Epidemiology, clinical characteristics and outcomes of patients with severe traumatic brain injury treated by emergency medical services in New Zealand: a retrospective observational study

Ben Jones, Bridget Dicker, Graham Howie, Kelly Jones, Irene Zeng, Andrew Swain, Aroha Brett, Verity Todd

ABSTRACT

AIM: This study aimed to characterise the epidemiology, clinical features and outcomes of adults with severe traumatic brain injury (sTBI) managed by emergency medical services (EMS) in New Zealand. Objectives included describing demographics, event and clinical characteristics, estimating national incidence, and 30-day mortality.

METHODS: This retrospective observational study analysed EMS data from the Aotearoa New Zealand Paramedic Care Collection (ANZPaCC) between 1 January 2020 and 31 December 2022. Patients aged ≥16 years with head injury and a Glasgow Coma Scale score ≤8 were included. Descriptive statistics and age-standardised incidence rates were calculated by sex, ethnicity, age, rurality and socio-economic deprivation.

RESULTS: EMS attended 630 sTBI patients over 3 years; most were male (n=430, 68.3%) and of European/Other ethnicity (n=398, 63.2%). sTBI incidence was higher among Māori than non-Māori (44.5–68.7 versus 28.6–35.6 per 100,000 person-years). Younger adults (≤45 years) had the highest rates. sTBIs in urban areas (n=485, 77%) and the most deprived quintile (n=213, 33.8%) were over-represented. Falls (n=217, 34.4%) and road traffic incidents (n=196, 31.0%) were the leading mechanisms. Thirty-day mortality was 37.8% (n=238).

CONCLUSION: EMS working diagnoses of sTBI provide a valuable perspective on patient needs at the point of injury, capturing cases that may be missed in hospital-based datasets yet still influence transport decisions, destination selection and tertiary healthcare capacity. The data indicate that sTBI disproportionately affects Māori, younger adults, individuals living in socio-economically deprived areas and urban populations, highlighting health inequities and the need for targeted interventions, informed service planning and further research.

Traumatic brain injury (TBI) is damage to the brain tissue due to an external force, typically caused by trauma to the patient's head.[1] TBI may result from blunt force, a penetrating injury, rapid acceleration or deceleration or exposure to blast waves, disrupting normal brain functions, potentially causing temporary or permanent neurological impairments.[1] A TBI can be categorised as either mild, moderate or severe, though accurately defining each type of brain injury is difficult. The Glasgow Coma Scale (GCS) is a traditional tool used by emergency medical services (EMS) to categorise a TBI into one of these three severity categories. The GCS assesses three aspects of the brain: eye opening, verbal response and motor response, which when combined create a GCS score ranging from 3 to 15. Using the GCS, mild TBI is classified as a GCS score of 14–15, moderate TBI as 9–13 and severe TBI (sTBI) as 3–8.[2]

sTBI, the most life-threatening category of TBI, is a critical global health issue associated with high mortality and long-term disability.[3] Incidence rates of sTBI are particularly difficult to find in the literature, but worldwide the overall annual TBI (all types) incidence is estimated to be as high as 69 million,[4] and it is the leading cause of long-term disability in children and young adults under 35 years old.[5] In the United States of America (USA) alone, approximately 1.7 million people sustain a TBI each year.[5] Of these, 1.1 million are treated and released from emergency departments, around 235,000 are hospitalised and

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approximately 50,000 die annually.[3] Moreover, an estimated 124,000 individuals develop long-term TBI-related disabilities.[5] Economically, the cost of TBI, including acute care, rehabilitation, disability compensation and lost productivity, is considerable, costing the global economy an estimated US$400 billion per year.[6] However, the burden of TBI extends beyond the individual. Due to its physical and cognitive impairments as well as emotional and social challenges,[7] it also affects families, caregivers and society.[8]

New Zealand Trauma Registry data (2023/2024) show that central nervous system injuries, including sTBI, account for approximately 70% (n=120) of major trauma deaths, with 212 total major trauma patients presenting with sTBI.[9] However, these figures rely on in-hospital diagnostic tools, such as computed tomography imaging and Injury Severity Score calculations, which are unavailable to EMS. This difference in diagnostic capability highlights the need to characterise the EMS cohort with working diagnoses of sTBI.[6] Further, we need to understand the number of EMS-diagnosed sTBIs here in New Zealand, because although some may be misdiagnosed, they will be treated as such until proven otherwise. Currently, this information is not available, as only those with a confirmed diagnosis will be reported.

