

## RESEARCH ARTICLE

# Association of ethnicity with unintentional injury-related hospitalisation and mortality among older people residing in two regions of Aotearoa New Zealand

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**Abstract**

**Objectives:** To characterise unintentional injury-related hospitalisation and mortality amongst older adults (aged 50+ years) in the Lakes and Bay of Plenty District Health Boards of Aotearoa New Zealand and to examine whether hospitalisation patterns differed by ethnicity.

**Methods:** This observational study analysed unintentional injury-related hospitalisations and deaths among older adults between 2014 and 2018. Routinely collected national data sets were used to calculate annualised, age-standardised injury rates. The independent variable of interest was ethnicity (Māori or non-Māori).

**Results:** There were 11,834 unintentional injury-related hospitalisations in the study period ( $n = 1444$  for Māori). Overall, there was no significant difference in the age-standardised hospitalisation rate between Māori and non-Māori (Standardised Rate Ratio [SRR] = 0.96 [95% CI 0.90, 1.02]). Falls were the most common mechanism of injury among Māori and non-Māori overall (50% and 71%) and relative risks of falls increased with age. Non-Māori were 57% less likely to be hospitalised for unintentional poisoning than Māori (SRR = 0.43, [0.34, 0.59]).

**Conclusions:** The mechanisms of injury, and variation in unintentional injury-related hospitalisation rates between Māori and non-Māori, change throughout older age, and incidence increase with age. Falls cause significant injury-related hospitalisations for older Māori and responsive injury prevention and rehabilitation efforts are warranted to achieve equitable health outcomes.

**KEYWORDS**

accessibility of health services, falls, indigenous population, injury, unintentional injury

Emily Dwight: Currently employed by Uniservices.

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## 1 | INTRODUCTION

In Aotearoa New Zealand (NZ), the number of people aged 65 years and older (65+) doubled between 1991 and 2020, and is projected to double again by 2056.<sup>1</sup> An ageing population is a triumph of public health, due in part to a reduction in injury-related mortality.<sup>2</sup> However, this triumph is not experienced equitably in Aotearoa New Zealand (NZ) with Māori, the Indigenous people of NZ comprising 17% of the population, experiencing lower life expectancy than non-Māori (7.4 years earlier for Māori men compared to non-Māori men).<sup>3</sup> An ageing population also brings challenges, including an increased prevalence of age-related health issues, including unintentional injury. Older people have a distinct pattern of unintentional injury compared to their younger counterparts, with falls becoming an increasingly prominent mechanism of injury with older age.<sup>4</sup> Approximately 30% of older people experience at least one fall each year, which is in part attributed to age-related physiological changes and a higher prevalence of chronic co-morbidities than younger people.<sup>5</sup> These factors also make it more likely that older people will suffer severe fall-related consequences, including fractures and death.<sup>6</sup> The Accident Compensation Corporation (ACC), NZ's no-fault injury compensation scheme, covers personal injury-related care and loss-of-income compensation. In 2014, falls among older adults cost the scheme an estimated NZ\$159 million in claims.<sup>7</sup> Given the preventable nature of falls, and the fact they are one of the most common causes of morbidity and mortality in older New Zealanders, the ACC places substantial investment into falls prevention initiatives.<sup>7</sup> The mortality and morbidity resulting from other types of unintentional injuries in older adults in NZ is underexamined; however, internationally, transport-related injuries (TRIs), cuts, overexertion, poisonings and fires commonly contribute to older adults hospitalisations.<sup>8,9</sup>

Māori bear a disproportionate burden from unintentional injury compared to non-Māori throughout the life course.<sup>10</sup> It has been estimated that nearly 20,000 years of healthy life were lost in Māori resulting from injury between 2006 and 2016, with Māori experiencing twice the rate of injury-related health loss compared to non-Māori over this period.<sup>11</sup> Māori also have higher rates of unintentional injury-related hospitalisation<sup>12</sup> and an increased risk of disability compared to non-Māori 12-month post-injury after controlling for preinjury and injury-related factors.<sup>13</sup> These outcomes have occurred in the context of Māori having inequitable access to timely, high-quality, culturally appropriate healthcare in NZ, including lower access to ACC-funded prevention, injury health care and injury rehabilitation services.<sup>14–16</sup>

### Practice Impact

The characteristics of unintentional injury-related hospitalisations, and variation in rates between Māori and non-Māori, change throughout older age. These findings suggest variable and targeted injury prevention and rehabilitation approaches are warranted to achieve equitable health outcomes.

