ORIGINAL ARTICLE

Hospital service use for young people with chronic health conditions: A population-based matched retrospective cohort study

Rebecca J Mitchell [1] Anne McMaugh,[2] Geoffrey Herkes,[3,4] Nusrat Homaira,[5,6] Tien-Ming Hng,[7,8] Cate M Cameron[9,10] and Reidar P Lystad [1]

[1]Australian Institute of Health Innovation, [2]The Macquarie School of Education, Macquarie University, [3]Sydney Medical School, University of Sydney, [4]Department of Neurology, Royal North Shore Hospital, [5]School of Women's and Children's Health, University of New South Wales, [6]Respiratory Department, Sydney Children's Hospital, [7]Department of Diabetes and Endocrinology, Blacktown and Mount Druitt Hospital, [8]School of Medicine, Western Sydney University, Sydney, New South Wales, [9]Jamieson Trauma Institute, Royal Brisbane & Women's Hospital, Metro North Health and [10]Queensland University of Technology (QUT), Centre for Healthcare Transformation, Australian Centre for Health Services Innovation (AusHSI), Brisbane, Queensland, Australia

Aim: This study aims to identify the hospitalised morbidity associated with three common chronic health conditions among young people using a population-based matched cohort.

Methods: A population-level matched case-comparison retrospective cohort study of young people aged ≤18 years hospitalised with asthma, type 1 diabetes (T1D) or epilepsy during 2005–2018 in New South Wales, Australia using linked birth, health and mortality records. The comparison cohort was matched on age, sex and residential postcode. Adjusted rate ratios (ARR) were calculated by sex and age group.

Results: There were 65 055 young people hospitalised with asthma, 6648 with epilepsy, and 2209 with T1D. Young people with epilepsy (ARR 10.95; 95% confidence interval (CI) 9.98–12.02), T1D (ARR 8.64; 95% CI 7.72–9.67) or asthma (ARR 4.39; 95% CI 4.26–4.53) all had a higher risk of hospitalisation than matched peers. Admission risk was highest for males (ARR 11.00; 95% CI 9.64–12.56) and females with epilepsy (ARR 10.83; 95% CI 9.54–12.29) compared to peers. The highest admission risk by age group was for young people aged 10–14 years (ARR 5.50; 95% CI 4.77–6.34) living with asthma, children aged ≤4 years (ARR 12.68; 95% CI 11.35–14.17) for those living with epilepsy, and children aged 5–9 years (ARR 9.12; 95% CI 7.69–10.81) for those living with T1D compared to peers.

Conclusions: The results will guide health service planning and highlight opportunities for better management of chronic health conditions, such as further care integration between acute, primary and community health services for young people.

Key words: asthma; epilepsy; hospitalisation; type 1 diabetes.

What is already known on this topic

- Asthma, type 1 diabetes and epilepsy are common chronic health conditions of young people.
- Uncontrolled chronic health conditions can have an adverse impact on a range of life aspects.
- Limited information on hospital service use of young people with a chronic health condition compared to peers.

What this paper adds

- Young people with asthma, epilepsy or type 1 diabetes all had a higher hospitalisation risk than matched peers.
- Admission risk was highest for males and females with epilepsy compared to peers.
- Need for further care integration between acute, primary and community health services for young people.

Asthma, type 1 diabetes (T1D), and epilepsy are among some of the most common chronic health conditions experienced by children and adolescents aged ≤18 years.[1–3] Asthma is the most prevalent

chronic disease for young people, ranked in the top 10 in terms of disability-adjusted life years,[1] an estimated 2.58 million young people aged ≤19 years are living with T1D,[2] and an estimated 1% of young people are living with epilepsy[4] world-wide. In both high- and low-income countries, chronic non-communicable diseases in adolescents represent a considerable disability-adjusted life year burden.[1] In Australia, among young people aged ≤14 years, around 460 000 were living with asthma in 2017–2018, representing around 10% of the population,[5] an estimated 19 000 had epilepsy in 2019–2020,[6] and approximately 6500 had T1D in 2017.[5]

If not adequately controlled, chronic conditions can have an adverse impact on all aspects of life for a young person, including their general health, sleep quality, school attendance, and family and peer relationships.[7–9] Recurrent chronic illness has also been associated with poor academic performance and an increased likelihood of not finishing high school compared to peers.[10–12]

Young people with a chronic health condition are more likely to use hospital and health services than the general population due to their ongoing need for health services to maintain their health.[13] However, there is limited current information available that has quantified the extent of hospital service use among young people with asthma, T1D, or epilepsy compared to their peers in the general population in Australia to guide health service planning and chronic disease management. This study aims to identify the hospitalised morbidity associated with three common chronic health conditions among young people aged ≤18 years using a population-based matched cohort.