A critical phase in the management of acute sTBI is the prehospital period, during which the prevention of secondary brain insults, such as hypoxia, hypotension and hypo/hypercarbia, is paramount.[10] Although the prehospital phase is clearly important, most studies focus on in-hospital care, which leaves a gap in understanding how early interventions by EMS impact sTBI patients. Factors such as ambulance response times and patient-specific characteristics (e.g., age, sex, ethnicity and socio-economic status) likely contribute to patient outcomes. However, these influences remain poorly characterised in the literature, particularly within the context of the New Zealand EMS system.

Prior to understanding the impact of prehospital treatment and care, it is imperative to understand the anticipated need at the point of injury, including patients who influence destination choice, transport burden and tertiary capacity but may be excluded from in-hospital datasets. However, no nationwide study has comprehensively examined the epidemiology, clinical characteristics and outcomes of patients with a working EMS diagnosis of sTBI treated by EMS in New Zealand. To address this gap, a retrospective, quantitative, observational study was conducted using 3 years of national EMS data. The study aimed to describe the cohort's demographic, event and clinical characteristics, as well as incidence and mortality rates.

Methods

Using the Aotearoa New Zealand Paramedic Care Collection (ANZPaCC) dataset (which has been previously described[11]), this retrospective, observational cohort study included patients aged 16 years or older with a head injury and an EMS-calculated GCS score of 8 or less, occurring between 1 January 2020 and 31 December 2022. Patients were excluded if they sustained a brain injury due to drowning or hanging, or if they were deceased upon EMS arrival. Though the clinical care records of some New Zealand helicopter emergency medical services (HEMS) are held within the ANZPaCC dataset, no permissions were sought to use this data; as such, any patient who was cared for by HEMS was excluded.

This manuscript adheres to the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) standards.[12] Ethical approval for this study was obtained from the Northern B Health and Disability Ethics Committee (HDEC), Aotearoa New Zealand, Paramedic Care Collection (HDEC reference: 2023 AM 13415).

New Zealand has a land area of 264,920 square kilometres and a population of 5.2 million, of which over 4.3 million live in an urban area.[13,14] Two primary ambulance services operate in New Zealand: Hato Hone St John, serving 90% of the country, and Wellington Free Ambulance, covering the remaining 10%. These services respond to at least 500,000 incidents annually and operate under the same clinical practice guidelines (CPGs) that all EMS personnel follow.[15]

Ambulances in New Zealand are typically staffed by two clinicians with varying Authority to Practice (ATP) levels, including emergency medical assistants, emergency medical technicians, paramedics, intensive care paramedics, extended care paramedics and critical care paramedics (CCPs). For major trauma cases such as sTBI, an ambulance crew is usually supported by a CCP operating from a separate vehicle. In rural or remote settings, a HEMS crew is often deployed to provide advanced care and expedite transport.

Demographic variables included patient age, sex, ethnicity, socio-economic deprivation score and rurality. Patient ethnicity was prioritised according to the Ministry of Health – Manatū Hauora HISO

10001:2017 Ethnicity Data Protocols.[16] Ethnic classification was coded at Level 1, including European, Māori (the Indigenous population of New Zealand), Pacific peoples and Asian/Middle Eastern/Latin American/African (grouped as Asian and MELAA). Residual responses such as “don’t know”, “refused to answer”, “response unidentifiable”, “not stated” and “other” were grouped as “Other”.

Meshblocks created by Stats NZ Tatauranga Aotearoa categorise each section of the country as either Urban 1, Urban 2, Rural 1, Rural 2 or Rural 3.[17] Summarised as rurality, the category a meshblock is assigned depends on that area’s access to healthcare. Due to small numbers, we have combined Urban 1 and 2 into a single group called “Urban” and merged all Rural groups into the group “Rural”.

Socio-economic deprivation was estimated using the New Zealand Index of Deprivation 2018 (NZDep2018)[18] with scores ranging from 1 (least deprived) to 10 (most deprived top 10%), reported as quintiles. This deprivation index takes into account the patients’ income, employment status, overcrowding and educational level. 2018 meshblocks of the patients’ residential addresses were utilised to determine their deprivation index.[18]

Event variables included the mechanism of injury and 30-day mortality. Time-based metrics comprised two intervals: response time, defined as the duration from when the emergency call was answered at the call centre to EMS arrival on scene, and alarm-to-hospital time, defined as the duration from call answer to patient arrival at the hospital. Median times for both intervals were manually calculated.

The primary outcome variable was mortality evaluated at 30 days in alignment with the Utstein Trauma Template.[19] The clinical variables analysed were the patient’s first and last GCS score, their first and last systolic blood pressure (SBP) and their first and last respiratory rate (respiration rate per minute) as reported by the treating clinicians.