Inequities in access to the determinants of health result in Māori being more likely to develop chronic co-morbidities at younger ages.<sup>10,17</sup> The effect of earlier co-morbidities, exacerbated by prescription medication use, can lead to functional impairment and thus increased risk of falls.<sup>17,18</sup> Additionally, reduced access to high-quality postinjury care increases the impact of injury, such as Māori experiencing less timely surgical intervention following a hip fracture compared to non-Māori.<sup>19</sup> The magnitude of harm owing to such inequities is set to increase, as the older Māori population is growing at a faster rate than the older non-Māori population.<sup>20</sup> This is largely driven by an increase in the number of Māori aged over 65 years; an age group that has experienced a marked increase in the rate of unintentional injury hospitalisations over time.<sup>10,20</sup> There is also evidence of regional variation in injury rates, with an earlier analysis of ACC data showing Māori men in the Lakes and Bay of Plenty (BOP) District Health Board (DHB) regions of NZ (comprising of approximately 350,000 people; 7% of total NZ population) had higher population and claim-corrected fall-related fracture rates (ACC claims per 1000 people/number of ACC claims).<sup>21</sup> Data from this study showed that Māori men and women had over 50-fold and 18-fold fracture rates, respectively, compared to non-Māori men and women. These stark variations have the potential to be influenced by both incidence and claim-making behaviour, and warrant further investigation.

To date, there has been minimal published research focussing on the patterns of unintentional injuries amongst older Māori specifically. To inform interventions that could enable equitable health outcomes for older Māori, this critical knowledge gap needs to be addressed. This study aimed to characterise unintentional injury-related hospitalisation and mortality amongst older adults (aged 50+) in the Lakes and BOP DHBs and to examine whether hospitalisation and mortality patterns differed between Māori and non-Māori. These regions were chosen to inform the development of an injury-prevention intervention specific to this region.

## 2 | METHODS

This observational study used quantitative descriptive methodology to analyse deidentified data from the Ministry of Health's (MOH) National Minimum Dataset and Mortality Collection, consisting of national routinely collected data on all publicly funded hospital admissions and deaths, respectively. All acute hospitalisations among those aged 50+ years domiciled in BOP or Lakes DHBs for unintentional injury that occurred less than 7 days from the incident and involved a stay crossing midnight, and all injury-related deaths (where the underlying cause of death was an unintentional injury code), between January 2014 and December 2018 (date of injury incidence) were included. Each individual may have had multiple hospital admissions within the study period that met these inclusion criteria, either because of hospital transfers or readmission for the same injury, or due to a different injury, and these were treated as independent events. For hospitalisations, all-cause mortality within 30-days of the event end date was calculated using date of death from the NHI. The younger age of 50+ years was used for both cohorts, as Māori are often eligible for 'age-related' services from a younger age in the regions of interest. Unintentional injury hospitalisations and deaths (underlying cause of death e.g., diagnosis type 'D') were identified using the primary ICD-10-AM-VI external cause codes (V00-X59).<sup>22</sup> Intentional injuries, such as assault and self-inflicted injuries, were excluded. Sequelae of unintentional injuries (Y85-86) were also excluded. Ethnicity was obtained from each patient's unique National Health Index (NHI) number linked to each hospitalisation and mortality record. For cases where Māori and other ethnicities were documented, records were only included once and categorised as Māori ethnicity using the NZ prioritised ethnicity standard.<sup>23</sup> The New Zealand Deprivation Index (NZDep2013) was used as an indicator for socio-economic deprivation. NZDep is assigned to NZ residential addresses using geographic meshblocks and is an ordinal scale.<sup>24</sup> The Ministry of Health's data included domicile codes, which we mapped to census area units to obtain the population weighted average NZDep2013 decile for each Census Area Unit.<sup>24</sup> NZDep2013 quintiles were used for data description, with quintile one being the least and quintile five the most deprived.

