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Predictive Characteristics of Childhood Emergency Injury Presentations in a Non-Urban Area of Victoria, Australia

Blake Peck [1,2], Daniel Terry [1,2,3] and Kate Kloot [4,*]

[1] Institute of Health & Wellbeing, Federation University, Ballarat, VIC 3350, Australia; b.peck@federation.edu.au (B.P.); daniel.terry@unisq.edu.au (D.T.)
[2] School of Nursing and Midwifery, University of Southern Queensland, Ipswich, QLD 4305, Australia
[3] Centre for Health Research, University of Southern Queensland, Ipswich, QLD 4305, Australia
[4] School of Medicine, Deakin University, Warrnambool, VIC 3280, Australia
* Correspondence: kate.kloot@deakin.edu.au

Abstract: Injury is the leading cause of death and disability amongst those between 0 and 16 years of age. Routinely associated with a social gradient of health, childhood injury is reportedly higher in rural and regional areas. A retrospective cross-sectional study collected deidentified emergency injury presentation data from nine health services in regional Victoria for children aged 0–14 years between 2017 and 2022. Emergency injury presentation incidence rates and predictor variables were analysed using hierarchical multiple regression. Significance was determined at $p < 0.05$. Amongst the 15,884 emergency injury presentations, 35.2% ($n = 5597$) occurred at health services that did not routinely report data to government datasets. Although some findings are consistent with current research, this study highlights specific factors that are predictive of injury amongst 0–4-year-old children who require deeper investigation, including general practitioner access and health literacy-related elements such as preschool health assessment attendance rates, parent education levels, and overseas birth. These findings provide more comprehensive insights for healthcare workers and policymakers as they seek to support people with injuries and accurately address health inequities.

Keywords: childhood injury; emergency presentation; socioeconomic; preschool; early intervention; non-urban; injury surveillance

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1. Introduction

Injury amongst children is the leading persistent disease burden and cause of death; internationally it accounts for approximately one million deaths and many millions of non-fatal hospitalisations each year [1]. Reflecting these global trends, injury remains the leading cause of death and disability in children under sixteen years of age in Australia and persists as a significant public health burden [2]. According to the Australian Institute of Health and Welfare (AIHW) [3], in 2017–2018 there were more than half a million paediatric presentations to Emergency Departments across Australia following injury. Additionally, a nationwide, 10-year retrospective study of injuries sustained by Australia's children found that hospitalisations have not decreased across the ten-year period of the study [1,4]. The Victorian Injury Surveillance Unit (VISU) found a statistically significant increase in the annual rate of injury admissions to Victorian hospitals amongst children (0–14 years of age) at a rate of 3.2% per year over a ten-year period (2010/11–2019/20) [5].

Limitations were noted given the Victorian Emergency Minimum Dataset (VEMD) aggregates episode-level data on patients presenting to one of the 40 public hospitals with a designated and state-funded 24 h Emergency Department [6]. In contrast, episode-level emergency presentation data from the remaining 67 health services that have an Urgent Care Centre (UCC), located within more rural areas of the state, are not routinely captured within the VEMD [7]. Urgent Care Centres provide urgent or critical access services, including emergency resuscitation, stabilisation, and, where clinically appropriate, the

preparation of patients for transfer to facilities capable of delivering a higher level of care [8]. Current inconsistencies in the collection and aggregation of data from UCCs result in an incomplete picture of childhood injury presentations, particularly amongst the rural and regional health services.

In their South West Victoria study, Peck et.al. [9] identified a number of key data gaps that could not be addressed within the VEMD that may have masked, or, in some way, underestimated how significant an issue injury is amongst children in the region. These gaps in the data did not provide a full appreciation of the injury incidence and presentation rate in rural areas, or the characteristics that contribute to the occurrence of injury in this region [9]. One solution for understanding the genuine emergency presentation incidence rate in rural Victoria is the Rural Acute Hospital Data Register (RAHDaR) [10]. RAHDaR collates data from health services in the region that provide mandated reporting to the government that appears in the VEMD. RAHDaR also collates data from less-resourced facilities with UCCs that are not currently mandated to report episode-level emergency data to the Department of Health (DH), classified here as non-VEMD data. Health facilities in South West Victoria, including those that are not mandated to report data to the DH (non-VEMD UCCs), provide ongoing episode-level data to RAHDaR, which collates the data in return for twice-yearly benchmarking reports [10].

