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# Impact of chronic health conditions and injury on school performance and health outcomes in New South Wales, Australia: a record linkage study protocol

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## Abstract

**Introduction**: Children who have sustained a serious injury or who have a chronic health condition, such as diabetes or epilepsy, may have their school performance adversely impacted by the condition, treatment of the condition and/or time away from school. Examining the potential adverse impact requires the identification of children most likely to be affected and the use of objective measures of education performance. This may highlight educational disparities that could be addressed with learning support. This study aims to examine education performance, school completion and health outcomes of children in New South Wales, Australia who were hospitalised with an injury or a chronic health condition compared to children who have not been hospitalised for these conditions.

**Method and analysis**: This research will be a retrospective population-level case-comparison study of hospitalised injured or chronically ill children (i.e. diabetes, epilepsy, asthma, or mental health conditions) aged ≤18 years in New South Wales (NSW) Australia using linked health and education administrative data collections. It will examine the education performance, school completion and health outcomes of children who have been hospitalised in NSW with an injury or a chronic health condition compared to children randomly drawn from the NSW population (matched on gender, age and residential postcode) who have not been hospitalised for these conditions.

**Ethics and dissemination**: The study received ethics approval from the NSW Population Health Services Research Ethics Committee (2018HRE0904). Findings from the research will be published in peer-reviewed journals and presented at scientific conferences.

**What is known on this subject**

- Poor health can have a negative impact on a child's ability to learn.
- Determining the impact of poor health on learning requires objective measures of education performance.
- There is limited information available regarding a child's ongoing healthcare use while they attend school.

**What this study adds**

- A population-level study to examine the impact of injury or chronic disease on children's scholastic performance.
- This study will identify the types of injuries and chronic illness associated with problems with learning at school.
- The developmental timing and need for educational support will be highlighted for chronically ill children accounting for age, gender and illness type.

## Introduction

Participation in school-based education is important for a child's mental, social and physical development. Any restrictions on the ability of a child to perform to the best of their ability at school may adversely affect their career prospects and long-term quality of life. Traumatic injury or the presence of a chronic health condition, such as diabetes, epilepsy, asthma, or mental health conditions can have an adverse impact on the child's performance at school [1-8]. Interruptions to education can have a cumulative effect, resulting in being less likely to complete school or attend university and potentially limiting future employment opportunities [9]. Therefore, early identification and recognition of a child's need for learning support at school is critical.

Traumatic injury is the leading cause of hospitalisation among children in Australia, with almost 70,000 children aged ≤16 years hospitalised each year [10]. Different types of injuries (e.g. burns, traumatic brain injury, orthopaedic injury) and the mechanism of injury (e.g. vehicle crash, pedal cycle collision, falls, self-harm) can affect children in different ways. The more serious the injury, often the more adverse impact on the child's psychological and physical health, and on the child's family [11]. Chronic health conditions can also have an adverse impact on a child and their ability to perform well at school and to complete their schooling [9 12]. Previous research has not always considered objective measures of school performance, instead relying on subjective reports from parents or teachers [12 13]. This research has lacked information regarding a child's ongoing healthcare use [12], lacked an indication of the severity of the child's injury or illness [9], often involved small sample sizes [14], and has not been able to examine the impact on school performance over a range of ages or over time for the same child [14]. This study aims to examine education performance, school completion and health outcomes of children who have been hospitalised with an injury or a chronic health condition compared to children who have not been hospitalised for these conditions.

### *Study objective and aims*

The overall objective is to examine education performance, school completion and health outcomes of children who have been hospitalised with an injury or a chronic health

condition (i.e. diabetes, epilepsy, asthma, or a mental health condition). The specific aims are to:

(1) compare school performance among injured or chronically ill children and a matched comparison group;
(2) examine factors influencing school performance of injured or chronically ill children compared to a matched comparison group, such as sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical factors;
(3) determine factors that either positively or negatively mediate young people completing high school (year 10, 11 or 12); and
(4) assess characteristics of long-term health service utilization and hospital treatment cost among injury or chronically ill children compared to a matched comparison group.