Methods

This is a population-level case-comparison retrospective cohort study of young people hospitalised with asthma, T1D or epilepsy aged ≤18 years in New South Wales (NSW), Australia, using linked birth, health and mortality data collections from 1 January 2005 to 31 December 2018. Ethical approval and a waiver of consent were obtained from the NSW Population and Health Services Research Ethics Committee (2018HRE0904).

Data sources

Information on hospital service use was obtained from emergency department (ED) visit and hospital admission data collections in NSW. ED visits to public hospitals included data on arrival and departure times, visit type and provisional diagnosis. Hospital admissions were to public or private hospitals, and contained information on demographics, diagnoses, separation type (e.g. hospital transfer, death) and clinical procedures. Health service use was followed until 30 June 2019. Mortality data were obtained from the NSW Registry of Births, Deaths and Marriages and included date of death. Young people who died during the study timeframe were excluded from the analysis of hospital service use (i.e. 124 deaths in the asthma cohort, 271 in the epilepsy and 6 in the T1D cohorts).

The Centre for Health Record Linkage linked the birth, health and mortality records using probabilistic record linkage. Upper and lower probability cut-offs for a link were 0.75 and 0.25 and record groups with probabilities between the cut-offs were clerically reviewed. The Centre for Health Record Linkage also identified the population comparison group.

Case and comparison inclusion criteria

Cases included young people with a year of birth ≥1997 who were aged ≤18 years at the index hospitalisation who had a principal or additional diagnosis of asthma (International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM: J45), T1D (ICD-10-AM: E10) or epilepsy (ICD-10-AM: G40-G41) (Table S2, Supporting Information) in up to

50 additional diagnosis classifications during 1 January 2005 to 31 December 2018. Whether a young person hospitalised with asthma or epilepsy was diagnosed with status asthmaticus (ICD-10-AM: J46) or status epilepticus (ICD-10-AM: G41), respectively, was also identified. Refractory epilepsy was identified using the fifth digit of G40 and/or if the young person had undergone surgery related to their epilepsy (i.e. anterior section of corpus callosum: 40700-00; corticectomy of brain 40703-00; topectomy 40703-01; partial lobectomy of brain 40703-02; and hemispherectomy 40706-00).

Three population-based comparison groups who were not hospitalised with asthma, T1D or epilepsy from 1 July 2001 to 31 December 2018 were randomly selected from NSW birth records matched 1:1 on age, sex and residential postcode to their respective counterparts with asthma, T1D or epilepsy. The selection timeframe for comparisons included a 3.5-year wash-out period prior to the case selection timeframe to avoid the potential selection of comparison group members who may have been hospitalised either with asthma, any form of diabetes or epilepsy, respectively, prior to the case criteria timeframe.

Identification of other health conditions

Common chronic health conditions for young people were considered as conditions reasonably expected to last 12 months or need ongoing health care. For this study, a chronic health condition was identified using a 3-year look-back period (to 1 January 2002) and diagnosis classifications from ICD-10-AM, excluding the health condition of interest (Table S1, Supporting Information). Three additional comorbidities related to epilepsy were also identified: Rhett's syndrome (ICD-10-AM: F84.2), viral encephalitis (ICD-10-AM: G00-G03) and bacterial meningitis (ICD-10-AM: A83-A87).

Socio-economic status and geographical location

The young person's postcode of residence was used to categorise socio-economic disadvantage into quintiles from most (i.e. 1) to least (i.e. 5) disadvantaged using the Index of Relative Socio-Economic Disadvantage, 2011. The Australian Statistical Geographical Standard, 2011 is based on distance to service centres and was used to classify the postcode of residence of the young person as either urban (i.e. major cities) or rural (i.e. inner and outer regional, remote and very remote).

ED visits, hospital admissions and hospital length of stay

The number of ED visits and hospital admissions post the index hospital admission were identified for both the cases and their matched peers. The calculation of hospital length of stay (LOS) post the index admission was cumulative and included transfers between hospitals. The index admission was not included in the count of ED visits, hospital admissions or in the calculation of cumulative hospital LOS.