The VEMD is one of three core datasets of injury surveillance utilised by VISU to underpin injury prevention policies, stimulate research, and develop and evaluate prevention strategies and measures [11]. Unfortunately, without the data from non-VEMD-reporting UCCs that manage in excess of 140,000 emergency cases annually, ref. [7] current datasets may be limited. This is particularly evident as at least a third of the emergency injury presentation data are currently not captured by the VEMD [9]. RAHDaR offers one solution to address the absence of data from UCCs and, in so doing, it provides a more complete and holistic understanding of injury that allows us to begin to identify potential inequalities between the rural, regional, and urban populations.

Within the context of the current state-wide limitations of the VEMD reporting system, this study sought to describe the characteristics of childhood injury presentations to emergency care departments, including the previously unreported UCC data, and to gain an understanding of postcode-level socio-demographic variables that may impact these presentations.

2. Materials and Methods

Using a retrospective cross-sectional research design, the study collected deidentified injury presentation data over a five-year period from 1 February 2017 to 31 January 2022 for children aged 0 to 14 years, where age groups were predetermined by standardised government agencies and also used in VEMD reporting [12]. All paediatric emergency presentation events across the five-year period were collected through RAHDaR [10], collating data from participating healthcare services across six Local Government Areas (LGAs) in South West Victoria that provide emergency or urgent care. Emergency presentation data based on the Victorian Emergency Minimum Dataset (VEMD V.25 for 2020–2021), where the principal diagnosis was indicated to be injury-related (ICD-10 AM: S00-T78) [13], were extracted for analysis. The injury presentation data included gender, age, residential postcode, time and date of arrival and departure, and departure status (admitted, transferred, death, or discharged).

2.1. Data Collection

Informed by existing work [14,15], LGA-level data were obtained from the 2016 [15] and 2021 Australian Censuses of Population and Housing [12], and the Victorian and Regional Health Profile for the relevant data time periods [16]. Other key data were examined and included from the Australian Government Department of Health and Aged Care and the Victorian Department of Health and Human Services (VicHealth) [16–20].

The data gathered were at the LGA level and encompassed the 2017–2021 population data to accommodate for the demographic evolution of the population over the five-year period. The data included population density, Indigenous status, the number of full-time equivalent general practitioners (GPs) per 1000 population, the number and proportion of children attending state-funded three-and-a-half-year final-stage child health assessments (conducted at 3.5 years), and the number and proportion of children enrolled in preschool. In Victoria, preschool includes 3–4-year-old education programs prior to commencing primary school, also known as kindergarten (kinder) [21]. Other data included the proportion of adults who have completed high school, annual average income, unemployment rate, the proportion of adult smokers (18 years of age and older), and the rate of private health coverage. [16,19]. Finally, the four sub-sets of the Socio-Economic Indexes for Areas (SEIFA) were incorporated: the Index of Relative Socio-Economic Disadvantage (IRSD), Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD), Index of Economic Resources (IER), and Index of Education and Occupation (IEO) [16,18]. The data were also cleaned and triangulated by gender, age, and postcode to identify potential multiple presentations of individuals, as a single injury may result in multiple episodes of care. In these instances where repeat presentation occurred or where a child was transferred between institutions, the data beyond the initial presentation were excluded to prevent duplication.