## Method and analysis

### *Study design*

This will be a retrospective population-level case-comparison study of injured or chronically ill children (i.e. diabetes, epilepsy, asthma, or mental health conditions). These five conditions were selected as injuries are the leading cause of hospitalisation in Australia for children aged 1-18 years [15] and the 4 chronic health conditions represent the most common health conditions experienced by children in Australia [16] that have previously been associated with having a detrimental impact on learning [1-8]. This will be a retrospective epidemiological study of children aged ≤18 years at the date of admission for their index hospitalisation in New South Wales (NSW), Australia. It will include matched population-level comparison groups for each health condition.

### *Data sources*

Nine administrative data collections in NSW will be linked and analysed for this study: hospital admissions, emergency department (ED) presentations, ambulatory mental health client contacts, the Registry of Births, Deaths and Marriages (RBDM) and the Cause of Death Unit Record File (COD-URF) mortality data collections, the National Assessment Plan for Literacy and Numeracy (NAPLAN), school enrolments, high school completions (year 10, 11 or 12), and RBDM birth data.

***Information on hospital service use***: will be obtained from ED presentation and hospital admission data collections. Hospitalisation data includes information on admissions to public and private hospitals and records of patient demographics, source of referral, diagnoses, separation type, acute/non-acute care, Australian Refined Diagnosis Related Groups (AR-DRGs), and clinical procedures. Data collected on ED presentations in public hospitals also include arrival and departure times, triage category, type of visit, provisional diagnosis, and clinical procedures.

***Ambulatory mental health client contacts***: includes information regarding the care individuals received from ambulatory specialist mental health services at public hospitals. This includes mental health day programs, psychiatric outpatients and outreach services, including home visits. It contains information on care provided by hospital-based consultation liaison services to admitted patients in non-psychiatric and hospital emergency settings, care provided by community workers to admitted patients and clients in staffed community residential settings, and mental health promotion and prevention services.

***Scholastic performance***: the NAPLAN assessments are conducted on all Australian children in primary school years 3 (7-9 years of age) and 5 (9-11 years of age), and secondary school years 7 (11-13 years of age) and 9 (13-15 years of age), and includes assessments in five domains: reading, spelling, writing, grammar, punctuation and numeracy. Each domain is scored out of 1000 and translated into bands that indicate whether the child performed above or below the national minimum standard (NMS). Inability to achieve the NMS indicates that a child will have difficulty making progress in school without assistance [17]. A child's attendance or absence from NAPLAN assessments will also be obtained.

***Parent demographics***: parents' occupation and highest level of education will be obtained.

***School enrolments and school completion***: information on school enrolment and school changes will be obtained; high school retention to years 10, 11 and 12 will be obtained through records of high school completion awards known as the Record of School Achievement, and the Higher School Certificate.

***Survival:*** Mortality data from the RBDM mortality data will provide information on fact of death and information from the COD-URF will provide information on the cause of death.

***Births:*** RBDM birth data will provide a NSW population-level sample to identify the comparison cohorts for the injured or chronically ill children.

***Case inclusion criteria***

A principal diagnosis of injury (International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM): S00-T79) in hospitalisation data during an 18 year timeframe (i.e. 1 January 2001 to 31 December 2018) and aged ≤18 years at the date of admission. A principal or any diagnosis (up to 50 diagnoses) of diabetes (ICD-10-AM: E09-E14), epilepsy (ICD-10-AM: G40, G41), asthma (ICD-10-AM: J45), or a mental health condition (ICD-10-AM: F10-F99). Different types of mental health conditions have not been individually selected as children with one mental health condition can experience multiple conditions e.g. mood effective disorders (ICD-10-AM: F30-F39) and neurotic disorders (ICD-10-AM: F40-F49), which would result in duplicate case identification [18]. Mental health condition data will be analysed on receipt of this information and condition groups detailed. Some children may have multiple health conditions recorded and these cases will be reviewed on receipt of the hospitalisation data and will likely be treated as a 'multiple health condition' group.

***Population-comparison group criteria***

The population comparison group will consist of children aged ≤18 years who were born in NSW, who had not previously had a hospital admission with a principal diagnosis of injury or a principal or any diagnosis of diabetes, epilepsy, asthma, or a mental health condition, and who were alive at the date of admission of their matched case. The comparison group will be randomly matched in a 1:4 ratio on age, gender and residential postcode to their matched case.

