, 4-19, 20+)	4 level variable created [low=1-3 drinks, high=4+]
	Maternal employment	C	AN	Statistics NZ classifications	Binary variable created
	Maternal health	C	AN	Perceived General Health [c]	Binary variable created
	Maternal stress	S	AN	Perceived Stress Scale [d]	Sum score calculated
	Maternal smoking	C	AN	*GUiNZ* item	Binary variable created
	Parity	B	AN	*GUiNZ* item	None
	Rurality	B	AN	Statistics NZ classifications	None
	Was pregnancy planned?	B	AN	*GUiNZ* item	None
Safety features	Maternal sources of safety information	B	2Y	*GUiNZ* items	None
	Safety features in the home	B/C	2Y	*GUiNZ* items	Sum scores calculated

Variable type: B=binary; C=categorical (>2 levels); S=scale. DCW: AN=Antenatal, w=week, m=month, Y=year

	Variable	Type	DCW	Original source	Adaptation for this study
Childhood home and family environment	Crowding	C	All DCW	No. of bedrooms & people in house	>2 people per bedroom
	Damp, mould, or condensation	B	9m	Mould in room baby sleeps in (Y/N); Any/never damp in house; Any/never condensation in baby's room	Combined 3 items into 1 (damp, mould or condensation vs. none of these)
	Dwelling condition	C	9m, 2Y	Statistics NZ classifications	Binary variables created
	Family structure	C	2Y,4.5Y	Statistics NZ classifications	Binary variables created
	Family Stress	S	9m, 2Y	*GUiNZ* items	Sum scores calculated
	Family Support	S	9m	Family Support Scale [a]	Sum score calculated
	Household heating	B	9m	*GUiNZ* items	Binary variable created
	Housing tenure	C	All DCW	Statistics NZ classifications	Longitudinal variable
	Material deprivation	S	9m, 4.5Y	Items from the Statistics NZ General Social Survey [e]	Sum scores calculated
	Material standard of living	B	9m	3 scale questions	3 binary variables created
	Maternal anxiety	S	2Y	GAD-7 [f]	Sum score calculated
	Maternal discipline	S	2Y	Conflict Tactics Scale [g]	Sum score calculated
	Maternal employment	C	All DCW	Statistics NZ classifications	Longitudinal variable
	Maternal health	C	9m, 4.5Y	Perceived General Health [c]	Longitudinal variable created
	Maternal parenting satisfaction	S	9m	What being the Parent of a New Baby is Like [h]	Sum score calculated
	Maternal parenting values	S	4.5Y	Family Values items [i]	Sum score calculated
	Maternal warmth	S	9m	Iowa Family Interaction Rating [j]	Sum score calculated
	Maternal work-life balance	S	4.5Y	Work-life balance scale [k]	Sum score calculated
	Mother-child affiliation	S	9m	Time spent with child scale [l]	Sum score calculated
	Mother & partner involvement with child	C	2Y	*GUiNZ* items	
	Parental conflict	S	9m	Resilience in Stepfamilies Study [m]	Sum score calculated
	Residential mobility	C	All DCW	Any moves (& number) since last DCW	Longitudinal variable
	Siblings	C	AN,16m 4.5Y	Any siblings at birth, from birth to 16m, from 16m to 4.5Y	Longitudinal variable created
Socio-cultural variable	Maternal cultural connectivity	S	AN	MEIM [n], Lifestyle Attitude Questionnaire [o]	Sum scores calculated
	Maternal experience of discrimination	B			Composite variable created

	Variable	Type	DCW	Original source	Adaptation for this study
Care and neighbourhood environment	ECE/care arrangements	C	2Y,4.5Y	Any and type of care arrangement	
	Maternal neighbourhood belonging	S	9m	PISA Sense of Belonging [p]	Sum score calculated
	Neighbourhood integration	S	AN	Neighbourhood Integration [q]	Sum score calculated
	Neighbourhood quality	S	2Y	Parental perception of Neighbourhood Facilities [r]	Sum score calculated
	Neighbourhood safety for children	B	AN	*GUINZ* item	Binary variable created
	Transport	B	9m	*GUINZ* item	Binary variable created
	Well Child/Tamariki Ora checks	B	All DCW	Checks at birth, 2w, 6w, 3m, 5m, 8m, 15m, 21-24m, 2-3Y, B4SC	Composite variables created for each DCW
Services and support	Household income-tested benefit receipt	B	All DCW	*GUiNZ* items	Binary variable created
	Interaction with social services	B	2Y,4.5Y	Any contact with Whanau Ora, CYFs	Binary variable created
	Maternal external support	S	9m	Family Support Scale [a]	Sum score calculated
	Maternal social networks	S	9m	Participation in Social Networks [s]	Sum score calculated
	Parenting programmes	C	9m	*GUiNZ* item	3 level variable created
	Primary care use and access	C	All DCW		Composite variable created
Child characateristics	Behaviour	S	2Y,4.5Y	Strength & Difficulties Questionnaire [t]	Sum scores calculated
	Birth conditions	B	16m	Single item	
	Birthweight	S	6w	Linked health data	None
	Body Mass Index	S	4.5Y	Anthropometry – height & weight	Weight/Height^2
	Cognitive functioning	S	4.5Y	Luria task [u], Affective Knowledge Task [v], DIBELS [w], Counting from 1-10 [x]	Sum scores used
	Developmental milestones	S	9m	*GUiNZ* items	Categorical variable created
	Ear infections	C	2Y,4.5Y	*GUiNZ* items	Composite variable created
	General health	C	All DCW	Perceived General Health [d]	Composite variable created
	Gestational age	C	6w	Linked Health Data	None
	Health/developmental problems	B	2Y,4.5Y	*GUiNZ* items	Composite variable created
	Language	S	2Y	MacArthur CDI-II short form A [y]	Sum score calculated
	Level/type of participation in activities	S	2Y	*GUiNZ* items	Count score calculated
	Perinatal health	C		*GUiNZ* items	Binary variable created
	Temperament	S	4.5Y	CBQ-VSF [z]	Sum scores calculated