2.2. Data Analysis

Population figures at the LGA level were used to calculate emergency injury presentation incident rates across the related LGAs. Episodes were divided by the corresponding population estimates for each year according to gender, age, and LGA to obtain age-standardised emergency injury presentation rates [22]. Emergency injury presentation rates and predictor variables were analysed by LGA using the Statistical Package for the Social Sciences (SPSS, Version 28.0). The analysis included both ANOVA and *t*-tests along with hierarchical multiple regression. This approach was used to examine the association between emergency injury episodes and the predictor variables. Multivariable weighted least squares regression was also performed to account for any violations of the assumption of equal variance of observations between populations. The initial analysis was conducted to ensure that there was no violation of the assumptions of normality or homoscedasticity, linearity was present where the scatterplot of standardised residuals met the assumptions, while multicollinearity met correlation coefficients greater than 0.8 and variance inflation factors less than 10, as described in Pallant [23]. Significance was determined at two-tailed $p < 0.05$.

2.3. Ethical Approval

Ethical approvals were obtained from the South West Healthcare Human Research Ethics Committee (SWH 2019-167 567), the Deakin University Human Research Ethics Committee (DUHREC 2019-134), and the Federation University Human Research Ethics Committee (FUHREC E19-005) for the use of RAHDaR with all healthcare institutions consenting to participation in the study.

3. Results

Amongst the 15,884 emergency injury presentations, 35.23% (n = 5597) of all presentations occurred at non-VEMD health services, 57.27% (n = 9095) of the total presentations were male, and the highest number of emergency injury episodes was amongst the 10–14-year age group (38.50%, n = 6119) (Table 1).

Examining the rates of emergency injury presentations amongst male and female children at non-VEMD health services, the highest occurred in males 10–14 years of age (175.80 presentations per 1000 children per year), with the lowest rates occurring amongst 5–9-year-old female children (117.49 presentations per 1000 children per year; Table 2). Differences between gender and age group injury rates were significantly different ($p < 0.0001$).

Table 1. Demographic Data.

Factor	Number	Percentage
Where care received (n = 15,884)		
Non-VEMD service	5597	35.23%
VEMD service	10,287	64.17%
Age (n = 15,884)		
0–4 years	4846	30.50%
5–9 years	4919	31.00%
10–14 years	6119	38.50%
Gender (n = 15,884)		
Female	6788	42.73%
Male	9095	57.27%
Other	1	0.0001%

Table 2. Injury emergency presentation incidence rate between age groups from 2017 to 2022.

Age ¥ (Years)	*n*	Incidence Rate *	95% CI	*n*	Incidence Rate *	95% CI	Significance
		Female			Male		
0–4	2170	128.42	125.79–131.05	2676	152.13	149.07–155.19	$p < 0.0001$
5–9	2134	117.49	115.17–119.81	2785	141.87	139.17–144.57	$p < 0.0001$
10–14	2484	129.38	126.89–131.87	3634	175.80	172.54–179.06	$p < 0.0001$
Total	6788	125.10	123.67–126.53	9095	157.10	155.36–158.84	$p < 0.0001$

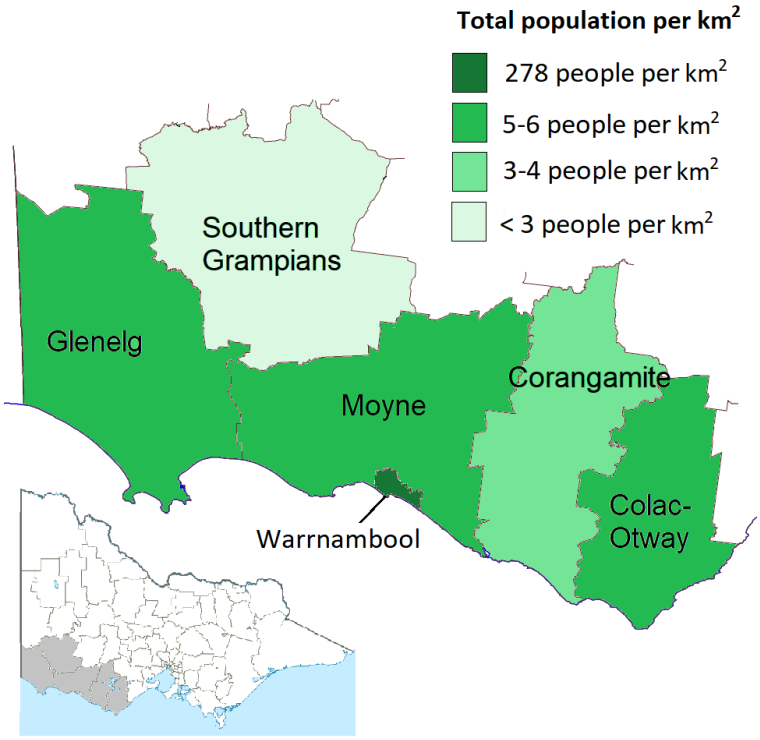
* Per 1000 children per year; ¥ non-binary children excluded due to insufficient numbers.