Descriptive analyses of demographic, clinical and outcome variables were conducted using medians and interquartile ranges (IQRs) for continuous data, and frequencies and percentages for categorical data. Age-standardised and crude incidence rates of sTBI per 100,000 person-years were calculated using Health New Zealand – Te Whatu Ora population data.[20] To account for potential differences in age structure, particularly within the Māori population, age-standardisation was performed using the World Health Organization (WHO) standard population for non-Māori and a Māori-specific standard population. [21,22]

Incidence rates were calculated for 2020, 2021 and 2022 and stratified by ethnicity (Māori versus non-Māori), age (16–24, 25–44, 45–64, 65+ years), sex (male, female), rurality (Urban, Rural) and socio-economic deprivation (Q1–Q5). Ethnic categories followed Ministry of Health – Manatū Hauora protocols, with non-Māori comprising European, Pacific peoples, Asian and Other.[23] Crude and age-adjusted rates were expressed per 100,000 person-years and were calculated using standard epidemiological formulas.

Results

Between 1 January 2020 and 31 December 2022, 630 adult patients with sTBI met the study inclusion criteria (Table 1). Most were male (n=430, 68.3%), of European/Other ethnicity (n=398, 63.2%) and urban residents (n=485, 77%). The highest proportion occurred in the most deprived areas (quintile 5: n=213, 33.8%).

Falls (n=217, 34.4%) and road traffic incidents (n=196, 31.0%) were the leading mechanisms of injury (Table 2). Blunt trauma accounted for over 99% of cases, with only one instance of penetrating injury. The median EMS response time was 8.9 minutes (IQR 5.8–14.1), and the median time from call to hospital arrival was 62.8 minutes (IQR 41.7–98.4). Of the 630 patients, 30-day mortality was 238 (37.8%).

A GCS score of 3 was the most common first- and last-recorded score (first n=290, 46.0%; last n=343, 54.4%). The SBP remained stable between first and last assessments (137mmHg, IQR 120–158 versus 135mmHg, IQR 120–158). Respiratory rates were similarly consistent, with medians of 18 breaths per minute (IQR 12–24) initially and 16 (IQR 12–20) at final assessment (Table 3).

Over the 3 years of this study, Māori experienced higher crude incidence rates of sTBIs than non-Māori (Appendix Table 1 and Appendix Figure 1). The incidence rate ratio consistently showed that there were nearly or more than twice as many sTBIs among Māori compared with non-Māori (Appendix Table 1). No clear trend was observed over time.

After adjustment to standard populations, age-adjusted incidence rates varied by ethnicity and age group. sTBI rates for Māori ranged from 44.5 to 68.7 per 100,000 person-years (Figure 1), compared with 28.6 to 35.6 per 100,000 for non-Māori. Adults aged 25–44 years exhibited the

Table 1: Demographic variables of severe traumatic brain injury cases attended by road-based ambulance between 1 January 2020 and 31 December 2022.

Variable	Description	Number (%) Total n=630
Sex	Male	430 (68.3%)
	Female	198 (31.4%)
	Unknown	2 (0.3%)
Age	16–24	130 (20.6%)
	25–44	176 (27.9%)
	45–64	149 (23.7%)
	65+	173 (27.5%)
	Missing	2 (0.3%)
Ethnicity	Māori	175 (27.8%)
	European/Other (Indian, Asian, African)	398 (63.2%)
	Pacific peoples	52 (8.3%)
	Other	5 (0.8%)
Socio-economic deprivation (patient home address)	Quintile 1 (least deprived)	104 (16.5%)
	Quintile 2	85 (13.5%)
	Quintile 3	100 (15.9%)
	Quintile 4	128 (20.3%)
	Quintile 5 (most deprived)	213 (33.8%)
Rurality	Urban	485 (77.0%)
	Rural	136 (21.6%)
	Missing	9 (1.4%)

highest incidence in both ethnicity groups (19.3–30.5 per 100,000 for Māori and 8.2–10.6 per 100,000 for non-Māori [Appendix Table 2]). A <45 years versus >45 years trend was evident across ethnicities, where younger adults experienced a higher rate of sTBI compared with adults over 45 years old. Though this pattern was observed in both ethnic groups, it was more pronounced among Māori (Appendix Table 2). Conversely, individuals aged ≥65 years consistently had the lowest rates (2.85–6.0 per 100,000 person-years).

The results of incidence by deprivation score (Figure 2) demonstrate a clear correlation, with higher deprivation linked to increased risk of sTBI. Across all three years, quintile 5 showed the highest incidence, rising from 6.2 per 100,000 person-years in 2020 to 7.6 in 2022.