***Sample size calculation***

There will be an estimated 22,300 injury[10] and 16,647 chronic disease[19-21] hospitalisations of children aged ≤18 years each year. To detect a relative risk of 1.5, with 5% significance and

80% power, a minimum sample size of 200 cases will be required with 800 in each comparison group. It is possible that there will be a number of children absent from school for NAPLAN assessments, but this large cohort the study will retain sufficient power for analysis.

***Record linkage***

The data linkage component of the study will be conducted by a third party agency, the Centre for Health Record Linkage (CHeReL). To link the data extracts, the CHeReL retains only the identifying information (e.g. first name, last name, date of birth) from each data extract. Linkage is conducted using probabilistic record linkage which is based on computing the probability that two records belong to the same person. The linkage process creates a project specific linkage key. The project specific key is returned to the CHeReL Data Integration Unit (or the data custodian) along with their original source record identifier. The CHeReL Data Integration Unit (or the data custodian) extracts the approved content variables (excluding identifying information such as names), attaches the project specific linkage key and securely transfers the data extract to the study investigators. The study investigators will then re-link the data extracts using the project specific linkage key and date-based and other content variables.

***Classification frameworks***

***Geographical identification:*** The Australian Statistical Geographical Standard (ASGS) will be used to identify children living in rural and urban NSW. Residents are assigned to one of five geographical categories using index scores of distance to service centres [22]. For ease of analysis and reporting, the five categories will be collapsed into: urban (i.e. major cities) and rural (i.e. inner and outer regional, remote, and very remote) [23].

***Socioeconomic status identification:*** A measure of socioeconomic status will be assigned to each case or comparison using their postcode of residence and the Index of Relative Socioeconomic Disadvantage [24]. Socioeconomic disadvantage will be partitioned into quintiles from most (i.e. 1) to least disadvantaged (i.e. 5).

***Injury or condition severity:*** For injured children, injury severity will be estimated using the International Classification of Injury Severity Score [25]. The injury severity score is derived for each injured child by multiplying the probability of survival for each injury diagnosis using survival risk ratios (SRR). Injury severity will be estimated using previously developed SRRs [26] and will be categorised as minor (≥0.99), moderate (>0.941-<0.99) or serious (≤0.941) [27]. Proxy indicators of severity of the chronic health conditions will be considered, including number of ED presentations or hospital admissions, and hospital length of stay [28].

**Outcomes**

The primary outcome measures will be school performance on each of the five NAPLAN domains (i.e. reading, spelling, writing, grammar and punctuation, and numeracy) above or below the NMS, and school completion at year 10, 11 or 12. Secondary outcomes will include hospital length of stay, hospital treatment costs, number of hospital admissions, number of ED presentations, number of mental health client contacts, where relevant (Table 1).

**Data analysis plan**

All hospital episodes of care related to the one event will be linked to form a period of health care. Child injury and each chronic illness will be examined separately. To compare school performance for injured or chronically ill children to their comparison groups, generalized linear regression will assess the difference in proportions of performances below the NMS for each of five NAPLAN domains for the school grades 3, 5, 7 and 9. To identify factors influencing school performance of injured or chronically ill children, factors related to performance below NMS such as sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical (e.g. number of ED presentations, hospital admissions, hospital length of stay) factors (Table 2) will be examined using multivariate logistic regression. Relative risks, odds ratios and 95% confidence intervals (CIs) will be calculated. It is likely that sensitivity analyses for potential missing values will need to be conducted for some data variables. In addition, group-based trajectory modelling [29] will be undertaken to identify clusters of children with similar school performance outcomes over time. Information such as sociodemographic (i.e. age, gender, socioeconomic status),

clinical and parental education will be used to estimate a child's probability of group membership over time.

To identify factors influencing high school completion at either year 10, 11 or 12 for injured or chronically ill children compared to the comparison group, factors related to poor school completions, including sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical (e.g. ED presentations, hospital admissions) factors will be examined using multivariate logistic regression. Relative risks, odds ratios and 95% CIs will be calculated.