Age group and gender were divided into quartiles and a heatmap approach was used to classify presentation rates (Table 3). Within the table, the highest presentation rates are denoted as red and amber, with green and light green the lowest rates amongst the various groups. When examining emergency presentations by age group, the highest rates were specifically amongst males aged 10–14 years from Warrnambool (341.88 presentations per 1000 children per year), followed by Moyne males aged 10–14 years (208.08 presentations per 1000 children per year). Conversely, the lowest emergency injury presentation rates across the region occurred amongst females aged 10–14 from Colac-Otway (69.54 presentations per 1000 children per year), with the second lowest rates observed in the same area amongst females aged 5–9 (77.63 presentations per 1000 children per year). Overall, both male and female injury rates for each LGA were significantly different ($p < 0.0001$) (Figure 1).

Table 3. Injury emergency presentation incidence rate by gender and age group at LGA level.

		Injury Emergency Presentation Incidence Rate per 1000 Population							Key Variables Associated with Injury Presentation				
	n ¥ (*n* = 15,883)	0–4	5–9	10–14	0–4	5–9	10–14	Total	GP Ratio *	3.5-year Health Assessment *	Enrolled in Preschool *	Born Overseas *	IEO ¶
		Female			Male								
Warrnambool	5140	147.08	128.73	158.48	173.31	158.82	341.88	162.75	1.50	74.20	428	75.84	963
Moyne	2637	139.33	123.49	150.27	145.50	153.23	208.08	154.85	0.60	59.40	363	60.72	1032
Colac-Otway	1841	105.46	77.63	69.54	133.10	96.76	119.40	100.70	1.20	63.00	293	79.23	940
Corangamite	1929	121.50	185.82	99.23	129.59	189.18	156.33	129.57	1.20	71.20	298	32.24	969
Glenelg	2193	128.05	123.58	128.52	152.16	131.71	157.44	137.25	1.40	81.50	363	121.55	967
Southern Grampians	2143	112.35	139.80	145.32	157.59	151.96	190.64	151.00	0.80	84.60	344	18.46	987
Total/Average	15,884	128.42	117.49	129.38	152.13	141.87	175.80	141.63	1.12	72.32	348	64.67	976

* Per 1000 population; ¶ Index of Education and Occupation (IEO) score associated with Socio-Economic Indexes for Areas; ¥ non-binary children excluded. Heatmap legend: Red = highest rates (75–100%). Amber = moderate rates (50–75%). Green, Light green = lowest two quartile rates (0–25%, 25–50%).



LGA	Child Pop. ¶	Total Pop. ¶	% of Children	Pop. Density*	Incidence rate**
Warrnambool	6,261	35,419	17.68%	278	162.75
Corangamite	3,773	22,304	16.92%	5-6	129.57
Moyne	3,359	17,291	19.43%	3-4	154.85
Glenelg	3,164	20,056	15.78%	3-4	137.25
Southern Grampians	2,829	16,488	17.16%	<3	151.00
Colac-Otway	2,696	16,029	16.82%	3-4	100.70

¶ 2022 child and total population data (ABS, 2023)
* People per square kilometre (km^2)
**Emergency presentations per 1000 child population based on average over 5 years

Figure 1. Population and Incidence Rate by LGA.