Categorical variables were summarised with frequencies and percentages. Mechanisms of injury were categorised using ICD-10 external cause codes.<sup>22</sup> Annualised hospitalisation and mortality rates were calculated for Māori and non-Māori separately. For rate calculations, the numerator was the average annualised frequency of unintentional injury-related hospitalisations or deaths over the 5-year period. Stats NZ 2018 Census data (Population

and Migration data set) were used to estimate denominators for census usually resident overall, and by ethnicity, DHB, age and gender. Denominators for non-Māori were calculated by subtracting the number of Māori from the total usually resident population. To enable comparison of rates by ethnic group, directly age-standardised rates were calculated using the 2001 Māori Census population as the reference. The use of 2001 data for standardisation in this study was informed by the findings from an expert review panel convened by Statistics NZ (Census External Data Quality panel 2018), which determined that Level 1 (L1) ethnicity data from the 2018 census was of lower quality than L1 ethnicity data for people of European ethnicity, largely due to ethnicity data being populated from alternate sources at higher rates for Māori compared to European (29% vs. 12%, respectively).<sup>25</sup> In using data from the 2001 census, we further note that the age structure did not change significantly between 2001 and 2016.<sup>26</sup> Standardised Rate Ratios (SRR) comparing age-standardised incidence rates in non-Māori to Māori were calculated, with 95% confidence intervals (CIs) based on the gamma distribution.<sup>27,28</sup> Stata (StataCorp, version 17) was used for analyses.

Ethics approval for this study was obtained from the Auckland Health Research Ethics Committee (AH22920). All data were supplied to members of the research team in a de-identified format using secure electronic data transfer.

## 3 | RESULTS

Between January 2014 and December 2018, there were 11,834 unintentional injury-related hospitalisations and 420 unintentional injury-related deaths in those aged 50+ years at the time of injury and living in Lakes and BOP DHBs (total population in 2018 comprising 22,503 Māori and 109,131 non-Māori aged 50+ years). More than half of the Māori hospitalisations occurred in men (53%) compared to 43% of non-Māori hospitalisations. Half of non-Māori deaths and 54% of Māori deaths occurred in men. The median age for Māori hospitalisation was 64 years (interquartile range [IQR] 52–75) and 79 years (IQR 67–87) for non-Māori. The median age at death was 71 years (IQR 58–84) for Māori and 85 years (IQR 75–90) for non-Māori. The mean number of admissions per person during the study period was 1.5 (standard deviation [SD] 0.9, range 1–7) for non-Māori and 1.3 (SD 0.7, range 1–6) for Māori. A lower proportion of hospitalisations and deaths occurred among people living in the least deprived NZDep quintiles (22% of hospitalisations and 25% of deaths in NZDep 1–2 compared to 59% and 59%, respectively, in NZDep 4–5) (Tables 1 and 2).

**TABLE 1** Demographic characteristics of older adults (aged 50+ years) who were hospitalised due to an unintentional injury and domiciled in Lakes or Bay of Plenty District Health Boards, 2014–2018,  $n = 11,834$ .

Variable	Māori ( $n, \%$ ) $n = 1444$ (12% of total sample)			Non-Māori ( $n, \%$ ) $n = 10,390$ (88% of total sample)			Total sample ( $n, \%$ ) $n = 11,834$
	Female	Male	Māori total	Female	Male	Non-Māori total	
Total events ( $n$ )							
Number of events, row %	678 (47)	766 (53)	1444 (100)	5975 (58)	4415 (43)	10,390 (100)	11,834 (100)
Age group (in years)							
50–59	211 (31)	311 (41)	522 (36)	561 (9)	868 (20)	1429 (14)	1951 (17)
60–69	186 (27)	215 (28)	401 (28)	800 (13)	869 (20)	1669 (16)	2070 (18)
70–79	160 (24)	134 (18)	294 (20)	1247 (21)	949 (22)	2196 (21)	2490 (21)
80+	121 (18)	106 (14)	227 (16)	3367 (56)	1729 (39)	5096 (49)	5323 (45)
NZDep quintile							
1	21 (3)	14 (2)	35 (2)	504 (8)	375 (9)	879 (9)	914 (8)
2	28 (4)	43 (6)	71 (5)	892 (15)	666 (15)	1558 (15)	1629 (14)
3	78 (12)	75 (10)	153 (11)	1239 (21)	936 (21)	2175 (21)	2328 (20)
4	174 (26)	176 (23)	350 (24)	1791 (30)	1293 (29)	3084 (30)	3434 (29)
5	377 (56)	458 (60)	835 (58)	1549 (26)	1144 (26)	2693 (26)	3528 (30)
Domicile region							
Bay of Plenty	392 (58)	467 (61)	859 (60)	4472 (75)	3270 (74)	7742 (75)	8601 (73)
Lakes	286 (42)	299 (39)	585 (41)	1503 (25)	1145 (26)	2648 (26)	3233 (27)

**TABLE 2** Demographic characteristics of older adults (aged 50+ years) who died due to an unintentional injury and domiciled in Lakes or Bay of Plenty District Health Boards, 2014–2018,  $n = 420$ .