Discussion

This study provides the first nationwide analysis of suspected sTBI in New Zealand using solely prehospital EMS data, capturing the burden at the moment of first medical contact rather than after hospital confirmation. Over a 3-year period, EMS attended 630 sTBI patients, predominantly male (68.3%) and urban residents (77.0%), with falls (34.4%) and road traffic incidents (31.0%) being the leading injury mechanisms. The data quantify the operational load generated by EMS working diagnoses of sTBI, revealing time-critical pressures and resource demands that hospital-only datasets

Table 2: Event variables of severe traumatic brain injury cases attended by road-based ambulance between 1 January 2020 and 31 December 2022.

Variable	Description	Number (%) Total n=630
Mechanism of injury	Fall	217 (34.4%)
	Road traffic incident	196 (31.0%)
	Assault	67 (10.6%)
	Other	149 (23.7%)
	Missing	1 (0.2%)
Median time from alarm to EMS arrival (mins)		8.9 (5.8–14)
Median time from alarm to hospital arrival (mins)		62.8 (41.7–98.4)
Mortality	Alive ≥30 days	392 (62.2%)
	Deceased <30 days	238 (37.8%)

EMS = emergency medical service.

Table 3: Clinical variables of severe traumatic brain injury cases attended by road-based ambulance between 1 January 2020 and 31 December 2022.

Variables	Number (%) Total n=630	
EMS GCS (total score)	First	Last
3	290 (46.0%)	343 (54.4%)
4	65 (10.3%)	35 (5.6%)
5	50 (7.9%)	25 (4.0%)
6	66 (10.5%)	56 (8.9%)
7	80 (12.7%)	55 (8.7%)
8	79 (12.5%)	65 (10.3%)
EMS SBP (mmHg) (median, IQR)	137 (120–158)	135 (120–158)
EMS respiratory rate (per minute) (median, IQR)	18 (12–24)	16 (12–20)

EMS = emergency medical service; GCS = Glasgow Coma Scale; SBP = systolic blood pressure; IQR = interquartile range.

Figure 1: Overall age-standardised incidence rate of severe traumatic brain injury per 100,000 person-years for Māori and non-Māori.