Other

If unemployed: What are the reasons you are not currently in paid work? (9m, 2Y). If no care arrangement: What is the main reason your child does not have any regular child care arrangement? (9m, 2Y). If child was not able to see a GP when needed in last 12 months, reasons for this (2Y). If in contact with social support agencies, reasons for this (2Y).

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Longitudinal socioeconomic variables

Measures of NZDep at 9m, 2Y and 4.5Y were not significantly associated with being in the high injury risk group. Further analyses showed that participants experienced significant changes in NZDep between: AN and later DCW; 9m and later DCW; and 2Y and 4.5Y. Just over 50% of participants (n=3,046) remained in the low to medium NZDep group, 23% (n=1,384) stayed in the high group with 27% (n=1,651) moving between groups at different DCW. Two models explored the longitudinal impact of NZDep on injury outcome. The first assigned a count of the number of DCW that participants were in the low/med NZDep group (0 to 4). The second took movement from low/med to high NZDep (and vice versa) into account. After taking sociodemographic variables into account, there were no significant relationships between longitudinal measures of NZDep and injury.

Measures of household income at 9m, 2Y and 4.5Y were significantly associated with being in the high injury risk group. Further analyses showed that participants experienced significant changes in household income between: AN and later DCW; 9m and later DCW; and 2Y and 4.5Y. Just under 6% of participants (n=363) remained in the low household income group, 20% (n=1,213) stayed in the medium income group, 38% (n=2,308) stayed in the high group with 36% (n=2,226) moving between income groups at different DCW. Exploratory models analysed the longitudinal impact of household income on injury. After taking significant sociodemographic variables into account, there were no significant relationships between longitudinal measures of change in household income and injury outcome. As such, multivariable analyses continued to adjust for household income as measured at the antenatal DCW.

Longitudinal social and physical environment

Rurality at 9m, 2Y and 4.5Y was not significantly associated with injury outcome at univariate level. Further analyses showed that participants experienced significant changes in rurality between: AN and later DCW; 9m and later DCW; and 2Y and 4.5Y. Most movement was from urban to rural areas. Almost 90% of participants (n=5,348) remained in urban areas throughout their childhood, 5% (n=312) lived in rural areas and 7% (n=421) moved from urban to rural (or vice versa) at different DCW. An exploratory model analysed movement from urban to rural (and vice versa). There were no significant univariate relationships between longitudinal measures of rurality and being in the high injury risk group.

Housing tenure at 9m, 2Y and 4.5Y were significantly associated with injury at univariate level. Further analyses showed that participants experienced significant changes in tenure between: AN and later DCW; 9m and later DCW; and 2Y and 4.5Y. Most movement was from private rental to ownership. Over 42% of participants (n=2,474) remained in family-owned accommodation throughout their childhood, 24% (n=1,415) lived in private rentals, 4% (n=260) lived in public rentals and 29% (n=1,698) experienced a change in tenure. An exploratory model analysed tenure movement. After taking significant sociodemographic

variables into account, the strongest relationship was for **children who moved from private rental to public rental at some time between birth and 4.5Y** (OR=1.8; 95% CI: 1.2 to 2.9).

Residential mobility between 2Y and 4.5Y was significantly associated with injury at univariate level. Further analyses showed that 62% of participants (n=3,923) moved household at least once and 38% (n=2,362) did not experience residential mobility. A residential move between the ages of 2Y and 4Y was the most common. Exploratory models analysed residential mobility over time. After taking significant sociodemographic variables into account, the strongest relationship between residential mobility and being in the high injury risk group was for **children who had moved twice or more between birth and 4Y** (OR=1.3; 95% CI:1 to 1.5).