Variable	Māori ( $n, \%$ ) $n = 50$ (12% of total sample)			Non-Māori ( $n, \%$ ) $n = 370$ (88% of total sample)			Total sample $n = 420$
	Females	Males	Māori total	Females	Males	Non-Māori total	
Total events ( $n$ )							
Number of deaths, row %	23 (46)	27 (54)	50 (100)	185 (50)	185 (50)	370 (100)	420 (100)
Age group (in years)							
50–59	6 (26)	7 (26)	13 (26)	10 (5)	19 (10)	29 (8)	42 (10)
60–69	2 (9)	9 (33)	11 (22)	8 (4)	29 (16)	37 (10)	48 (11)
70–79	5 (22)	5 (19)	10 (20)	22 (12)	34 (18)	56 (15)	66 (16)
80+	10 (44)	6 (22)	16 (32)	145 (78)	103 (56)	248 (67)	264 (63)
NZDep quintile							
1	0	1 ()	1 (8)	16 (9)	15 (8)	31 (8)	32 (8)
2	0	0	0	34 (18)	37 (20)	71 (19)	71 (17)
3	1 (4)	2 (7)	3 (6)	32 (17)	34 (19)	66 (18)	69 (17)
4	7 (30)	5 (19)	12 (24)	56 (30)	46 (25)	102 (28)	114 (27)
5	15 (65)	19 (70)	34 (68)	47 (25)	52 (28)	99 (26)	133 (32)
Domicile region							
Bay of Plenty	15 (65)	16 (59)	31 (62)	119 (64)	131 (71)	250 (68)	281 (7)
Lakes	8 (35)	11 (41)	19 (38)	66 (36)	54 (29)	120 (32)	139 (33)

There was no evidence that the overall age-standardised hospitalisation or mortality rates differed between older Māori and non-Māori (Tables 3 and 4), with 95% CIs being wide indicating considerable uncertainty for both estimates. However, there were differences when considered by age group for hospitalisation rates; in the younger age groups (50–59 and 60–69 years), non-Māori had 13% (95% CI 4% to 22%) and 12% (95% CI 2% to 21%) lower hospitalisation rates, respectively, compared to Māori; however, in the 80+ year age group rates the direction was reversed, with 67% higher rates among non-Māori (95% CI 46% to 92%, Table 3).

Men experienced a higher hospitalisation rate than women among both Māori and non-Māori (Table S1). Hospitalisation rates also increased with advancing age for both Māori and non-Māori (Table S1). For Māori, the hospitalisation rate was more than four times greater in the 80+ year age group than in the 50–59-year age group. For non-Māori, this trend was even more marked, with the 80+ year age group experiencing nearly eight times higher rates of unintentional injury compared to the 50–59-year age group. Hospitalisation rates were similar in Lakes and BOP for both Māori and non-Māori (Table S1).

Falls were the most common mechanism of injury-related hospitalisation among Māori and non-Māori overall (50% and 71%; Table 5). The proportion of hospitalisations attributable to falls, length of stay and death during or within 30 days of injury all increased as age advanced for both groups (Table S2). A greater proportion of fall-related hospitalisations occurred in those aged under 70 years of age among Māori compared to non-Māori (52% cf. 19%). Transport-related injury represented the second most common external cause leading to admission for Māori and non-Māori overall (14% cf. 9%; Table 5). For both ethnicities, the proportion of injuries attributable to transport-related injuries decreased markedly with advancing age.

Non-Māori aged 50+ years were significantly less likely to be hospitalised for unintentional poisoning than Māori but were more likely to be hospitalised for falls (Table 5). Non-Māori were also significantly less likely to be hospitalised due to 'other' external causes of injury, which included injuries incurred through foreign bodies, crushing, and smoke, fire and flame. There were no significant differences between non-Māori and Māori age-standardised rates of transport-related injury, struck by, overexertion and machinery-related injury (Table 5).