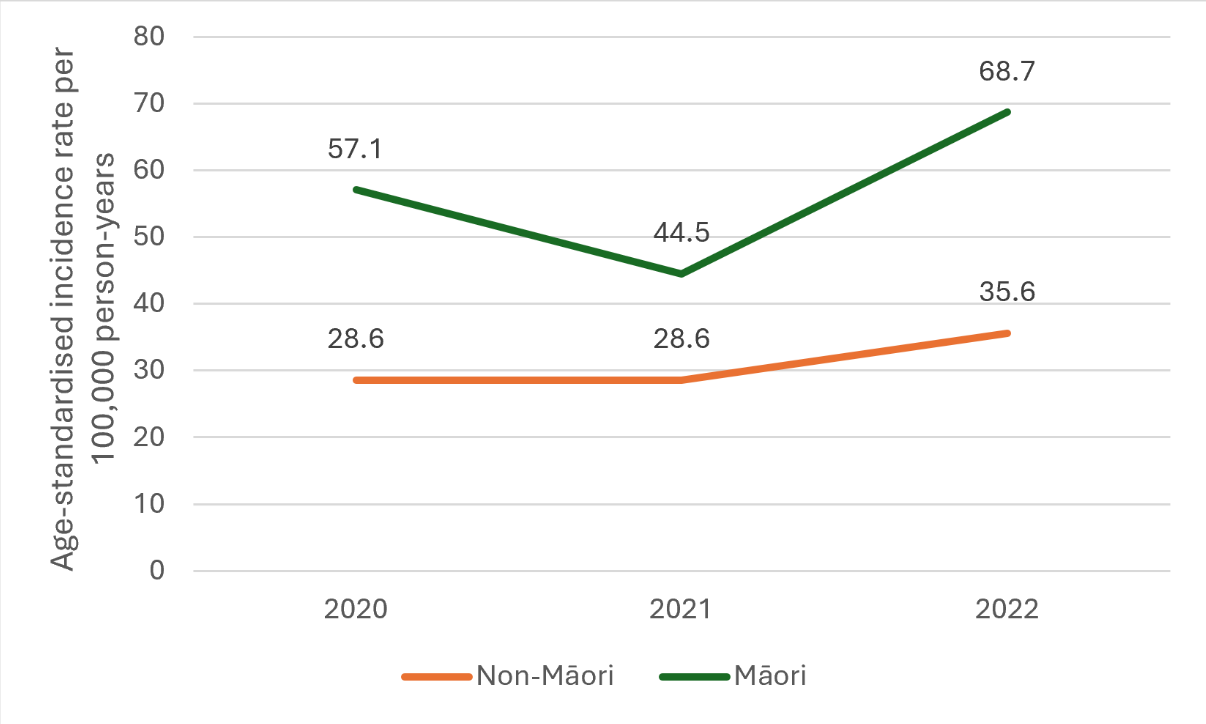
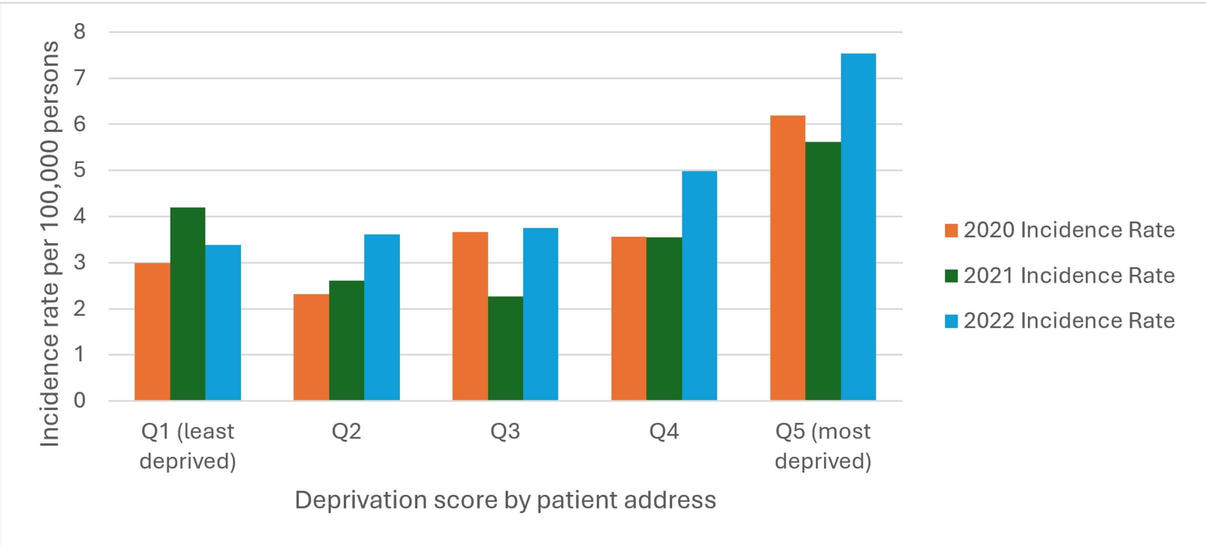


Figure 2: Incidence rate of severe traumatic brain injury per 100,000 persons by deprivation score quintile of patients' home address.



cannot show, and directly informing ambulance and hospital system planning, as these patients activate high-gresource pathways regardless of eventual diagnostic accuracy.

Marked inequities were evident, with Māori experiencing more than twice the incidence of sTBI compared with non-Māori, particularly among those under 45, and with incidence increasing alongside socio-economic deprivation. The overall 30-day mortality rate was 37.8% (n=238). These findings underscore the need to review current TBI prevention strategies and EMS practices through an equity lens, considering the intersecting roles of age, gender, ethnicity, socio-economic deprivation and access to advanced-level medical care.[24]

Annual crude incidence rates of sTBI among patients receiving prehospital EMS care between 2020 and 2022 ranged from 3.9 to 10.9 per 100,000 person-years. Direct comparison with international data is challenging due to inconsistent sTBI definitions and variable inclusion criteria; many studies report TBI broadly or combine moderate and severe cases, yielding rates from 47.3 to 694 per 100,000.[4,25] A more comparable study is BRAIN-PROTECT, a prospective observational study in the Netherlands, which reported an incidence of 3.2 per 100,000 for prehospital suspected sTBI, a finding remarkably similar to the results in this study.[7]