When examining the key variables associated with injury presentation in the context of each LGA, Warrnambool was found to have many of the highest rates on the heatmap (Table 3), particularly amongst males, whilst having the highest GP Ratio (1.50 per 1000 population) and proportion of children enrolled in preschool (428 per 1000 child 0–4 population). Southern Grampians, with the second highest rates on the heatmap, particularly males, had the highest rates of 3.5-year health assessment (84.60 per 1000 population) and the lowest number of families born overseas (18.46 per 1000 head of population). Moyne, represented by a comparable rate of injury on the heatmap, had the lowest number of 3.5-year health assessments (59.40 per 100 population) and the highest IEO measure (1032). Higher levels of IEO suggest that the area itself has more people with higher levels of qualification and/or more highly skilled jobs. Colac-Otway, with the lowest incidence rates of childhood injury, had the lowest number of children enrolled in preschool (293 per 1000 children, 0–4 population).

Multiple regression analyses highlighted several significant predictors of injury emergency presentation amongst the 0–4 age group ($F(6, 4839) = 93{,}107.474$, $p < 0.0001$), the 5–9 age group ($F(4, 4912) = 7558.000$, $p < 0.0001$), and the 10–14 age group ($F(4, 6111) = 9289.539$, $p < 0.0001$). After controlling for gender, it was indicated that other variables within each of the models explained 99.6%, 86.0%, and 85.9% of the variance impacting emergency presentations for each group, 0–4-, 5–9-, and 10–14-year-olds, respectively. As outlined in Table 4, males were more likely to present at an ED or UCC with injury, with the highest odds occurring amongst those aged 10–14 years. In addition, as the proportion of children aged 0–4 years attending free three-and-a-half-year final-stage child health assessments and attending

preschool within the LGA increased, so did the likelihood of presenting at an ED or UCC. No data were available to examine if previous preschool attendance increased the likelihood of presenting at an ED or UCC amongst those children now in the 5–9 and 10–14 age groups.

Table 4. Regression analysis associated with 2017–2022 injury emergency presentations and age group.

	0–4				5–9				10–14			
Predictor	**B**	**OR(adj) †**	**95% CI**	***p*-Value**	**B**	**OR(adj) †**	**95% CI**	***p*-Value**	**B**	**OR(adj) †**	**95% CI**	***p*-Value**
Gender (Males) ¥	32.175	1.82	1.79–1.85	0.000 **	32.046	1.86	1.83–1.88	0.000 **	31.666	1.89	1.86–1.91	0.000 **
GP ratio ¶	15.814	1.21	1.19–1.23	0.000 **	93.915	3.39	3.34–3.44	0.000 **	90.658	3.68	3.63–3.72	0.000 **
3.5-year health assessment ¶	0.440	1.15	1.13–1.17	0.000 **	-	-	-	-	-	-	-	-
Children enrolled in preschool ¶	0.309	1.81	1.78–1.23	0.000 **	-	-	-	-	-	-	-	-
Children born overseas ¶	−0.209	0.79	0.78–0.80	0.000 **	−0.318	0.69	0.68–0.70	0.000 **	−0.337	0.65	0.64–0.66	0.000 **
IEO	0.415	1.52	1.49–1.55	0.000 **	1.154	3.43	3.38–3.48	0.000 **	1.097	3.58	3.53–3.63	0.000 **

** $p \leq 0.001$; adjusted odds ratio, OR(adj); † adjusted for gender and age; ¶ per 1000 population; ¥ non-binary children excluded.