Family structure at 2Y and 4.5Y was significantly associated with injury index outcome at univariate level. Further analyses showed that participants experienced significant changes in family structure between: AN and later DCW; and 2Y and 4.5Y. Most movement was from living with two parents to living in a single parent household. Almost 90% of participants (n=5,756) remained in a two-parent family throughout their childhood, 2% (n=138) were in a one parent household, and 9% (n=565) experienced a change in family structure. Exploratory models analysed changes in family structure. After taking significant sociodemographic variables into account, the strongest relationship between family structure and being in the high-risk group was for **children who lived in a single parent family for at least one DCW** (OR=1.7; 95% CI: 1.3 to 2.2)

Maternal paid employment in childhood was not significantly associated with injury index outcome at univariate level. Further analyses showed that participants experienced significant changes in maternal employment between: AN and later DCW; 9m and later DCW; and 2Y and 4.5Y. Most movement was from unemployed to paid employment. Just over 20% of participants (n=1,275) had a mother who was not in paid employment throughout their childhood, 33% (n=2,003) had a mother who was always employed, and 46% (n=2,803) experienced a change in maternal employment. An exploratory model analysed changes in maternal employment. After taking significant sociodemographic variables into account, the strongest relationship between maternal employment and being in the high injury risk group was for **children who were 2Y when their mother went from not being in paid employment to employed** (OR=1.5; 95% CI: 1.1 to 2.0).

Number of siblings at 16m was significantly associated with injury outcome at univariate level. Further analyses showed that at birth, 59% of participants (n=3,341) had a sibling, at 16m this rose to 63% (n=3,766) and by 4.5Y, 88% (n=5,116) had at least one sibling. An exploratory model analysed these changes. After adjustment for sociodemographic variables, the strongest relationship between siblings and being in the high injury risk group was for **children who had siblings born between 16m and 4.5Y** (OR=0.7; 95% CI: 0.5 to 0.99).

Crowding in childhood was significantly associated with injury index outcome at univariate level. Further analyses showed that participants experienced significant changes in crowding between: AN and later DCW; 9m and 4Y. Most movement was from not crowded to overcrowded. Just under 72% of participants (n=4,298) never lived in a crowded home during their childhood, 11.5% (n=693) always lived in a crowded home, and 17% (n=1,015) experienced a change in crowding. An exploratory model analysed changes in overcrowding. After taking sociodemographic variables into account, the strongest relationship between crowding and being in the high injury risk group was for **children who experienced a change from overcrowding to not being overcrowded during childhood (9m to 4.5Y)** (OR=1.5; 95% CI: 1.1 to 2).

Maternal health in childhood was significantly associated with injury outcome at univariate level. Further analyses showed that participants experienced significant changes in maternal health between 9m and 4.5Y. Just under 86% of participants (n=5,169) had mothers with good to excellent health throughout their childhood, 3.5% (n=212) had mothers with fair to poor health throughout their childhood, and 11% (n=659) experienced a change in maternal health. An exploratory model analysed changes in maternal health. After taking sociodemographic variables into account, the strongest relationship between maternal health and being in the high injury risk group was for **children whose mothers were in poor to fair health for at least one DCW** (OR=1.7; 95% CI: 1.4 to 2.2).

Appendix 2: supplementary results tables

Greyed cells indicate variables (or levels of a variable) that were significantly associated with being in the high injury risk group after taking sociodemographic variables into account. Row % for the proportion of children in each injury group are provided.

Table S2: Associations between antenatal variables & injury

	Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Antenatal home physical environment	Housing tenure (N=5431)	Public renter	57	31	12	1.1 (0.8 to 1.6)
		Private renter	53	38	9	1.1 (0.9 to 1.4)
		Owner	51	41	7	
	Crowding (N=6014)	≥2 people/bedroom	59	31	10	1.1 (0.8 to 1.5)
		<2 people/bedroom	51	41	8	
	Rurality (N=6035)	Urban area	52	39.5	8.5	1.6 (1.0 to 2.4)
		Rural area	55	40	6	
Antenatal home family environment	Family structure (N=6028)	Single parent household	47	38	15	1.5 (1.0 to 2.3)
		Not a single parent household	52	39.5	8	
	Parity (N=6028)	Subsequent child	53	38	9	1.2 (1.0 to 1.5)
		First born	52	41.5	7	
	Family stress (N=5469)	Mean score	11.6	11.3	12.3	1.0 (1.0 to 1.1)
	External support (N=5469)	Mean score	24.5	24.2	23.6	1.0 (1.0 to 1.0)
	Family cohesion (N=6035)	Mean score	30.7	30.6	30.7	1.0 (0.98 to 1.0)
Antenatal maternal variables	Planned pregnancy (N=6006)	Unplanned	54	36	10	1.2 (0.99 to 1.5)
		Planned	51	42	7	
	Maternal smoking (N=6022)	Smoking during pregnancy	55	32	13	1.4 (1.1 to 1.9)
		No smoking during pregnancy	52	40	8	
	Maternal alcohol intake (N=6025)	High alcohol during pregnancy	52	37	11	1.2 (0.8 to 1.7)
		Low alcohol during pregnancy	50	42	8	0.9 (0.6 to 1.3)
		Alcohol before pregnancy	49.5	42	8	1.0 (0.8 to 1.3)
		No alcohol	55	37	8	
	Maternal stress (N=5469)	Mean score	13.2	12.8	14.1	1.0 (1.0 to 1.0)
	Maternal health (N=6028)	Fair to poor	53	38	9	0.9 (0.7 to 1.3)
		Good to excellent	52	40	8	
	Maternal employment (N=5758)	Not employed	53.5	36.5	10	1.2 (0.99 to 1.5)
		In paid employment	51	42	7	