Data management and analysis

Data analysis was conducted using SAS 9.4 (SAS Institute, Cary, NC, USA). All hospital episodes of care related to the same event were linked to form a period of care. χ^2 tests of independence and Wilcoxon Mann–Whitney tests, as appropriate, were used to examine characteristics of young people hospitalised with asthma, T1D or epilepsy and their matched counterpart.

Due to overdispersion, negative binomial regression, adjusted for asthma or T1D or epilepsy status, sex, age group, comorbidities (i.e. Y/N), location of residence and socio-economic status, with the log of the length of exposure post the index case admission as an offset was used to quantify associations between each health condition and counts of hospital admissions up to 30 June 2019 using rate ratios and 95% confidence intervals (CI). As comparison group members could have nil hospital LOS, a small constant value was added to LOS before transformation. Where rate ratios were calculated by sex or age group, these variables were not included as predictors in the models.

Results

There were 65 055 young people hospitalised with asthma, 6648 with epilepsy, and 2209 with T1D who were aged ≤18 years during 2005–2018. Males accounted for almost two-thirds of hospitalisations with asthma (63.3%), around half (51.8%) hospitalised with epilepsy, and 46.5% hospitalised with T1D. Children aged ≤4 years accounted for 65.2% of hospitalisations with asthma and 55.2% of those hospitalised with epilepsy. Children aged 5–9 years accounted for over one-third (38.9%) of hospitalisations with T1D. Almost three-quarters (70.3%–74.0%) of young people hospitalised with one of the chronic health conditions lived in urban areas and young people were living in a range of socio-economic areas. The majority of young people did not have other chronic comorbidities, but they did have a higher proportion of comorbidities compared to their matched peers (asthma: 2.1% vs. 1.0%; epilepsy: 18.0% vs. 7.6%; T1D: 2.4% vs. 1.8%) (Table 1).

For young people hospitalised with epilepsy, there were 669 (10.1%) with status epilepticus, 271 (4.1%) with refractory epilepsy, and 8 (0.1%) had had a surgical procedure conducted related to their epilepsy. None of the young people with epilepsy had Rhett's syndrome, 59 (0.9%) had viral encephalitis, and 34 (0.5%) had bacterial meningitis compared to none, 4 (0.1%) and 6 (0.1%) cases in their matched peers, respectively. Of the young people hospitalised with asthma, 1372 (2.1%) had status asthmaticus.

In terms of hospital service use, young people with asthma (82.5% vs. 53.3%, respectively), epilepsy (90.8% vs. 51.5%, respectively), and T1D (76.0% vs. 44.3%, respectively) all had a higher proportion of ED visits after their index admission than their matched peers. Young people with asthma (58.8% vs. 24.6%, respectively), epilepsy (69.5% vs. 23.9%, respectively) and T1D (73.6% vs. 20.6%, respectively) also had a higher proportion of admissions post their index admission than matched peers (Table 2).

After adjusting for covariates, young people with epilepsy (adjusted rate ratio (ARR) 10.95; 95% CI 9.98–12.02), T1D (ARR 8.64; 95% CI 7.72–9.67) or asthma (ARR 4.39; 95% CI 4.26–

4.53) all had a higher risk of hospitalisation than their matched peers. The risk of admission was highest for young males (ARR 11.00; 95% CI 9.64–12.56) and females (ARR 10.83; 95% CI 9.54–12.29) with epilepsy compared to matched counterparts. Compared to matched peers, the highest admission risk by age group was for young people aged 10–14 years (ARR 5.50; 95% CI 4.77–6.34) living with asthma, ≤4 years (ARR 12.68; 95% CI 11.35–14.17) for young people living with epilepsy, and 5–9 years (ARR 9.12; 95% CI 7.69–10.81) for young people living with T1D compared to peers (Table 3).

Discussion

The prevalence of chronic health conditions among young people is increasing and as a result, the health-care use associated with asthma, T1D and epilepsy among young people has increased over time.[13] This study found that young people who were hospitalised with each of the three health conditions had a higher risk of hospitalisation than their peers.