Within each LGA, as the number of GPs per head of population and Index of Education and Occupation (IEO) levels increased, so did the likelihood of presenting at an ED or UCC with injury; the highest odds were observed amongst the 10–14-year-old age group. Notably, regardless of age group, as the proportion of those who were born overseas increased, the likelihood of presenting at an ED or UCC with an injury would decrease, with the lowest odds occurring amongst the 10–14-year-old age group. No other factors, including IRSD, IRSAD, IER, Indigenous status, unemployment, parents completing high school, private health coverage, population density, or level of rurality, were determined to be significant factors.

4. Discussion

Existing research highlights that access to the non-VEMD data represents a 35% improvement in our current ability to detect emergency injury presentations in the region investigated [10,24]. With respect to age, emergency injury presentations increased across the sample in each of the age brackets. Existing Australian research routinely shows a reduction in emergency presentation for injury amongst the 5–9-year age group [4,25]. Parental perceived urgency is a leading cause of paediatric ED presentations with non-urgent conditions [26] and has been found to increase in instances where a child is of a younger age and unable to verbalise [27]. When coupled with a desire to access specialists with expertise in managing children and specialist equipment, these factors account for the consistently high rates of presentations amongst the 0–4 age group reported [26]. For children in the 5–9 age bracket, their ability to verbalise their signs and symptoms and associated lower levels of perceived urgency amongst parents has previously been noted to lead to a reduced need to attend the ED [27]. Instead, we suggest that children aged 5–9 may be triaged by their parents as requiring some form of review, but not to the level required of an ED or UCC, and so are satisfied to attend a GP. The increase in presentations amongst both female and male 5–9-year-olds in Corangamite requires further investigation and strongly supports the use of the RAHDaR data to highlight previously hidden anomalies.

In contrast to existing national and international research [25,28], this study has highlighted that decreased socioeconomic status, for children within the geographic area, does not lead to increased injury-related presentations. Interestingly, in the context of the four SEIFA indices, with the IEO measure specifically, children from areas classified as educationally advantaged had higher rates of injury presentation, particularly in the 10–14-year age group. Existing research has shown a direct correlation between level of education achieve-

ment and health literacy [29,30] and suggests that parents from educationally advantaged areas in the present study are likely to experience higher levels of health literacy.

Additionally, regardless of age group, as the proportion of those who were born overseas within an LGA increased, the likelihood of presenting at an ED or UCC with an injury would decrease, with the lowest odds occurring amongst the 10–14-year-old age group. Having parents born overseas has been shown to represent a significant risk for ED presentations for less urgent reasons across the lifespan; health literacy due to language barriers and unfamiliarity with the health system contribute to this risk [31,32]. This finding must be considered cautiously as the South West region in question represents a predominately monocultural population with less than 3% of the population being born outside of Australia [16].

Thus, in the context that lower levels of health literacy are typically shown to be associated with higher rates of ED use [33,34], these findings present opportunities to identify and better address the needs of culturally and linguistically diverse groups, and further targeted inquiry to understand the mitigating and complex interacting factors that explain the emergency injury presentations.

Another important finding suggests that, amongst the 0–4-year-old age group, as the proportion of children attending a free three-and-a-half-year final-stage child health assessment and attending preschool increases, so did the likelihood of presenting at an ED or UCC with injury. Preschool (kinder) education in Victoria for 3–4-year-olds is not compulsory, but early access to quality education and care has been shown to relate positively to a child's transition to primary school [35–37]. This finding provides compelling support for injury or safety awareness programs targeted at 3–4-year-old children [38]. The central aim of kinder education is enhancing physical and cognitive as well as social development, where some risk is considered essential [39] in challenging and testing limits and exploring boundaries [40,41]. Allowing children to engage in what Sandseter [42] describes as risky play involves "thrilling and exciting forms of physical play that involve uncertainty and a risk of physical injury" (p. 22) and helps the development of knowledge about the assessment and handling of risk [43]. Evidence for children's predisposition to risky play as a necessary and natural part of play and its positive influence is increasing [44]. Therefore, children of all ages who have attended kindergarten informed by a pedagogy that recognises the importance of risk and enables the experience of risk as an essential component of development, must assume that injury will naturally follow at some point. If this is indeed a driver of injury presentation rates for children, caution must be taken to address the inevitable tension between injury rate and the development of risk consciousness within this population, requiring sophisticated early years education.