Table S3: Associations between childhood home environment & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Residential mobility 9m to 4.5Y (N=6078)	2 or more moves	50	40	10	1.3 (1.0 to 1.5)
	None or 1 move	53	39	7	
Housing tenure 9m to 4.5Y (N=5847)	Public rental at 4.5Y	56	33	11	1.1 (0.7 to 1.7)
	Moved from private to public rental	56	27	17	1.8 (1.2 to 2.9)
	Private rental at 4.5Y	52.5	38	9	1.2 (0.9 to 1.5)
	Owner and other changes of tenure	52	41	7	
Dwelling condition (observation) 2Y[$] (N=5787)	Fair to poor dwelling condition	55	35	10	1.2 (0.98 to 1.5)
	Well-kept dwelling	50	42	7	
Dwelling condition 4.5Y (N=5709)	Average to very poor condition	49	40	10	1.2 (0.98 to 1.5)
	Good to excellent condition	51	41	8	
Damp, mould, or condensation 9m (N=5883)	Yes	52.5	35.5	12	1.4 (1.1 to 1.8)
	No	52	40.5	8	
Heating 9m (N=5880)	No	56	32	12	
	Yes	51.5	41	8	
Crowding 9m to 4.5Y (N=6108)	Always overcrowded	62	29.5	9	0.9 (0.7 to 1.3)
	Not crowded to overcrowded	53	38	10	1.2 (0.8 to 1.6)
	Overcrowded to not crowded	50	38	12	1.5 (1.1 to 2.0)
	Never overcrowded	51	41.5	6	
Material standard of living 2Y (N=5909)	Low standard of living	52	37	11	1.2 (0.9 to 1.7)
	Medium to high standard of living	51.5	40	8	
Satisfaction with Material standard of living 2Y	Not satisfied with standard of living	49	40	11	1.3 (0.9 to 1.7)
	Satisfied with standard of living	52	40	8	
Income is enough to meet needs 2Y (N=5909)	No	48	41	11	1.1 (0.8 to 1.5)
	Yes	52	40	8	
Material deprivation 9m to 4.5Y (N=5552)	Average mean score	1.9	1.8	2.7	1.1 (1.1 to 1.1)

Table S4: Associations between childhood family environment & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Maternal labour force status (N=6081)	Never in paid employment	55.5	35.5	9	1.0(0.8 to 1.3)
	Employed to unemployed/mixed	51	41	8	1.1 (0.9 to 1.4)
	Unemployed to employed at 2Y	50	38	12	1.7 (1.1 to 2.4)
	Always in paid employment	52	41	7	
Family structure (N=6112)	Single parent household ≥1DCW	47	39	14	1.7 (1.3 to2.2)
	Never in single parent household	53	39	8	
Siblings (N=6104)	Siblings at birth or born 0 to 16m	51	39	9.5	0.9 (0.7 to 1.3)
	Siblings born between 16m & 4.5Y	50	43.5	6	0.7 (0.5 to 0.99)
	No siblings from 0 to 4.5Y	50	41	9	
Family Stress 2Y (N=5910)	Mean score	14.4	14.6	15.7	1.0 (1.0 to 1.1)
Family Support 9m (N=5883)	Mean score	21.2	20.8	21.7	1.0 (0.98 to 1.0)
Maternal work-life balance 4.5Y (N=5709)	Mean score	27.9	27.8	28.4	1.0 (0.99 to 1.0)
Maternal health 9m to 4.5Y (N=6040)	Not always good to excellent	48	39	13	1.7 (1.4 to 2.2)
	Always good to excellent	53	40	7.5	
Maternal anxiety 9m	Mean score	10.2	10.5	11.0	1.0 (1.0 to 1.1)
Maternal warmth 2Y (N=5985)	Very high warmth	52.5	41.5	6	0.7 (0.5 to 0.9)
	Warmth	52	40	9	
Parenting satisfaction 9m (N=5883)	Mean scores	60.2	59.6	60.0	1.0 (0.98 to 1.0)
Mother-child 9m affiliation (N=5883)	Mean scores	14.0	14.1	14.1	1.0 (0.97 to 1.0)
Mother-child 9m involvement (N=5882)	Mean scores	21.6	21.8	21.6	0.99 (0.96 to 1.0)
Discipline 2Y (N=5987)	Mean scores	18.5	18.7	19.3	1.0 (1.0 to 1.1)
Maternal parenting values 4.5Y (N=5708)	Mean scores	20.2	20.0	20.3	1.0 (0.97 to 1.0)
Parental conflict 9m (N=5386)	Mean scores	9.7	9.6	10.5	1.0 (1.0 to 1.1)
Mother involved in day to day care 2Y (N=5322)	Not most of the time	57	37	6	0.8 (0.5 to 1.2)
	Most of the time	51	41	8	
Partner involved in day to day care 2Y (N=5322)	Not most of the time	53	41	6	0.8 (0.5 to 1.1.1
	Most of the time	52	40	8	