The age-standardised incidence of sTBI was consistently higher among Māori compared with non-Māori, with the disparity most pronounced in younger age groups. In 2022, Māori aged 16–24 years had an incidence rate of 35.3 per 100,000 person-years, nearly six times higher than non-Māori (6.1), while Māori aged 25–44 also exhibited substantially higher rates (25.1 versus 9.7). Although Māori aged 45–64 had lower rates than non-Māori in 2020 and 2021, this reversed in 2022 (9.0 versus 7.5). Among those aged ≥65 years, Māori consistently had a lower incidence than non-Māori. Overall, Māori rates increased sharply in 2022, rising from 44.5 to 68.7 per 100,000, compared with a smaller increase among non-Māori (28.6 to 35.6). These findings reflect a widening inequity, observed primarily in younger Māori populations, and align with international evidence showing disproportionately higher TBI rates among Indigenous groups. For example, Australian Indigenous populations experience TBI (all types) at 166.4 per 100,000 person-years compared with 86.3 among non-Indigenous groups,[26] and a systematic review found 12 of 26 studies reporting similar disparities across Australia, New Zealand, Canada and the USA.[27] In New Zealand, these findings underscore the need for prevention strategies that are not only targeted by age and mechanism, but co-designed with Māori communities to address the structural determinants driving inequitable sTBI burden.

Nationally, major trauma volumes in New Zealand fluctuated between 2019 and 2024, with a well-documented transient decline during COVID-19 Alert Level 4 restrictions in 2020, when transport-related injuries fell sharply, followed by a gradual increase in subsequent years.[9] Our 3-year study period (2020–2022) overlaps with pandemic-related disruptions to injury patterns. One New Zealand study conducted during the pre-lockdown and lockdown periods indicated a small (nearly 2%) decrease in EMS trauma callouts.[28] While reduced sTBI cases in 2020–2021 may partly reflect lockdown effects on injury-producing activity, the broader national trend of increasing major trauma across this period suggests COVID-19 restrictions alone do not fully explain the observed fluctuations in sTBI incidence.

Our findings reinforce the established association between socio-economic deprivation and major trauma.[29] Patients in the most deprived quintiles (quintile 4–quintile 5) consistently exhibited higher crude sTBI incidence across all 3 years, reaching 7.5 per 100,000, compared with 2.3–4.2 per 100,000 in the least deprived areas (quintile 1–quintile 3). These results align with international evidence showing elevated injury risk in deprived communities.[29]

Falls (34.4%, n=217) and road traffic incidents (31.0%, n=196) were the leading causes of injury among adults receiving prehospital EMS care, with blunt trauma accounting for over 99% of cases. Although penetrating injuries represented only 1%, the true number may be higher, as other patients with penetrating injuries likely died before EMS arrival and so were excluded. The high proportion of fall-related injuries likely reflects an ageing population and older adults' vulnerability to head trauma. Assaults accounted for 10.6% of cases, indicating a smaller yet notable contribution of interpersonal violence to the sTBI burden.

Given the high morbidity and mortality associated with sTBI, rapid access to both prehospital and in-hospital care is essential for improving outcomes. Our study had a median EMS response time of 8.9 minutes (IQR 5.8–14), closely aligning with a comparable study reporting 9 minutes (range 7–13). Total time from call to hospital arrival showed a similar pattern, with our study's median of 62.8 minutes comparable with the other study's 79 minutes.[30] The consistency across these time intervals suggests that EMS response and transport performance in New Zealand is broadly in line with international benchmarks. Collectively, these findings indicate that system-level time metrics are not a primary contributor to the burden of sTBI outcomes in the New Zealand context.

The study revealed a higher incidence of urban sTBIs (485) versus rural sTBIs (136). Given the larger population living in urban areas, it was not surprising to see these differences. Potentially compounding these differences was the exclusion of all 77 (roughly 10% of the total sTBI cases) HEMS cases. As HEMS are rarely dispatched to urban environments in New Zealand, most of these HEMS cases were likely completed in rural locations. However, an incidence rate by location of incident was not calculated, nor were the HEMS cases analysed, so the authors cannot comment directly on either the overall incidence rate by location or on whether the exclusion of HEMS cases definitely led to an over-representation of urban cases. As such, readers should exercise caution when interpreting the ratio of urban to rural sTBIs.

Early assessment and treatment of sTBI are strongly associated with improved outcomes. In this study, most patients presented with near-normal SBP and respiratory rates. Median SBP was slightly hypertensive but remained constant from initial to final EMS recordings, as were the respiratory rates (18 and 16 breaths per minute).[31] These findings are somewhat unexpected, as sTBI is typically associated with physiological instability and risk of secondary brain injury.[30] The observed stability may reflect effective early EMS intervention or, alternatively, selection bias towards patients who survived long enough to receive care.

The 30-day mortality rate of 37.8% among sTBI patients in this study aligns with international reports of 30–45%.[7,32] Reassuringly, these rates were nearly identical to those observed in the BRAIN-PROTECT study (37.8% versus 39%).[7] Although our study was retrospective, the methodologies and reporting criteria were comparable, as were EMS protocols between the two countries. However, a notable limitation of this study is the absence of analysis on prehospital factors that may have influenced patient outcomes.