The characteristics of long-term health service utilisation and hospital treatment cost among injured or chronically ill children compared to their comparison group will be assessed using a generalised linear model with a log link and gamma error distribution to assess hospital length of stay, hospital treatment costs, and the number of hospital admissions during the study period. These will be adjusted for sociodemographic and other characteristics, such as injury severity, as relevant.

**Ethics and dissemination plan**

Ethical approval was obtained from the NSW Population Health Services Research Ethics Committee (HREA: 018HRE0904). Dissemination of research results will be conducted through peer-review journal articles and presentations at relevant professional conferences. Research findings will also be provided to government agencies, including health and education authorities.

**Patient and public involvement**

There was no patient involvement in the design of the record linkage study.

**Limitations**

There will be some study limitations to take into consideration in the interpretation of findings. Only health conditions that are relevant to a hospital admission are indicated in hospital diagnosis records, so it is possible that some conditions could be under-enumerated. The study would identify cases where the child had been hospitalised for the

injury or chronic health condition, so would not identify children presenting solely to other medical professionals, such as general practitioners, for treatment. However, children who are hospitalised for their injury or health condition are likely to be the most seriously affected. There will not be an opportunity to examining the validity of diagnoses (except between administrative health records) and it is possible that there could be some misclassification. The NSW ED presentation data does not contain information on ED presentations to private hospitals, so private hospital ED presentations will not be examined. However, almost all (93%) of ED services are provided by public hospitals in Australia [30]. In identifying the matched comparison cohorts, the recency of postcode of usual residence may vary between data collections. For example, postcode of residence at birth could vary from postcode of residence while at school.

**Discussion**

This research will examine the impact on school performance and high school completion of children who are hospitalised for an injury or a chronic health condition – namely diabetes, epilepsy, asthma or mental health conditions – compared to children who have not been seriously affected and hospitalised for these health conditions. It will identify the characteristics of children who are most likely to be adversely affected by their health conditions. This may include children who have multiple hospital admissions, extended time in hospital, more serious injuries, multiple health conditions, specific types of injuries or children whose primary language is not English or who reside in disadvantaged socioeconomic areas. The study is also likely to include children whose injuries and illnesses are the direct cause of cognitive difficulties resulting in poor educational performance. It is anticipated that research findings will identify any educational outcome disparities with a comparison population and the characteristics of injured and chronically ill children most likely to have problems with learning at school and will highlight where educational support services are most needed.

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**Competing interests**: None declared.

**Patient consent for publication**: Not required.

**Ethics approval**: NSW Population Health Services Research Ethics Committee (HREA: 018HRE0904).

**Provenance and peer-review**: Not commissioned; an external peer-reviewed was conducted as part of the ethics application to the NSW Population Health Services Research Ethics Committee.

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**Table 1: School performance, school completion and health service use outcome measures**

| Outcome | Data source | Outcome measure |
|---|---|---|
| **School performance and completion** | | |
| NAPLAN – reading | NAPLAN | Number of children above/below NMS |
| NAPLAN – spelling | NAPLAN | Number of children above/below NMS |
| NAPLAN - writing | NAPLAN | Number of children above/below NMS |
| NAPLAN – grammar and punctuation | NAPLAN | Number of children above/below NMS |
| NAPLAN - numeracy | NAPLAN | Number of children above/below NMS |
| School completion – year 10 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 10 |
| School completion – year 11 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 11 |
| School completion – year 12 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 12 |
| **Health service use** | | |
| ED presentations | ED presentation data | Number of ED presentations |
| Hospital admissions | Hospital admissions data | Number of hospitalisations |
| Hospital length of stay | Hospital admissions data | Total hospital length of stay |
| Hospital treatment cost | Hospital admissions data | Total hospital treatment cost |
| Mental health client contacts | Ambulatory mental health client data | Number of mental health client contacts |

NAPLAN: National Assessment Plan for Literacy and Numeracy. NMS: National minimum standard. ED: Emergency Department.