Table S5: Associations between childhood care arrangements & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Care arrangement at 9m (N=5883)	Yes (35%)	53	40	7	0.8 (0.7 to 1.0)
	No (65%)	51.5	39.5	9	
Hours per week at 9m	Mean hours	23.1	21.3	23.3	1.0 (0.99 to 1.0)
Care arrangement type at 9m (N=5850)	Centre-based	51	42	8	0.9 (0.7 to 1.3)
	Relative or other individual	58	35	7	0.9 (0.6 to 1.2)
	Home-based	47	44	9	1.2 (0.7 to 2.1)
	No care arrangement	51	40	9	
Care arrangement at 2Y (N=5904)	Yes (55.5%)	49	42	9	1.2 (1.0 to 1.5)
	No (44.5%)	54	38	8	
Hours per week at 2Y	Mean hours	24.3	23.6	23.2	1.0 (0.99 to 1.0)
Care arrangement type at 2Y (N=5905)	Centre-based	48	43	8	1.1 (0.9 to 1.4)
	Relative or other individual	54	37	9	1.4 (1.0 to 1.9)
	Home-based	50.5	42	8	1.1 (0.7 to 1.7)
	No care arrangement	54	38	8	
Care arrangement at 4.5Y (N=5708)	Yes (97%)	57	33	10	0.9 (0.5 to 1.5)
	No (3%)	51	41	9	
Care arrangement type at 4.5Y (N=5708)	Centre-based or other	51	41	8.5	
	Relative or other individual	49	42	9	1.1 (0.7 to 1.9)
	ECE	51	41	9	1.0 (0.9 to 1.3)
	No care arrangement	58	33	10	0.9 (0.5 to 1.5)

Table S6: Associations between childhood neighbourhood variables & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Neighbourhood integration AN (N=5469)	Mean score	28.1	28.2	28.5	1.0 (0.99 to 1.0)
Neighbourhood safety for children AN (N=5469)	Not safe	50.5	40	10	1.2 (1.0 to 1.5)
	Safe	53	39	8	
Regular use of Public Transport 9m (N=5883)	Yes	51	36	13	1.8 (1.3 to 2.5)
	No	52	40	8	
Mainly use private car 2Y (N=5990)	No	55	37	8	0.9 (0.7 to 1.2)
	Yes	52	40	8	
Neighbourhood belonging 9m (N=5882)	Mean score	18.7	18.6	18.7	1.0 (0.98 to 1.1)
Neighbourhood quality 2Y (N=5909)	Mean score	27.3	27.2	27.0	1.0 (0.98 to 1.0)

Table S7: Associations between WCTOC & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
WCTOC 9m DCW (N=5961)	Not all checks completed (9%)	53	38	9	1.0 (0.8 to 1.4)
	All infant checks completed	52	40	8	
WCTOC 15m (N=5987)	Not completed (10%)	55	33	12	1.4 (1.1 to 1.9)
	Completed	51.5	41	8	
WCTOC 2Y DCW (N=5987)	Not all checks completed (71%)	52	40	8	0.9 (0.7 to 1.0)
	All checks completed	51	40	9	
WCTOC 2-3Y (N=5780)	Not completed (12.5%)	51	41.5	8	0.9 (0.6 to 1.2)
	Completed	51	40	9	
Before School Check (B4SC) (N=5780)	Not completed or scheduled (23%)	51	40	9	1.0 (0.8 to 1.3)
	Completed or scheduled	51	40.5	8	

Table S8: Associations between access to primary care services & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Primary care locality 9m (N=5883)	Not local	54	40	7	0.7 (0.6 to 0.9)
	Local to home or half local/half not	51.5	40	9	
Use of primary care 9m to 2Y (N=6045)	Child doesn't go to same practice	51	36.5	13	1.5 (1.0 to 2.2)
	Child goes to same GP or practice	52	40	8	
GP visits 2Y to 4.5Y (N=6101)	High number of visits	46	42	11	1.8 (1.5 to 2.2)
	Low number of visits	56	38	6	
Access to primary care 2Y to 4.5Y (N=6114)	Child needed to see GP but didn't	50	39	11	1.3 (1.0 to 1.8)
	No issues with access to GP	53	39.5	8	

Table S9: Associations between access to services and support & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Income-tested benefit receipt 2Y (N=5909)	Yes	50	37	13	1.7 (1.4 to 2.2)
	No	52	41	7	
Interaction with social services 2Y or 4.5Y (N=6070)	Yes	47	37	15	1.9 (1.5 to 2.5)
	No	53	40	8	
External support 9m (N=5883)	Mean scores	18.8	18.9	19.0	1.0 (0.99 to 1.0)
Parenting programmes 9m (N=5883)	Attended & found helpful	49	40	11	1.4 (1.1 to 1.8)
	Attended, not helpful	53	41	6	0.8 (0.5 to 1.1)
	Did not attend or not available	52.5	39.5	8	
Social networks 9m (N=5883)	Mean scores	2.3	2.5	2.5	1.1 (0.99 to 1.1)

Table S10: Associations between birth variables & injury index

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Perinatal health (N=6020)	At least one health problem	50	40	9.5	1.2 (0.9 to 1.6)
	No health problems at birth	52.5	39	8	
Any birth condition (N=5981)	Yes	40	45	15	1.9 (1.2 to 3.1)
	No	52	40	8	
Gestational age (N=6103)	Post-term	55	36	9	1.1 (0.6 to 1.9)
	Pre-term	55	39	6	0.7 (0.5 to 1.1)
	Term	52	40	8	
Birthweight (N=6109)	Mean grams	3451	3519	3546	1.0 (0.99 to 1.0)

Birthweight and gestational age are strongly associated. Therefore, a proxy index of weight for gestational age (W/GA) was created (exact gestational age was not available). Participants within 1 SD of the mean birthweight for term, post-term and pre-term children were classed as average W/GA, those below and above 1 SD from the mean were classed as low or high W/GA, see. There were no significant associations between W/GA and injury (Table S12), after taking sociodemographics into account.