The risk of hospitalisation was high for both sexes for each of the three health conditions examined compared to matched peers. The current study found that young females with asthma had a slightly higher risk of hospitalisation than males. Likewise, in the USA, young females had higher rates of hospital readmission than males.[14] Inadequately controlled asthma may contribute to the high hospitalisation risk among young people living with asthma.[15] For T1D, the highest hospitalisation risk compared to peers was for young females. Similarly, in Germany in an examination of hospital admissions among young people with T1D aged ≤19 years compared to the general population, young females were found to have a higher likelihood of hospitalisation compared to peers.[16] The higher hospitalisation risk among females with T1D could be due to worse metabolic control and subsequent severe hypoglycaemia, more frequent diabetic ketoacidosis, poor adherence to treatment, such as missed insulin, or due to irregular eating patterns being more likely among young females.[17,18]

The current study found that hospitalisation risk varied for each health condition by age group. Compared to peers, the highest hospitalisation risk for young people with asthma was for young people aged 10–14 years. Similarly, prior research found that young people aged 12–18 years who had been hospitalised were more likely to be readmitted to hospital.[14] It is possible that higher non-adherence to asthma medication, along with difficulty to control asthma in adolescents could play a part in contributing to admissions.[14] For young people with T1D, the highest hospitalisation risk compared to peers was for young people aged 5–9 years. Previous research also identified that young people aged 5–10 years had a higher likelihood of being hospitalised than their peers.[16] The higher risk of hospitalisation among young adolescents is likely due to poor metabolic control among adolescents,[17] along with development during puberty which has been associated with diabetic ketoacidosis.[16]

For young people with epilepsy, the highest hospitalisation risk compared to peers was for children aged ≤4 years. High use of hospital services has been associated with young people aged ≤17 years, who have additional comorbidities, and who have refractory epilepsy.[19] In NSW, young people account for one-third of hospital admissions for epilepsy and for accounted for

Table 1 Demographic characteristics at the index admission for young people hospitalised with asthma, type 1 diabetes or epilepsy and their matched comparison, linked health and mortality data NSW, 2005–2018

Characteristics	Asthma					Type 1 diabetes					Epilepsy				
	Asthma case (n = 65 055)		Comparison (n = 65 055)		P value	T1D case (n = 2209)		Comparison (n = 2209)		P value	Epilepsy case (n = 6648)		Comparison (n = 6648)		P value
	n	%	n	%		n	%	n	%		n	%	n	%	
Sex															
Male	41 203	63.3	41 203	63.3	1.0	1028	46.5	1028	46.5	1.0	3445	51.8	3445	51.8	1.0
Female	23 852	36.7	23 852	36.7		1181	53.5	1181	53.5		3203	48.2	3203	48.2	
Age group at index admission of case															
0–4	42 397	65.2	42 397	65.2	1.0	469	21.2	469	21.2	1.0	3669	55.2	3669	55.2	1.0
5–9	16 680	25.6	16 680	25.6		859	38.9	859	38.9		1765	26.6	1765	26.6	
10–14	4224	6.5	4224	6.5		690	31.2	690	31.2		846	12.7	846	12.7	
15–18	1754	2.7	1754	2.7		191	8.7	191	8.7		368	5.5	368	5.5	
Mean age at index admission of case (SD)	4.2	(3.6)				8.4	(4.2)				5.0	(4.7)			
Location of residence															
Urban	48 107	74.0	48 107	74.0	1.0	1552	70.3	1552	70.3	1.0	4772	71.8	4772	71.8	1.0
Rural	16 871	25.9	16 871	25.9		644	29.2	644	29.2		1862	28.0	1862	28.0	
Not known	77	0.1	77	0.1		13	0.6	13	0.6		14	0.2	14	0.2	
Socio-economic status															
Most disadvantaged	15 758	24.2	15 758	24.2	1.0	452	20.5	452	20.5	1.0	1542	23.2	1542	23.2	1.0
2	15 433	23.7	15 433	23.7		529	24.0	529	24.0		1549	23.3	1549	23.3	
3	13 957	21.5	13 957	21.5		485	22.0	485	22.0		1411	21.2	1411	21.2	
4	6713	10.3	6713	10.3		229	10.4	229	10.4		705	10.6	705	10.6	
Least disadvantaged	13 117	20.2	13 117	20.2		501	22.7	501	22.7		1427	21.5	1427	21.5	
Not known	77	0.1	77	0.1		13	0.6	13	0.6		14	0.2	14	0.2	
Number of other health conditions															
0	63 709	97.9	64 439	99.1	<0.0001	2155	97.6	2170	98.2	<0.0001	5449	82.0	6141	92.4	<0.0001
≥1	1346	2.1	616	1.0		54	2.4	39	1.8		1199	18.0	507	7.6	