**Table 2: Potential mediating and explanatory data variables**

| Type | Data variable |
|---|---|
| **School performance and completion** | |
| **Child** | Age |
| | Sex |
| | Socioeconomic status |
| | Geographic location |
| ***Children with an injury*** | Injury severity |
| ***Children with a chronic health condition*** | Proxy indicators of severity will be considered, including number of ED presentations or hospital admissions, or total hospital length of stay |
| **Parent** | Highest level of education |
| | Occupation |
| **Clinical** | Number of ED presentations |
| | Number of hospitalisations |
| | Total hospital length of stay |

ED: Emergency Department.

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- Determining the impact of poor health on learning requires objective measures of education performance.
- There is limited information available regarding a child's ongoing healthcare use while they attend school.

**What this study adds**

- A population-level study to examine the impact of injury or chronic disease on children's scholastic performance.
- This study will identify the types of injuries and chronic illness associated with problems with learning at school.
- The developmental timing and need for educational support will be highlighted for chronically ill children accounting for age, gender and illness type.

## Introduction

Participation in school-based education is important for a child's mental, social and physical development. The World Health Organization's acknowledges the importance of quality primary and secondary education for all children in their global strategy for children's and adolescents' health [1]. Any restrictions on the ability of a child to perform to the best of their ability at school may adversely affect their career prospects and long-term quality of life. Traumatic injury or the presence of a chronic health condition, such as diabetes, epilepsy, asthma, or mental health conditions can have an adverse impact on the child's performance at school [2-9]. Interruptions to education can have a cumulative effect, resulting in being less likely to complete school or attend university and potentially limiting future employment opportunities [10]. Therefore, early identification and recognition of a child's need for learning support at school is critical.

Worldwide traumatic injury is a common cause of hospitalisation among children [11]. In Australia, injury is the leading cause of hospitalisation among children , with almost 70,000 children aged ≤16 years hospitalised each year [12]. Different types of injuries (e.g. burns, traumatic brain injury, orthopaedic injury) and the mechanism of injury (e.g. vehicle crash, pedal cycle collision, falls, self-harm) can affect children in different ways. The more serious the injury, often the more adverse impact on the child's psychological and physical health, and on the child's family [13]. Chronic health conditions are prevalent worldwide [14] and can also have an adverse impact on a child and their ability to perform well at school and to complete their schooling [10 15]. Previous research has not always considered objective measures of school performance, instead relying on subjective reports from parents or teachers [15 16]. This research has lacked information regarding a child's ongoing healthcare use [15], lacked an indication of the severity of the child's injury or illness [10], often involved small sample sizes [17], and has not been able to examine the impact on school performance over a range of ages or over time for the same child [17]. This study aims to examine education performance, school completion and health outcomes of children who have been hospitalised with an injury or a chronic health condition compared to children who have not been hospitalised for these conditions.

### *Study objective and aims*

The overall objective is to examine education performance, school completion and health outcomes of children who have been hospitalised with an injury or a chronic health condition (i.e. diabetes, epilepsy, asthma, or a mental health condition). The specific aims are to:

(1) compare school performance among injured or chronically ill children and a matched comparison group;

(2) examine factors influencing school performance of injured or chronically ill children compared to a matched comparison group, such as sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical factors;

(3) determine factors that either positively or negatively mediate young people completing high school (year 10, 11 or 12); and

(4) assess characteristics of long-term health service utilization and hospital treatment cost among injury or chronically ill children compared to a matched comparison group.

## Method and analysis

### *Study design*

This will be a retrospective population-level case-comparison study of injured or chronically ill children (i.e. diabetes, epilepsy, asthma, or mental health conditions). These four health conditions and injury were selected as injuries are the leading cause of hospitalisation in Australia for children aged 1-18 years [18] and the four chronic health conditions represent the most common health conditions experienced by children in Australia [19] that have previously been associated with having a detrimental impact on learning [2-9]. This will be a retrospective epidemiological study of children aged ≤18 years at the date of admission for their index hospitalisation in New South Wales (NSW), Australia. It will include matched population-level comparison groups for each health condition.

### *Data sources*

Nine administrative data collections in NSW will be linked and analysed for this study: hospital admissions, emergency department (ED) presentations, ambulatory mental health client contacts, the Registry of Births, Deaths and Marriages (RBDM) and the Cause of Death

Unit Record File (COD-URF) mortality data collections, the National Assessment Plan for Literacy and Numeracy (NAPLAN), school enrolments, high school completions (year 10, 11 or 12), and RBDM birth data.