Table S11: Weight for gestational age proxy index

	Gestational age			N (%)
	Pre-term (mean=2416.24g, SD=713.52)	**Term** (mean=3553.44g, SD=496.55)	**Post-term** (mean=3835.11g, SD=497.42)	
Low W/GA	<1702.72g 62 (16%)	<3056.89g 828 (15%)	<3337.69g 26 (17%)	916 (15%)
Average W/GA	1702.72g to 3129.76g 275 (69%)	3056.89g to 4049.99g 3867 (70%)	3337.69g to 4332.53g 102 (67.5%)	4244 (70%)
High W/GA	>3129.76g 61 (15%)	>4049.99g 857 (15%)	>4332.53g 23 (15%)	941 (15%)

Table S12: Associations between W/GA and injury index

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
W/GA (N=6101)	Low	56	37	7	1.0 (0.7 to 1.3)
	High	46	44.5	10	1.1 (0.8 to 1.4)
	Average	53	39	8	

Table S13: Associations between early health/development variables & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Developmental milestones 9m (N=5959)	Did not meet milestones	57	34.5	8	0.9 (0.6 to 1.4)
	Met age appropriate milestones	52	40	8	0.8 (0.6 to 1.1)
	Met all milestones	50	40	10	
General health 9m & 2Y (N=5985)	Fair to poor at either 9m or 2Y	44	45	11	1.4 (1.0 to 1.95)
	Excellent to good	53	39	8	
Health/developmental problem 2Y (N=5983)	Yes	45	45	10	1.3 (0.9 to 1.8)
	No	52.5	39	8	
Ear infections 9m to 45Y (N=6114)	≥2	46	44	10	1.3 (1.1 to 1.6)
	None or 1	55	38	7.5	
Language 2Y(N=5985)	Mean CDI scores	43.1	46.6	44.9	-0.00005 to 0.002
SDQ total 2Y	Mean scores	11.5	11.1	12.5	1.0 (1.0 to 1.0)

Table S14: Associations between later health/development variables (4.5Y) & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Body Mass Index (N=5726)[a]	Kg/m^2	16.7	16.7	17.1	1.0 (0.99 to 1.1)
General health (N=5780)	Fair to poor	46	40	14	1.8 (1.1 to 2.9)
	Excellent to good	51	40.5	8	
Cognitive functioning measures: mean scores	Luria (N=5391)	11.2	11.2	10.9	1.0 (0.98 to 1.0)
	Affective knowledge (N=5547)	7.8	8	7.95	1.0 (0.98 to 1.1)
	DIBELS (N=5421)	8.6	8.5	6.4	1.0 (0.98 to 1.0)
	Counting (N=5572)	8.6	8.7	8.4	1.0 (0.96 to 1.0)
Hearing problems (N=5780)	No	52	40	8	1.2 (0.9 to 1.5)
	Yes	47	42	11	
Vision problems(N=5780)	No	51	40	8	1.0 (0.7 to 1.3)
	Yes	49	43	8	
Speech problems (N=5780)	No	52	40	8	1.3 (1.0 to 1.7)
	Yes	46	43	11	
Behaviour problems (N=5780)	No	52	40	8	1.8 (1.3 to 2.4)
	Yes	41	44	15	
Learning difficulties (N=5780)	No	51	40.5	8	1.2 (0.8 to 1.9)
	Yes	49	40	11	
Movement or mobility concerns (N=6144)	No	51	40.5	8	1.6 (0.9 to 2.8)
	Yes	48	39	13	
Growth/physical development problem (N=6144)	No	51	41	8	2.3 (1.5 to 3.5)
	Yes	47	37	17	
SDQ emotion scale (N=5781)	Mean scores	2.0	1.9	2.3	1.1 (1.0 to 1.1)
SDQ conduct scale	Mean scores	3.3	3.3	3.5	1.1 (0.99 to 1.1)
SDQ hyperactivity/attention scale	Mean scores	4.5	4.5	4.9	1.1 (1.0 to 1.2)
SDQ peer problems scale	Mean scores	4.8	4.7	5.0	1.1 (1.0 to 1.2)
SDQ total difficulties	Mean scores	14.7	14.4	15.6	1.0 (1.0 to 1.1)