Table 2 Emergency department visits and hospital admissions for young people hospitalised with asthma, type 1 diabetes or epilepsy and their matched comparison, linked health and mortality data NSW, 2005–2018

Health service use	Asthma					Type 1 diabetes					Epilepsy				
	Asthma case (n = 65 055)		Comparison (n = 65 055)		P value	T1D case (n = 2209)		Comparison (n = 2209)		P value	Epilepsy case (n = 6648)		Comparison (n = 6648)		P value
	n	%	n	%		n	%	n	%		n	%	n	%	
Emergency department visits post the index admission															
No ED visits	11 386	17.5	30 348	46.7	<0.0001	529	24.0	1231	55.7	<0.0001	1275	19.2	3289	48.5	<0.0001
1–2 ED visit	18 099	27.8	19 001	29.2		631	28.6	562	25.4		1742	26.2	1872	28.2	
3–4 ED visits	11 966	18.4	7820	12.0		345	15.6	209	9.5		1105	16.6	716	10.8	
≥5 ED visits	23 604	36.3	7886	12.1		704	31.9	207	9.4		2526	38.0	771	11.6	
Mean number of visits (SD)	4.8	(6.4)	1.8	(3.1)	<0.0001	4.7	(7.6)	1.4	(2.6)	<0.0001	6.0	(9.3)	1.7	(3.1)	<0.0001
Hospital admissions post the index admission															
No admissions	26 786	41.2	49 049	75.4	<0.0001	583	26.4	1753	79.4	<0.0001	2028	30.5	5062	76.1	<0.0001
1–2 admission	24 623	37.9	13 732	21.1		805	36.4	386	17.5		2205	33.2	1370	20.6	
3–4 admissions	7935	12.2	1732	2.7		389	17.6	53	2.4		855	12.9	158	2.4	
≥5 admissions	5711	8.8	542	0.8		432	19.6	17	0.8		1560	23.5	58	0.9	
Mean number of admissions (SD)	1.8	(4.6)	0.4	(1.6)	<0.0001	2.9	(4.5)	0.3	(0.8)	<0.0001	4.5	(15.5)	0.4	(1.1)	<0.0001
Hospital length of stay, cumulative post the index admission (days)															
None	26 727	41.1	48 989	75.3	<0.0001	583	26.4	1750	79.2	<0.0001	2023	30.4	5056	76.1	<0.0001
1–2	18 673	28.7	11 455	17.6		559	25.3	319	14.4		1539	23.2	1072	16.1	
3–4	8005	12.3	2569	4.0		296	13.4	71	3.2		676	10.2	268	4.0	
5–7	5415	8.3	1133	1.7		286	13.0	41	1.9		591	8.9	156	2.4	
≥8	6235	9.6	909	1.4		485	22.0	28	1.3		1819	27.4	96	1.4	
Mean hospital cumulative LOS (SD)	3.6	(16.1)	0.7	(5.4)	<0.0001	6.6	(17.6)	0.6	(2.1)	<0.0001	15.2	(78.0)	0.7	(3.7)	<0.0001

ED, emergency department; LOS, length of stay; T1D, type 1 diabetes.

Table 3 Rate ratio of hospital admissions for young people hospitalised with asthma, type 1 diabetes or epilepsy and their matched comparison, linked health and mortality data NSW, 2005–2018

Characteristic	Asthma				Type 1 diabetes				Epilepsy			
	Unadjusted rate ratio	95% CI	Adjusted† rate ratio	95% CI	Unadjusted rate ratio	95% CI	Adjusted rate ratio	95% CI	Unadjusted rate ratio	95% CI	Adjusted rate ratio	95% CI
Overall	4.44*	4.30–4.59	4.39*	4.26–4.53	8.60*	7.68–9.62	8.64*	7.72–9.67	12.82*	11.68–14.06	10.95*	9.98–12.02
Sex												
Male	4.27*	4.10–4.43	4.23*	4.07–4.39	8.51	7.20–10.04	8.63*	7.34–10.14	12.47*	10.87–14.31	11.00*	9.64–12.56
Female	4.79*	4.51–5.09	4.73*	4.48–4.99	8.68	7.45–10.12	8.71*	7.46–10.16	13.21*	11.69–14.94	10.83*	9.54–12.29
Age group												
0–4	4.40*	4.23–4.57	4.40*	4.24–4.56	9.03*	7.09–11.49	9.04*	7.12–11.49	14.25*	12.79–15.89	12.68*	11.35–14.17
5–9	4.26*	3.95–4.59	4.21*	3.95–4.50	8.96*	7.56–10.62	9.12*	7.69–10.81	10.90*	9.09–13.07	8.92*	7.56–10.54
10–14	5.69*	4.96–6.53	5.50*	4.77–6.34	8.17*	6.67–10.01	8.21*	6.70–10.06	8.11*	6.13–10.74	7.76*	5.85–10.28
15–18	4.40*	3.69–5.25	3.95*	3.32–4.69	6.81*	3.82–12.15	7.06*	4.27–11.68	10.70*	5.43–21.07	8.63*	4.92–15.13