***Information on hospital service use***: will be obtained from ED presentation and hospital admission data collections. Hospitalisation data includes information on admissions to public and private hospitals and records of patient demographics, source of referral, diagnoses, separation type, acute/non-acute care, Australian Refined Diagnosis Related Groups (AR-DRGs), and clinical procedures. Data collected on ED presentations in public hospitals also include arrival and departure times, triage category, type of visit, provisional diagnosis, and clinical procedures.

***Ambulatory mental health client contacts***: includes information regarding the care individuals received from ambulatory specialist mental health services at public hospitals. This includes mental health day programs, psychiatric outpatients and outreach services, including home visits. It contains information on care provided by hospital-based consultation liaison services to admitted patients in non-psychiatric and hospital emergency settings, care provided by community workers to admitted patients and clients in staffed community residential settings, and mental health promotion and prevention services.

***Scholastic performance***: the NAPLAN assessments are conducted on all Australian children in primary school years 3 (7-9 years of age) and 5 (9-11 years of age), and secondary school years 7 (11-13 years of age) and 9 (13-15 years of age), and includes assessments in five domains: reading, spelling, writing, grammar, punctuation and numeracy. Each domain is scored out of 1000 and translated into bands that indicate whether the child performed above or below the national minimum standard (NMS). Inability to achieve the NMS indicates that a child will have difficulty making progress in school without assistance [20]. A child's attendance or absence from NAPLAN assessments will also be obtained.

***Parent demographics***: parents' occupation and highest level of education will be obtained.

***School enrolments and school completion***: information on school enrolment and school changes will be obtained; high school retention to years 10, 11 and 12 will be obtained through records of high school completion awards known as the Record of School Achievement, and the Higher School Certificate.

***Survival:*** Mortality data from the RBDM mortality data will provide information on fact of death and information from the COD-URF will provide information on the cause of death.

***Births:*** RBDM birth data will provide a NSW population-level sample to identify the comparison cohorts for the injured or chronically ill children.

***Case inclusion criteria***

A principal diagnosis of injury (International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM): S00-T79) in hospitalisation data during an 18 year timeframe (i.e. 1 January 2001 to 31 December 2018) and aged ≤18 years at the date of admission. A principal or any diagnosis (up to 50 diagnoses) of diabetes (ICD-10-AM: E09-E14), epilepsy (ICD-10-AM: G40, G41), asthma (ICD-10-AM: J45), or a mental health condition (ICD-10-AM: F10-F99). Different types of mental health conditions have not been individually selected as children with one mental health condition can experience multiple conditions e.g. mood effective disorders (ICD-10-AM: F30-F39) and neurotic disorders (ICD-10-AM: F40-F49), which would result in duplicate case identification [21]. Mental health condition data will be analysed on receipt of this information and condition groups detailed. Some children may have multiple health conditions recorded and these cases will be reviewed on receipt of the hospitalisation data and will likely be treated as a 'multiple health condition' group.

***Population-comparison group criteria***

The population comparison group will consist of children aged ≤18 years who were born in NSW, who had not previously had a hospital admission with a principal diagnosis of injury or a principal or any diagnosis of diabetes, epilepsy, asthma, or a mental health condition, and who were alive at the date of admission of their matched case. The comparison group will be randomly matched in a 1:4 ratio on age, gender and residential postcode to their matched case.

***Sample size calculation***

There will be an estimated 22,300 injury[12] and 16,647 chronic disease[22-24] hospitalisations of children aged ≤18 years each year. To detect a relative risk of 1.5, with 5% significance and 80% power, a minimum sample size of 200 cases will be required with 800 in each comparison group. It is possible that there will be a number of children absent from school for NAPLAN assessments, but this large cohort the study will retain sufficient power for analysis.