For Māori aged 50+ years from BOP and Lakes with a death resulting from an injury over the 5-year period (total  $n = 50$ , Table 4), transport-related injuries were the most common cause ( $n = 21$ , 42%), closely followed by falls ( $n = 20$ , 40%). In contrast, for non-Māori fatal injuries (total  $n = 370$ , Table 4), falls represented the greatest

proportion of deaths leading to injury ( $n = 261$ , 71%) with a much smaller proportion being attributable to transport-related injury ( $n = 66$ , 18%). Unintentional poisoning-related deaths represented a greater proportion of deaths for Māori ( $n = 5$ , 10%) than non-Māori ( $n = 5$ , 1% of deaths due to unintentional injury).

## 4 | DISCUSSION

This study described and characterised unintentional injury-related hospitalisation and mortality amongst older people in Lakes and BOP DHBs over a five-year period. Unintentional injury hospitalisation and mortality rates increased with age within the older adult population, and the mechanism of injury changed with age, with falls being the most significant cause of injury-related hospitalisation. Falls were a significant burden for older Māori with fall-related injuries comprising half the unintentional injury-related hospitalisations for Māori overall.

The finding that unintentional injury hospitalisation rates increased with advancing age aligns with the previously published literature.<sup>4,9</sup> Characteristics of NZ trauma admissions for people aged 65+ years in the Midlands region using Midlands Trauma Registry (MTR) data<sup>4</sup> found that the rate of trauma admissions increased with advancing age for both Māori and non-Māori.<sup>4</sup> The hospitalisation rates in the Midlands region are notably lower than those reported in the present study, which may be partially explained by different case definitions. The MTR data set excludes insufficiency or peri-prosthetic fractures and isolated hip fractures, more frequent in older populations,<sup>4,29,30</sup> thus, these injuries in older people are disproportionately excluded from the MTR data set. This is an issue shared with other trauma registries.<sup>31</sup> The rates reported in the current study are more similar to studies that analysed injury-related hospital admission data<sup>32</sup> showing benefit in using MOH hospitalisation data to more accurately characterise the impact of injury on hospitalisations.

Māori hospitalisation and mortality rates for unintentional injury were higher than non-Māori in the younger age groups included in this study and the median age of people experiencing these events was 15 and 14 years younger, respectively, for Māori. There is the potential that this could be associated with the disproportionate burden of chronic and multi-morbidity at a younger age for Māori.<sup>10</sup> The positive association between chronic comorbidities and the prevalence of falls, the leading cause of injury in the current study, is well known. This finding demonstrates the importance for Māori to have flexible access to injury prevention services, which respond to individual clinical contexts, potentially from a much younger age than non-Māori rather than the use of arbitrary age

**TABLE 3** Age-standardised annualised unintentional injury-related hospitalisation rates for older adults (aged 50+ years) in Lakes and Bay of Plenty District Health Boards (2014–2018),  $n = 11,834$ .

Variable	Māori (age-standardised rate per 100,000 <sup>a</sup> , 95% CI) $n = 1444$			Non-Māori (age-standardised rate per 100,000 <sup>a</sup> , 95% CI) $n = 10,390$			SRR <sup>b</sup> non-Māori compared to Māori (95% CI)
	Female	Male	Overall	Female	Male	Overall	
Total	1007.5 (930.8, 1088.7)	1417.6 (1317.5, 1523.1)	1194.1 (1131.9, 1258.7)	1049.4 (1013, 1086.8)	1242.4 (1196.7, 1289.3)	1145.7 (1116.6, 1175.3)	0.96 (0.90, 1.02)
Age group (in years)							
50–59	713.9 (619.8, 818.3)	1204.3 (1072.5, 1347.7)	943.8 (863.6, 1029.4)	607.9 (557.7, 661.5)	1,044.5 (974.9, 1117.8)	816.9 (774.3, 861.3)	0.87 (0.78, 0.96) <sup>c</sup>
60–69	972.8 (838, 1123.2)	1291.3 (1124.1, 1476.2)	1120.9 (1013.8, 1236.3)	899.5 (837.5, 964.9)	1072.9 (1001.8, 1147.7)	982.6 (935.4, 1031.6)	0.88 (0.79, 0.98) <sup>c</sup>
70–79	1768.3 (1503.2, 2066.8)	1766.6 (1478.5, 2094.1)	1767.9 (1570.4, 1983.4)	1743.7 (1646.8, 1844.8)	1467.4 (1374.4, 1565)	1611.9 (1544.3, 1681.8)	0.91 (0.81, 1.03)
80+	3297.3 (2731.2, 3945.5)	4902.8 (4008.2, 5938.4)	3881.0 (3392.1, 4420.4)	7263.3 (7006, 7527.7)	5392.6 (5135.4, 5659.3)	6488.0 (6303.8, 6676.4)	1.67 (1.46, 1.92) <sup>c</sup>
Domicile region							
Bay of Plenty	950.1 (855.3, 1052.2)	1397.2 (1271.0, 1532.4)	1155.0 (1077.0, 1236.9)	1038.5 (996.4, 1081.9)	1242.3 (1188.2, 1298.1)	1138.8 (1104.7, 1173.6)	0.99 (0.91, 1.06)
Lakes	1097.9 (970.9, 1236.4)	1455.5 (1,293.7, 1631.8)	1257.4 (1155.8, 1365.3)	1073.9 (1002.8, 1148.6)	1244.5 (1159.8, 1333.3)	1162.3 (1106.9, 1219.6)	0.92 (0.84, 1.02)