Table S15: Associations between child activity variables & injury index

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Sleep 2Y (N=5977)	Mean hours of sleep at night	10.5	10.6	10.5	1.0 (0.9 to 1.1)
	Mean hours of sleep during the day	1.8	1.7	1.8	1.0 (0.9 to 1.1)
Child participation in activities	Mean number at 2Y (N=5983)	12.2	13.0	13.2	1.0 (1.0 to 1.1)
	Mean score at 4.5Y (N=5779)	15.7	15.8	16.1	1.1 (1.0 to 1.1)
Media & device use 2Y (N=5987)	No regular weekday use (6%)	53	38	9	1.1 (0.7 to 1.6)
	Regular weekday use (94%)	52	40	8	
	Mean hours of use (N=5641)	2.3	2.2	2.7	1.1 (1.0 to 1.1)

Table S16: Associations between child temperament & injury (N=5780)

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
CBQ-VSF Negative Affect	Mean scores	39.5	39.0	40.6	1.0 (1.0 to 1.0)
CBQ-VSF Surgency	Mean scores	50.0	51.1	52.4	1.0 (1.0 to 1.0)

Table S17: Associations between socio-cultural variables & injury index

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Connectivity to other cultures 9m (N=5883)	Mean scores	12.4	12.5	12.9	1.1 (1.0 to 1.1)
Own cultural connectivity 4.5Y (N=5709)	Mean scores	40.6	40	41.5	1.0 (1.0 to 1.0)
Connectivity to 'NZ culture' 4.5Y (N=5709)	Mean scores	17.5	17.5	17.6	1.0 (0.97 to 1.0)
Treated differently by health professional because of ethnicity (Antenatal; N=6035)	Yes	46.5	41	12	1.4 (1.0 to 2.0)
	No	53	39	8	
Any experience of being treated differently or unfairly (Antenatal; N=6035)	Yes	52	39	9	1.1 (0.9 to 1.4)
	No	52	40	8	
Discrimination due to ethnicity 2Y (N=5909)	Yes	49	41	11	1.4 (1.1 to 1.9)
	No	52	40	8	
Discrimination due to socio-economic status 2Y (N=5909)	Yes	44	42	14	1.6 (1.1 to 2.3)
	No	52	40	8	

Table S18: Associations between safety information sources & injury (N=5909)

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Main source of safety information 2Y	Family (29%)	54	37	9	1.2 (0.8 to 1.7)
	Friends (6%)	47	44.5	8.5	1.2 (0.7 to 2.1)
	GP/primary care nurse (6%)	60	30	10	1.3 (0.8 to 2.1)
	Well Child Book (19%)	52	40	9	1.2 (0.8 to 1.8)
	The Internet (7%)	53	42	4.5	0.7 (0.4 to 1.2)
	Books, magazines, newspapers, TV (10%)	47	44.5	8	1.2 (0.8 to 1.9)
	Plunket Nurse (13%)	49	43	8	1.1 (0.7 to 1.7)
	General knowledge/experience (9%)	51	41.5	7	

Table S19: Associations between safety features & injury

Variable	Level	No injury	Low	High	OR & CI (95%) for high injury risk
Medicines/poisons out of reach 2Y (N=5909)	Not always (28%)	50.5	41	9	1.0 (0.8 to 1.3)
	Always (72%)	52	40	8	
Matches/lighters out of reach 2Y	Not always (13%)	50	42	8	0.9 (0.7 to 1.1)
	Always or N/A (87%)	52	40	8	
Working smoke alarms at home 2Y	No (21%)	56	36	9	1.0 (0.8 to 1.3)
	Yes (79%)	50.5	41	8	
Locked doors/secure gates for stairs 2Y	Not always (31%)	50.5	40	9.5	1.2 (0.99 to 1.5)
	Always or N/A (69%)	52	40	8	
Use of car seat 2Y	Not always (1%)	51	37	12	1.2 (0.6 to 2.4)
	Always (99%)	52	40	8	
Hot water adjusted to recommendation 2Y	No (23.5%)	52	38	10	1.3 (1.0 to 1.6)
	Yes or don't know (76.5%)	51.5	41	8	
Electrical outlets covered 2Y	Not always (78%)	52	39	8	0.9 (0.7 to 1.1)
	Always or N/A (22%)	49	42	8	
Home outside areas fully fenced 2Y	No (23%)	53	38	9	1.0 (0.8 to 1.3)
	Yes (77%)	51	41	8	
Driveway fully fenced off from play areas 2Y	No (39%)	54	37	9	1.0 (0.9 to 1.3)
	Yes (61%)	50	42	8	
Use of booster seat 4.5Y (N=5780)	Not always (4%)	55	28	17	1.9 (1.3 to 2.7)
	Always (96%)	51	41	8	