This nationwide study provides a crucial first look at the burden of suspected severe traumatic brain injury at the moment of first medical contact in New Zealand, revealing the substantial operational pressures placed on EMS and the profound inequities shaping who is most affected. The consistently higher incidence of sTBI among Māori, particularly younger Māori, alongside the clear socio-economic gradient, underscores that sTBI is not only a clinical challenge but an equity issue embedded within broader structural determinants. While EMS performance indicators aligned with international benchmarks, mortality remained high, indicating that system-level time metrics alone do not account for outcomes. Together, these findings highlight the urgent need for prevention and response strategies that are co-designed with Māori communities, targeted by age and mechanism and grounded in principles of equity. Future work will require larger, multi-year analyses that integrate hospital outcomes, explore modifiable prehospital factors and deepen understanding of how early clinical decisions influence survival, ensuring that future system improvements are both evidence based and equity focussed.

Implications and recommendations

The findings of this study have important implications for trauma system planning and policy in New Zealand. The strong socio-economic gradient and disproportionate burden of suspected sTBI among Māori, particularly younger adults, demonstrate that upstream determinants such as poverty, unsafe environments and structural inequities are key drivers of injury risk. Effective prevention must therefore extend beyond clinical interventions to address the broader social and infrastructural conditions that increase vulnerability in high-deprivation communities.

The study also highlights inequities at the point of first medical contact, suggesting that disadvantaged groups may experience not only higher exposure to injury but also unequal access to prevention, emergency response and trauma services, as discussed earlier.[24] These findings reinforce the need for an equity-focussed trauma system in which resources, workforce capability and service design are aligned with demonstrated patterns of need. Ensuring culturally safe and responsive care, particularly for Māori and other minority populations, is essential to reducing these disparities across the trauma pathway.

Future research will expand on this work by disaggregating data by mechanism of injury and ethnicity to better understand which injury types disproportionately affect specific populations. Additionally, investigations will examine inequities across the full continuum of trauma care, from injury occurrence through prehospital management, acute care and rehabilitation. Linking multiple datasets, including additional ANZPaCC years and the National Trauma Registry, will allow more detailed analysis of where inequities emerge and where interventions may have the greatest impact. Together, these directions will support the development of a more equitable and effective trauma system for New Zealand.

Limitations

Several limitations existed with this study. These include its retrospective design and the decision not to exclude multi-system trauma, meaning other injuries may have influenced outcomes. Although stratification of injury mechanism by ethnicity and year would have strengthened the epidemiological value of these findings, group sizes within ethnic sub-groups were insufficient to permit reliable analysis. Reliance on EMS-diagnosed sTBI for inclusion introduces a risk of misclassification, where, for example, alcohol or drugs may have reduced the patient's GCS score rather than the sTBI. Finally, as previously discussed, the timing of the study and the decision to remove all HEMS cases may have impacted our reported rates of sTBI.

Conclusion

Use of EMS working diagnoses of sTBI in this study provides a more accurate picture of anticipated need at the point of injury, a critical population that includes patients who influence destination choice, transport burden and tertiary capacity but may be excluded from in-hospital datasets. This study highlights that sTBI disproportionately impacts Māori, younger adults and socio-economically deprived communities. The findings of this study have important implications for trauma system planning and policy in New Zealand.

COMPETING INTERESTS
Nil.