* P < 0.0001. † Adjusted for sex, age group, comorbidities (Y/N), location of residence and socio-economic status. Excludes n = 77 missing for asthma, n = 13 missing for type 1 diabetes and n = 14 missing for epilepsy for location of residence/socio-economic status. Where rate ratios were calculated by sex or age group, these variables were not included as predictors in the models. CI, confidence interval.

27% of those with refractory epilepsy.[20] That young children living with epilepsy have the highest rate ratio for hospitalisations compared to their peers is likely due to their need for assessment, diagnosis, and seizure treatment.[21]

Hospital admissions for each chronic health condition are potentially preventable if the condition is managed well with assistance from primary care.[14,22] For young people living with epilepsy, more effective management of seizures and the development of a comprehensive care plan and treatment strategy[23] would likely reduce hospital admissions. For young people living with T1D, there is a need for good metabolic control and adherence to treatment regimens.[14] For young people living with asthma, the development of an asthma management plan, increased awareness around self-management and better asthma symptom control, including medication[14,24] may assist to reduce the need for hospital admission. Future research could incorporate Medicare and pharmaceutical records to identify ongoing use of primary and other specialist health-care services, and use of medication to manage symptoms.

This study's strength is that it was a large population-based study linking birth, ED visit, hospital admission, and mortality records over a 13-year period. The study adjusted for key factors that may influence health service use, including comorbidities, residential location and socio-economic status. However, there were study limitations. Only chronic health conditions relevant to a hospital admission are indicated in hospital diagnosis classifications, and it is possible that some conditions experienced are under-enumerated. This is likely for the comparison cohort where they had not been admitted to hospital and as a result, there was no opportunity to identify comorbidities, despite the 3-year look-back period. No information was available on the exact date of disease onset, on type or frequency of medication use, seizure activity for young people living with epilepsy or metabolic control, number of severe hypo/hyperglycaemic episodes or frequency of diabetic ketoacidosis for young people living with T1D. A small number of residential postcodes were not known to the authors and location of residence and socio-economic status for these records were not able to be identified. The study only included young people who had been hospitalised, and did not include young people presenting solely to other health professionals for treatment. Visits to private hospital EDs were not able to be accessed. Data validity assessments were not able to be conducted and it is possible that there could be some data misclassification.

Conclusions

This study has provided insight into hospital service use for young people with common chronic health conditions compared to their peers. The results will inform health service planning and resourcing and will highlight opportunities for better management of chronic health conditions to reduce the need for hospitalisation, such as further care integration between acute, primary and community health services for young people.

Acknowledgements

Data availability statement

The data that support the findings of this study are available from the NSW Health Department. Restrictions apply to the availability of these data, which were used under licence for the current study, so are not publicly available.

References

1 Gore FM, Bloem PJ, Patton GC *et al*. Global burden of disease in young people aged 10–24 years: A systematic analysis. *Lancet* 2011; **377**: 2093–102.

2 Patterson CC, Karuranga S, Salpea P *et al*. Worldwide estimates of incidence, prevalence and mortality of type 1 diabetes in children and adolescents: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes Res. Clin. Pract.* 2019; **157**: 107842.

3 Beghi E, Giussani G, Nichols E *et al*. Global, regional, and national burden of epilepsy, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet Neurol.* 2019; **18**: 357–75.

4 Russ SA, Larson K, Halfon N. A national profile of childhood epilepsy and seizure disorder. *Pediatrics* 2012; **129**: 256–64.

5 Australian Institute of Health and Welfare. *Australia's Children*. Canberra: Australian Institute of Health and Welfare; 2020.

6 Deloitte Access Economics. *The Economic Burden of Epilepsy in Australia, 2019–2020*. Sydney: Deloitte Access Economics; 2020.