<sup>a</sup>Age-standardised to Māori 2001 Census population using direct standardisation.

<sup>b</sup>Hospitalisation Standardised Rate Ratio (SRR) comparing non-Māori to Māori, with 95% CIs based on the gamma distribution.

<sup>c</sup>95% CI for SRR does not include 1.

**TABLE 4** Age-adjusted mortality rates of older adults (aged 50+ years) who died due to an unintentional injury and domiciled in Lakes/BOP DHBs at the time of death (2014–2018).

Variable	Māori (age-standardised rate per 100,000 <sup>a</sup> , 95% CI) $n = 50$			Non-Māori (age-standardised rate per 100,000 <sup>a</sup> , 95% CI) $n = 370$			SRR <sup>b</sup> non-Māori compared to Māori (95% CI)
	Female	Male	Overall	Female	Male	Overall	
Total	29.3 (17.9, 45.3)	48.9 (32, 71.4)	38.6 (28.3, 51.3)	22.1 (17.5, 27.5)	39.7 (32.5, 47.9)	30.5 (26.3, 35.2)	0.79 (0.57, 1.12)
Age group (in years)							
50–59	20.6 (7.4, 45.1)	27.8 (11.0, 57.5)	24.0 (12.6, 41.1)	11.0 (5.2, 20.4)	22.5 (13.4, 35.4)	16.5 (11.0, 23.8)	0.69 (0.34, 1.46)
60–69	10.7 (1.3, 38.3)	54.8 (25.0, 104.0)	31.2 (15.6, 55.8)	9.5 (4.0, 18.7)	37.2 (24.8, 53.5)	22.8 (16.0, 31.5)	0.73 (0.36, 1.59)
70–79	60.1 (19.4, 139.0)	64.4 (20.7, 151.3)	62.0 (29.6, 114.0)	31.1 (19.3, 47.4)	52.3 (36, 73.3)	41.3 (31.1, 53.8)	0.67 (0.34, 1.47)
80+	241.6 (115.5, 450.3)	285.1 (103.7, 622.8)	266.1 (152.0, 432.8)	300.4 (251, 356.9)	305.2 (247.9, 372)	302.0 (264.2, 343.8)	1.14 (0.68, 2.02)
Domicile region							
Bay of Plenty	34.2 (18.3, 57.9)	47.4 (26.7, 77.4)	39.9 (26.7, 57.4)	18.7 (14.2, 24.3)	36.8 (28.8, 46.2)	27.2 (22.7, 32.4)	0.68 (0.45, 1.06)
Lakes	22.1 (8.9, 46.5)	52.3 (26.0, 94.0)	37.1 (22.1, 58.6)	31.3 (20.6, 45.7)	47.3 (32.7, 65.8)	39.3 (30.1, 50.4)	1.06 (0.62, 1.89)

<sup>a</sup>Age-standardised to Māori 2001 Census population using direct standardisation.

<sup>b</sup>Mortality Standardised Rate Ratio (SRR) comparing non-Māori to Māori, with 95% CIs based on the gamma distribution.