***Record linkage***

The data linkage component of the study will be conducted by a third party agency, the Centre for Health Record Linkage (CHeReL). To link the data extracts, the CHeReL retains only the identifying information (e.g. first name, last name, date of birth) from each data extract. Linkage is conducted using probabilistic record linkage which is based on computing the probability that two records belong to the same person. The linkage process creates a project specific linkage key. The project specific key is returned to the CHeReL Data Integration Unit (or the data custodian) along with their original source record identifier. The CHeReL Data Integration Unit (or the data custodian) extracts the approved content variables (excluding identifying information such as names), attaches the project specific linkage key and securely transfers the data extract to the study investigators. The study investigators will then re-link the data extracts using the project specific linkage key and date-based and other content variables.

***Classification frameworks***

***Geographical identification:*** The Australian Statistical Geographical Standard (ASGS) will be used to identify children living in rural and urban NSW. Residents are assigned to one of five geographical categories using index scores of distance to service centres [25]. For ease of analysis and reporting, the five categories will be collapsed into: urban (i.e. major cities) and rural (i.e. inner and outer regional, remote, and very remote) [26].

***Socioeconomic status identification:*** A measure of socioeconomic status will be assigned to each case or comparison using their postcode of residence and the Index of Relative

Socioeconomic Disadvantage [27]. Socioeconomic disadvantage will be partitioned into quintiles from most (i.e. 1) to least disadvantaged (i.e. 5).

***Injury or condition severity:*** For injured children, injury severity will be estimated using the International Classification of Injury Severity Score [28]. The injury severity score is derived for each injured child by multiplying the probability of survival for each injury diagnosis using survival risk ratios (SRR). Injury severity will be estimated using previously developed SRRs [29] and will be categorised as minor (≥0.99), moderate (>0.941-<0.99) or serious (≤0.941) [30]. Proxy indicators of severity of the chronic health conditions will be considered, including number of ED presentations or hospital admissions, and hospital length of stay [31].

**Outcomes**

The primary outcome measures will be school performance on each of the five NAPLAN domains (i.e. reading, spelling, writing, grammar and punctuation, and numeracy) above or below the NMS, and school completion at year 10, 11 or 12. Secondary outcomes will include hospital length of stay, hospital treatment costs, number of hospital admissions, number of ED presentations, number of mental health client contacts, where relevant (Table 1).

**Data analysis plan**

Data analyses will be conducted using SAS 9.4. All hospital episodes of care related to the one event (e.g. all episodes of care related to the same injury event) will be linked to form a period of health care. Child injury and each chronic illness will be examined separately. Depending on sample size, some types of injuries may be examined separately, such as traumatic brain injury. For descriptive analyses, results with cell sizes <5 will not be reported to prevent potential identification of individuals. To compare school performance for injured or chronically ill children to their comparison groups, generalized linear regression will assess the difference in proportions of performances below the NMS for each of five NAPLAN domains for the school grades 3, 5, 7 and 9. To identify factors influencing school performance of injured or chronically ill children, factors related to performance below NMS such as sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical (e.g. number of ED presentations, hospital admissions, hospital

length of stay) factors (Table 2) will be examined using multivariate logistic regression. Relative risks, odds ratios and 95% confidence intervals (CIs) will be calculated. It is likely that sensitivity analyses for potential missing values will need to be conducted for some data variables. Potential missing values will be imputed using the discriminant function method with 100 imputations using PROC MI. Parameter estimates will be log-transformed and pooled results and 95%CIs will be generated using PROC MIANALYSE. Analyses will be performed with and without imputed data. In addition, group-based trajectory modelling [32] will be undertaken to identify clusters of children with similar school performance outcomes over time. Information such as sociodemographic (i.e. age, gender, socioeconomic status), clinical and parental education will be used to estimate a child's probability of group membership over time.

To identify factors influencing high school completion at either year 10, 11 or 12 for injured or chronically ill children compared to the comparison group, factors related to poor school completions, including sociodemographic (e.g. age, gender, socioeconomic), parental (e.g. education), and clinical (e.g. ED presentations, hospital admissions) factors will be examined using multivariate logistic regression. Relative risks, odds ratios and 95% CIs will be calculated.