In 2023, the Victorian Government introduced opportunities for 3–4-year-olds to access preschool free of payment. However, at the time of the data collection period, 3-year-old preschool services were available by way of a fee. We postulate a possible link here between parents from areas classified as having a higher IEO and the attendance of their children at 3-year-old kinder. Parents with higher levels of education themselves are more supportive of early educational opportunities for their children [45,46], and therefore, are more likely to send their child(ren) to 3-year-old kinder. As a function of the kinder curriculum itself, we postulate that the pedagogy of learning through risky play, coupled with the characteristics of parents with higher levels of IEO who, arguably, enable opportunities for learning, subsequently culminate in higher levels of childhood injury being presented for care.

Interestingly, as the number of GPs per head of population increased, so did the likelihood of presenting at an ED or UCC with injury, where the highest odds were observed amongst the 10–14-year-old age group. Research globally has consistently reported an association between ED utilisation and reduced accessibility of primary care services, particularly general practitioners [47]. Despite this, other studies have identified a changing trend in the utility of GP services, given the appeal of extended hours of service, and the access to specialised multidisciplinary healthcare with no co-payment that EDs and many UCCs offer. Elsewhere it has been identified that timely access—within 2 days—to GP

services is negatively associated with self-referral to ED services [48]. We postulate that while the GP ratio per head of population is high, it is possible that timely access to these services might be impacted by a number of GPs who are employed on a part-time basis, a finding consistent with other works in the Australian literature [49]. Further research is needed to better understand the decision-making process of parents presenting at an ED or UCC with an injured child.

Limitations

The present study reflects the injury reporting system within Victoria and includes 22,082 presentations across the nine facilities, representing 1.9% of children living across Victoria and needs to be considered in terms of meaningful implications. Further, Australian states and territories adopt injury reporting mechanisms that are customised for their own needs. The findings, therefore, may not be transferable to other jurisdictions. The study was limited to children aged 0–14 years. A more comprehensive overview of injuries amongst all age groups would facilitate a greater understanding of current reporting deficits, the genuine injury burden, and the prioritisation of injury prevention strategies for children.

5. Conclusions

Targeting policy and practice-based interventions in an effort to redress injury amongst Victoria's children requires a solid foundation of accurate and accessible data. In rural Victoria, this has not been the case. Gaps in the available governmental data do not provide a complete appreciation of the injury incidence and presentation rates in more rural areas and have underestimated how significant an issue injury is amongst children in the South West region. While a number of the findings are consistent with existing research, the study highlights the specific population factors, including rates of attendance at health assessments, access to general practitioners, parent education levels, and overseas birth, which are predictive of emergency injury presentations in South West Victoria. Significantly, access to the non-VEMD data has highlighted that a higher percentage of childhood injury presentations occurred in lower-resourced health services than was anticipated. Improving our understanding of the characteristics of childhood injury through access to more complete data provides the basis for the better-informed allocation of resources to meet the needs of the previously overlooked rural communities.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the South West Healthcare Human Research Ethics Committee (SWH 2019-167 567), the Deakin University Human Research Ethics Committee (DUHREC 2019-134), and the Federation University Human Research Ethics Committee (FUHREC E19-005).

Informed Consent Statement: This is a retrospective study using non-identifiable data collected as part of usual care. As such, informed consent for each participant was unable to be obtained and waived by the ethics committees (the South West Healthcare Human Research Ethics Committee, Deakin University Human Research Ethics Committee, and Federation University Human Research Ethics Committee). All healthcare institutions provided their written consent to participate in the study.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author due to restricted access to hospital data.

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