7 Toyran M, Yagmur I, Guvenir H *et al*. Asthma control affects school absence, achievement and quality of school life: A multicenter study. *Allergol. Immunopathol.* 2020; **48**: 545–52.

8 Murillo M, Bel J, Pérez J *et al*. Health-related quality of life (HRQOL) and its associated factors in children with type 1 diabetes mellitus (T1DM). *BMC Pediatr.* 2017; **17**: 1–9.

9 Baker GA, Hargis E, Hsih MM-S *et al*. Perceived impact of epilepsy in teenagers and young adults: An international survey. *Epilepsy Behav.* 2008; **12**: 395–401.

10 Mitchell RJ, McMaugh A, Homaira N, Lystad RP, Badgery-Parker T, Cameron CM. The impact of childhood asthma on academic performance: A matched population-based cohort study. *Clin. Exp. Allergy* 2021; **52**: 286–96.

11 Parent KB, Wodrich DL, Hasan KS. Type 1 diabetes mellitus and school: A comparison of patients and healthy siblings. *Pediatr. Diabetes* 2009; **10**: 554–62.

12 Wo S, Ong L, Low W, Lai P. The impact of epilepsy on academic achievement in children with normal intelligence and without major comorbidities: A systematic review. *Epilepsy Res.* 2017; **136**: 35–45.

13 Berry JG, Hall M, Hall DE *et al*. Inpatient growth and resource use in 28 children's hospitals: A longitudinal, multi-institutional study. *JAMA Pediatr.* 2013; **167**: 170–7.

14 Veeranki SP, Ohabughiro MU, Moran J *et al*. National estimates of 30-day readmissions among children hospitalized for asthma in the United States. *J. Asthma* 2018; **55**: 695–704.

15 McConnochie KM, Russo MJ, McBride JT, Szilagyi PG, Brooks A-M, Roghmann KJ. Socioeconomic variation in asthma hospitalization: Excess utilization or greater need? *Pediatrics* 1999; **103**: e75.

16 Bohn B, Schwandt A, Ihle P *et al*. Hospital admission in children and adolescents with or without type 1 diabetes from Germany: An analysis of statutory health insurance data on 12 million subjects. *Pediatr. Diabetes* 2018; **19**: 721–6.

17 Kalla Vyas A, Oud L. Temporal patterns of hospitalizations for diabetic ketoacidosis in children and adolescents. *PLoS One* 2021; **16**: e0245012.

18 Auzanneau M, Rosenbauer J, Icks A *et al*. Hospitalization in pediatric diabetes: A nationwide analysis of all admission causes for Germany in 2015. *Exp. Clin. Endocrinol. Diabetes* 2020; **128**: 615–23.

19 Lystad RP, Rapport F, Bleasel A, Herkes G, Nikpour A, Mitchell R. Hospital service utilization trajectories of individuals living with epilepsy in New South Wales, Australia, 2012–2016: A population-based study. *Epilepsy Behav.* 2020; **105**: 106941.

20 Mitchell R, Herkes G, Nikpour A *et al*. Examining health service utilization, hospital treatment cost, and mortality of individuals with epilepsy and status epilepticus in New South Wales, Australia 2012–2016. *Epilepsy Behav.* 2018; **79**: 9–16.

21 Argumosa A, Herranz J. Childhood epilepsy: A critical review of cost-of-illness studies. *Epileptic Disord.* 2004; **6**: 31–40.

22 Cecil E, Bottle A, Ma R *et al*. Impact of preventive primary care on children's unplanned hospital admissions: A population-based birth cohort study of UK children 2000–2013. *BMC Med.* 2018; **16**: 1–11.

23 Wilner A, Sharma B, Thompson A, Soucy A, Krueger A. Diagnoses, procedures, drug utilization, comorbidities, and cost of health care for people with epilepsy in 2012. *Epilepsy Behav.* 2014; **41**: 83–90.

24 Karaca-Mandic P, Jena AB, Joyce GF, Goldman DP. Out-of-pocket medication costs and use of medications and health care services among children with asthma. *JAMA* 2012; **307**: 1284–91.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Health conditions and ICD-10-AM classifications.
Table S2. Type of epilepsy at the index admission for young people hospitalised with epilepsy, linked health and mortality data NSW, 2005–2018.

Beautiful beach by Cassidy Hort (aged 7) from "A Pop of Colour" art competition, Youth Arts, Children's Hospital at Westmead