**TABLE 5** Annualised hospitalisation rates by unintentional injury mechanism for older adults (aged 50+ years) admitted to, Lakes or Bay of Plenty District Health Boards (2014–2018),  $n = 11,834$ .

Injury mechanism <sup>a</sup>	Māori aged 50+, $n = 1444$		Non-Māori aged 50+, $n = 10,390$		SRR <sup>c</sup> non-Māori compared to Māori (95% CI)
	$n$ (%)	Age-standardised rate per 100,000 <sup>b</sup> , 95% CI	$n$ (%)	Age-standardised rate per 100,000 <sup>b</sup> , 95% CI	
Fall	722 (50)	564.6 (523.1, 608.5)	7375 (71)	626.5 (607.3, 646.2)	1.11 (1.02, 1.20) <sup>d</sup>
Transport-related	198 (14)	179.2 (154.8, 206.2)	925 (9)	181.7 (168.6, 195.4)	1.01 (0.86, 1.19)
Struck by	67 (5)	59.0 (45.5, 75.0)	321 (3)	48.6 (42.3, 55.5)	0.82 (0.62, 1.10)
Overexertion	87 (6)	44.8 (33.7, 58.3)	213 (2)	54.5 (47.9, 61.7)	1.22 (0.91, 1.66)
Poisoning	56 (4)	72.9 (58.1, 90.2)	353 (3)	32.6 (27.5, 38.3)	0.45 (0.34, 0.59) <sup>d</sup>
Machinery	42 (3)	37.4 (26.9, 50.6)	223 (2)	45.9 (39.5, 52.9)	1.23 (0.87, 1.76)
Other	272 (19)	236.2 (208.4, 266.5)	980 (9)	155.9 (144.2, 168.2)	0.66 (0.57, 0.76) <sup>d</sup>

<sup>a</sup>Injury mechanism was categorised using ICD-10 external cause codes.

<sup>b</sup>Age-standardised to Māori 2001 Census population using direct standardisation.

<sup>c</sup>Hospitalisation Standardised Rate Ratio (SRR) comparing non-Māori to Māori, with 95% CIs based on the gamma distribution.

<sup>d</sup>95% CI for SRR does not include 1.

cut-offs. Perhaps more importantly, these findings indicate a whole-of-systems approach to injury prevention is required which identifies well-being as protective against injury and incorporates action to address earlier burden of chronic co-morbidities, including equitable access to primary health-care service for Māori.<sup>33</sup>

Falls were the leading cause of hospitalisation from unintentional injury for all age groups for Māori and non-Māori in this study, highlighting the significant public health issue of falls in the context of a rapidly ageing population, particularly for Māori.<sup>20</sup> Falls as a significant mechanism of injury leading to hospitalisation for 'younger older' Māori (50–69 years) is a finding consistent with international research examining rates of injury hospitalisation in older Indigenous populations.<sup>34</sup> One Australian study that compared fall-related hospitalisations of older (50+) Aboriginal and Torres Strait Islander people to other Australians reported that most fall-related injury hospitalisations of Aboriginal people were of people aged under 75 years.<sup>34</sup> These are important findings given the known issues with access to age-related health services for Indigenous populations both in NZ and elsewhere.<sup>35,36</sup> These findings highlight the importance of challenging the one-size-fits-all approach to injury prevention in older age. Both the type of service offered, and age thresholds for access to services, need to be reviewed to improve the likelihood of equitable health outcomes for Māori and other marginalised groups. This is especially the case given effective injury prevention interventions exist to prevent and minimise harm, such as strength and balance exercises,<sup>37</sup> however, access and culturally specific service development remains low for Māori.<sup>38</sup>

Transport-related injuries were the second most common cause of injury-related hospitalisation in our study.

TRIs are a major public health issue in NZ and an area where significant inequities exist.<sup>39</sup> An earlier, larger study in those 18 years plus demonstrated higher rates of TRIs for Māori compared to non-Māori.<sup>39</sup> Although our study did not show a statistically significant difference in TRI rates between older Māori and non-Māori, the high TRI rates in both groups indicate further research would be useful to investigate the circumstances of TRI and appropriately design preventative interventions for this cause of injury.