The characteristics of long-term health service utilisation and hospital treatment cost among injured or chronically ill children compared to their comparison group will be assessed using a generalised linear model with a log link and gamma error distribution to assess hospital length of stay, hospital treatment costs, and the number of hospital admissions during the study period. These will be adjusted for sociodemographic and other characteristics, such as injury severity, as relevant.

**Ethics and dissemination plan**

Ethical approval was obtained from the NSW Population Health Services Research Ethics Committee (HREA: 018HRE0904). Dissemination of research results will be conducted through peer-review journal articles and presentations at relevant professional conferences. Research findings will also be provided to government agencies, including health and education authorities.

## Patient and public involvement

There was no patient involvement in the design of the record linkage study.

## Limitations

There will be some study limitations to take into consideration in the interpretation of findings. Only health conditions that are relevant to a hospital admission are indicated in hospital diagnosis records, so it is possible that some conditions could be under-enumerated. The study would identify cases where the child had been hospitalised for the injury or chronic health condition, so would not identify children presenting solely to other medical professionals, such as general practitioners, for treatment. However, children who are hospitalised for their injury or health condition are likely to be the most seriously affected. There will not be an opportunity to examining the validity of diagnoses (except between administrative health records) and it is possible that there could be some misclassification. The NSW ED presentation data does not contain information on ED presentations to private hospitals, so private hospital ED presentations will not be examined. However, almost all (93%) of ED services are provided by public hospitals in Australia [33]. In identifying the matched comparison cohorts, the recency of postcode of usual residence may vary between data collections. For example, postcode of residence at birth could vary from postcode of residence while at school.

## Discussion

This research will examine the impact on school performance and high school completion of children who are hospitalised for an injury or a chronic health condition – namely diabetes, epilepsy, asthma or mental health conditions – compared to children who have not been seriously affected and hospitalised for these health conditions. It will identify the characteristics of children who are most likely to be adversely affected by their health conditions. This may include children who have multiple hospital admissions, extended time in hospital, more serious injuries, multiple health conditions, specific types of injuries or children whose primary language is not English or who reside in disadvantaged socioeconomic areas. The study is also likely to include children whose injuries and illnesses are the direct cause of cognitive difficulties resulting in poor educational performance. It is

anticipated that research findings will identify any educational outcome disparities with a comparison population and the characteristics of injured and chronically ill children most likely to have problems with learning at school and will highlight where educational support services are most needed.

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**Table 1: School performance, school completion and health service use outcome measures**

| Outcome | Data source | Outcome measure |
|---|---|---|
| **School performance and completion** | | |
| NAPLAN – reading | NAPLAN | Number of children above/below NMS |
| NAPLAN – spelling | NAPLAN | Number of children above/below NMS |
| NAPLAN - writing | NAPLAN | Number of children above/below NMS |
| NAPLAN – grammar and punctuation | NAPLAN | Number of children above/below NMS |
| NAPLAN - numeracy | NAPLAN | Number of children above/below NMS |
| School completion – year 10 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 10 |
| School completion – year 11 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 11 |
| School completion – year 12 | Record of School Achievement and the Higher School Certificate | Number of children not completing/completing year 12 |
| **Health service use** | | |
| ED presentations | ED presentation data | Number of ED presentations |
| Hospital admissions | Hospital admissions data | Number of hospitalisations |
| Hospital length of stay | Hospital admissions data | Total hospital length of stay |
| Hospital treatment cost | Hospital admissions data | Total hospital treatment cost |
| Mental health client contacts | Ambulatory mental health client data | Number of mental health client contacts |

NAPLAN: National Assessment Plan for Literacy and Numeracy. NMS: National minimum standard. ED: Emergency Department.

**Table 2: Potential mediating and explanatory data variables**

| Type | Data variable |
|---|---|
| **School performance and completion** | |
| **Child** | Age |
| | Sex |
| | Socioeconomic status |
| | Geographic location |
| ***Children with an injury*** | Injury severity |
| ***Children with a chronic health condition*** | Proxy indicators of severity will be considered, including number of ED presentations or hospital admissions, or total hospital length of stay |
| **Parent** | Highest level of education |
| | Occupation |
| **Clinical** | Number of ED presentations |
| | Number of hospitalisations |
| | Total hospital length of stay |

ED: Emergency Department.