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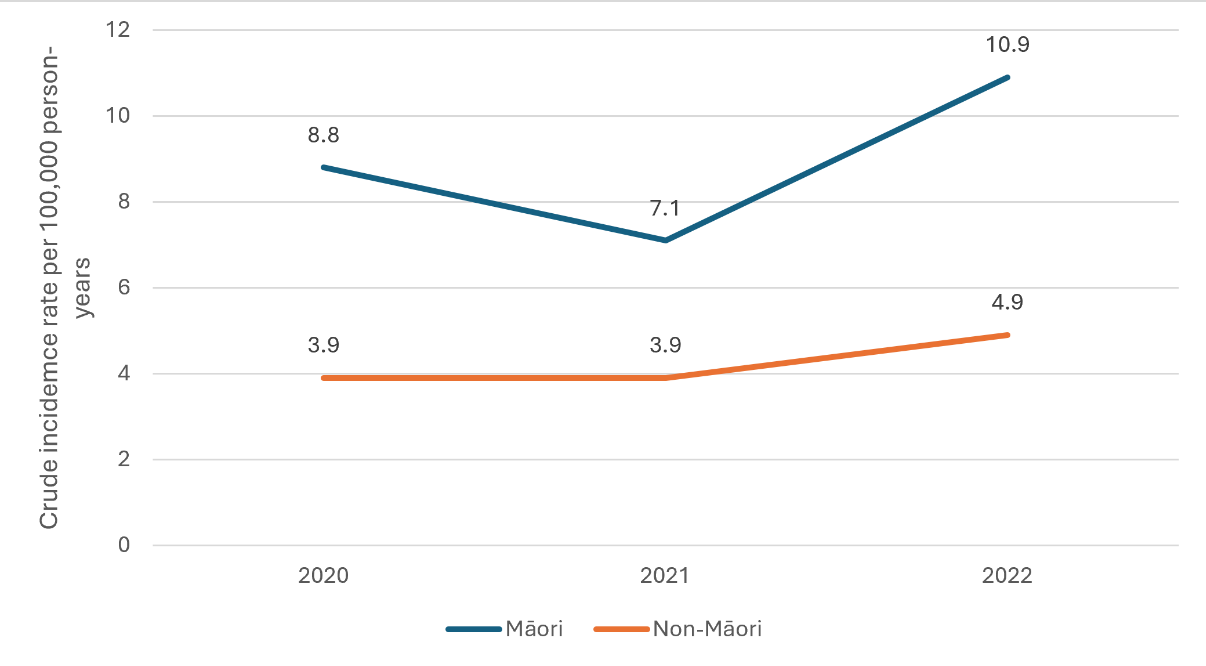
Appendix

Appendix Figure 1: Severe traumatic brain injury: crude incidence rate per 100,000 person-years, Māori versus non-Māori.



Appendix Table 1: Severe traumatic brain injury crude incidence rates per 100,000 person-years, Māori compared with non-Māori.

	2020		2021		2021	
	Adult non-Māori pop ≥16	**Adult Māori pop ≥16**	**Adult non-Māori pop ≥16**	**Adult Māori pop ≥16**	**Adult non-Māori pop ≥16**	**Adult Māori pop ≥16**
Total number of TBIs	137	52	137	43	172	68
Population	3,526,940	592,790	3,534,270	609,350	3,536,990	623,830
Crude incidence rate	3.9	8.8	3.9	7.1	4.9	10.9
Incidence rate ratio Māori/non-Māori	2.26		1.82		2.24	

TBI = traumatic brain injury.

Appendix Table 2: Severe traumatic brain injury age-standardised incidence rate per 100,000 person-years for Māori and non-Māori.

Māori									
	2020	2021	2022	2020	2021	2022	2020	2021	2022
Age group (years)	Population (n)			Number of cases (n)			Age-standardised incidence rate per 100,000 persons		
16–24	149,930	153,120	156,310	14	15	29	17.7	18.6	35.3
25–44	218,730	225,610	231,180	23	15	20	30.5	19.3	25.1
45–64	167,870	170,910	173,200	5	7	13	3.6	4.9	9.0
≥65	56,250	59,670	63,200	10	6	6	5.3	3.0	2.9
Total	592,780	609,310	623,890	52	43	68	57.1	44.5	68.7
Non-Māori									
16–24	506,430	492,080	483,870	20	18	32	6.6	6.1	11.0
25–44	1,179,540	1,180,440	1,176,800	33	43	39	8.2	10.6	9.7
45–64	1,105,200	1,103,840	1,099,340	42	31	42	7.5	5.5	7.5
≥65	735,800	757,920	776,950	42	45	58	4.6	4.8	6.0
Total	3,526,970	3,534,280	3,536,960	137	137	171	28.6	28.6	35.6

Appendix Table 3: Severe traumatic brain injury (sTBI) incidence rates per 100,000 person-years by patient home address deprivation score.

2020	No. sTBI	Population	Incidence rate/100,000 person years
Q1 (least deprived)	29	971,600	2.98
Q2	23	989,781	2.32
Q3	37	1,008,482	3.67
Q4	37	1,037,987	3.56
Q5 (most deprived)	67	1,082,349	6.19
Total	193	5,090,199	3.79
2021			
Q1 (least deprived)	41	975,628	4.20
Q2	26	993,884	2.62
Q3	23	1,012,662	2.27
Q4	37	1,042,290	3.55
Q5 (most deprived)	61	1,086,836	5.61
Total	188	5,111,300	3.68
2022			
Q1 (least deprived)	33	976,754	3.38
Q2	36	995,031	3.62
Q3	38	1,013,831	3.75
Q4	52	1,043,493	4.98
Q5 (most deprived)	82	1,088,090	7.54
Total	241	5,117,199	4.71