This study showed that non-Māori were less likely to be hospitalised due to unintentional poisonings than Māori. Unintentional poisonings have previously been noted to be an important public health issue amongst adults in NZ.<sup>40</sup> However, the present study appears to be the first-time comparison of hospitalisation rates from unintentional poisoning have been made between older Māori and non-Māori. The ability to examine this difference was partly enabled as NMDS data were used; trauma registries exclude poisonings.<sup>4</sup> Poisonings include alcohol use, and accidental overdose with prescription and non-prescription pharmacological agents. Further research is recommended to examine causation in more depth and solutions for mitigation.

It has previously been shown that Māori carry a disproportionate burden of injury in NZ.<sup>11</sup> This study adds to this picture and indicates that falls contribute significantly to injury burden for Māori aged 50+ years. This evidence in the contexts of, (i) a rapidly ageing Māori population, and (ii) that Māori who experience injury are currently underserved by the health system and ACC services,<sup>13,19</sup> can serve as further impetus to reduce the incidence of injuries through prevention efforts. In the case of falls, prevention efforts could reduce hip fractures and disability

through interventions such as lower leg strengthening and balance retraining, medication review, and home hazard assessment and modification.<sup>37,38</sup> Although it is known that such interventions prevent the likelihood of serious injury from falls, these services are not universally available in NZ. Integrated, age-appropriate, culturally acceptable services relevant to different populations and individuals, are needed to improve uptake, access and outcomes, particularly combinations of multiple complementary components.<sup>38</sup> Robust economic analysis of the cost of prevention interventions versus the cost of rehabilitation after injuries is important. The analysis should assess impact on both public funding and individual/family resources and include wider determinants of health such as benefit of injury prevention to income, quality of life, and societal contribution.

#### 4.1 | Strengths and limitations

The strengths of this study include the use of population-based, routinely collected data. The relatively high proportion of Māori living in the areas of interest enabled ethnic variation between Māori and non-Māori to be explored. The definition of 'older' people included people aged 50+ years, which acknowledges the compounding inequities experienced by Māori throughout the life course and the 7-year difference in life expectancy compared to non-Māori.<sup>3</sup> The importance of this is demonstrated in the study findings which reveal the median age of hospitalisation and mortality was 15 and 14 years lower, respectively, for Māori than non-Māori. In addition to adopting a broader age definition of older people, the grouping of the findings into 10-year age bands, enabled the exploration of different injury patterns by age group. However, the study findings need to be considered in the light of several limitations. Routinely collected data from the MOH were used, which likely undercounts Māori as an ethnic group, potentially resulting in the underestimation of rates for Māori.<sup>41</sup> The 2001 census data were used for age-standardisation and although this is now over 20 years old, government agencies note flaws in more recent census data and recommend continued use of 2001 data which was noted to have not changed significantly between the years 2001–2016.<sup>25</sup> NZDep 2013 was used instead of the more recent NZDep 2018, although this is unlikely to materially affected the results. Co-morbidities may have influenced hospitalisation and mortality rates. These were not able to be adjusted for due to complexities and reliability of using NMDS data for co-morbidity calculations,<sup>42</sup> including the need to obtain extra data. Each admission was treated as a separate event and repeat

admissions were not adjusted for. This may have resulted in an overcount for Māori more than non-Māori given Māori are more likely to live rurally, which is associated with higher rates of hospital transfer due to the potential to require higher level hospital care in urban centres. Only hospitalisations with a length of stay crossing midnight or longer were included as a proxy of injury severity; this restriction was based on the assumption that different ethnic groups have equal access to appropriate medical services in primary care and emergency departments, which is unlikely to be the case. Low numbers of deaths meant that the characterisation of injuries causing death, and associated variables, could not be fully explored, and incidence rates and SRR for mortality were calculated with low precision, particularly within specific groups. This study does not include those that do not access, or were not admitted to, secondary care for injuries and may undercount those that already have inequitable access to health care, including Māori. The collection of additional information should be considered in future research and may be best suited to a prospective study design which would enable data linkage with primary care records. The study focussed on two regions of NZ, and therefore, the findings may not be generalisable to the rest of NZ.

## 5 | CONCLUSIONS

Falls are the most common cause of unintentional injury-related hospitalisations for older Māori and non-Māori in Lakes and BOP regions in NZ. The characteristics of unintentional injuries and variation in rates between Māori and non-Māori change throughout older age, suggesting variable and targeted injury prevention interventions are warranted to achieve equitable health outcomes.

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## DATA AVAILABILITY STATEMENT

Research data are not shared.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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