Table S20: Associations between injury and binary variables

Variables	Missing data % of 6114	Missing % after step 1*	High risk group	Hospital-isation	Injury at 2Y	Injury at 4.5Y	High NZ Dep	Low-med NZDep	Children of Asian mothers	Children of Māori mothers	Children of Pacific mothers	Children of European mothers	Girls	Boys
Child sex	0	0			✓	✓	✓		✓		✓	✓	-	-
Mother ethnicity	1.6	1.6	✓		✓	✓	✓		-	-	-	-		✓
Total SDQ 4.5Y	7.4	0	✓	✓				✓			✓	✓	✓	
Participation in activities 2-4.5Y	7.1	0	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
Temperament: Surgency	5.8	0	✓	✓										
Household income average	22	-			✓						✓			
Material deprivation 9m-4.5Y	9.2	0		✓					✓					✓
Income tested benefits average	3.4	3.4		✓	✓			✓						
Use of public transport 9m	3.8	3.8	✓										✓	
Neighbourhood safety for children	10.5	0			✓									
Smoking during pregnancy	1.5	1.5												
Maternal stress at antenatal DCW	10.5	0				✓						✓		
Maternal anxiety at 9m	3.8	3.8				✓								
Maternal health 9m to 54m	1.2	1.2	✓			✓	✓	✓		✓		✓	✓	
Maternal warmth 2Y	2.1	2.1												
Maternal discipline 2Y	2.1	2.1				✓								
Single parent household ever	<1%	<1%				✓								
Subsequent child (parity)	1.4	1.4												
Family stress average	3.3	3.3			✓		✓							
Siblings	1.7	1.7							✓					
Parental conflict average	11.9	0												✓
Combined care/employment 2Y	0.5	0.5	✓									✓		
External support AN	3.8	3.8	✓					✓				✓		✓
WCTOC 15m	2.1	2.1	✓	✓			✓				✓			
Primary care risk factors	0	0	✓		✓		✓	✓			✓	✓	✓	✓
Social services 2Y to 4.5Y	0.7	0.7	✓									✓		✓
Use of parenting programmes 9m	3.8	3.8	✓	✓			✓	✓			✓	✓	✓	

* See Missing data, Method, page 17 and Multivariable analyses, Results, page 27

Refining the final multivariable models

The final model included 5,192 participants. Further exploration was carried out to determine the following impacts on the study results and sample size:

- using measures from specific DCW or averages (e.g. family stress at AN, 9m, 2Y);
- further replacing missing values
- transforming continuous variables (e.g. stress) into dichotomous variables;

Using measures taken at different DCW

Table S21 shows the impact of using measures taken at different DCW or average measures on the results. For consistency, household income, income tested benefits, family stress and parental conflict variables were replaced by average score variables. The binary regression model was rerun with these variables.

Maternal ethnicity, child sex, low external support, fair to poor maternal health, employment/care arrangement variable, use of public transport, WCTOC at 15m, primary care risk factors, interactions with social support services, use of parenting programmes at 9m, SDQ total score, and **child participation in activities** were associated with being in the high injury risk group.

Table S21: Alternative measures from different DCW

Variable in final model	Alternative measures	Impact
Household income at antenatal DCW	9m, 2Y, average	Average: material deprivation now significant, no need for missing category
Income-tested benefits 2Y	Antenatal, 9m, 4.5Y, average, any 0 to 4.5Y	No impact, except reduced sample size for some DCW
Single parent family ever	Antenatal, 2Y, 4Y	No impact or reduced sample size
Family Stress 2Y Parental conflict 9m	Antenatal, 9m, average Antenatal, average	No impact No impact

Replacing all missing values

For continuous variables, SPSS was used to replace missing values with the series mean for the entire study sample. This increased the sample size included in the final regression model to 5,556 participants. Next, all categorical missing values were replaced with the reference category value. This increased the sample size included in the final regression model to 6,114 participants.

Maternal ethnicity, child sex, low external support, fair to poor maternal health, employment/care arrangement variable, use of public transport, WCTOC at 15m, primary care risk factors, interactions with social support services, use of parenting programmes at 9m, SDQ total, and **child activity participation score** were associated with being in the high injury risk group.

Using dichotomised variables

The following variables were included in the final model as continuous/scale variables: average household income; average income-tested benefit receipt; parental conflict at 9m, average family stress, external support; maternal stress; maternal anxiety; material deprivation; maternal discipline; SDQ total; child participation in activities; and Surgency. Each of these were transformed into binary variables (see Methods) and the model was rerun. The results are shown in Figure 5 (page 38).

Factor analysis method

A factor analysis of the independent variables used an examination of the scree plot for an initial varimax rotation using principal components extraction to determine that there were five factors with eigenvalues >1.2.

Well Child Tamariki Ora checks (WTCOC)

Safety issues discussed with caregivers at the 15m WCTOC are: (a) car restraint, (b) falls safety, (c) driveway safety, (d) household safety, (e) safety around dogs, (f) water safety, and (g) safe play areas. Issues (a) and (b) are included at every WCTOC; issues (c), (d) and (e) from 5m onwards; and (f) and (g) from 15m onwards. None of these issues are specific to just the 15m check. Other assessments/topics introduced at the 15m WCTOC include weight measurement, social and play needs, behaviour and needs, early learning in the home, and health education on nutrition and activity. Pneumococcal, Haemophilus influenzae b and MMR immunisations are administered.

The WCTO *My Health Book* only mentions promoting a safer neighbourhood (playgrounds, drains, etc.) in relation to the 15m check. In the *Learning and Growing* section, the following are first mentioned in *Your child between 1 and 2 years*: Use a child car seat in all cars, for all trips; Offer safe places to crawl, walk, run, jump and climb; Have fenced areas for outside play so that children can't get on the driveway, the road or in water; Vertical bars on fences make it hard for children to climb over to dangers.