Epidemiology of dog-related injuries within New Zealand

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ABSTRACT

BACKGROUND: Understanding the epidemiology of injury caused by dogs is crucial for targeting injury prevention efforts and monitoring their effectiveness. There are no contemporary published New Zealand studies describing the epidemiology of dog-related injuries (DRIs). This study aims to address this gap.

AIM: To describe the epidemiology of DRIs in New Zealand.

METHODS: A review of Accident Compensation Corporation (ACC) new claims for DRIs that required medical attention, and publicly funded hospital discharges identified from the National Minimum Dataset (NMDS) for the period of 1 July 2014 to 30 June 2019. ACC cases were identified using the TE60 READ code and relevant diagnosis or external agency descriptions; NMDS cases with an ICD-10-AM external cause of injury code of W540, W541, or W548 were included.

RESULTS: There were 108,324 new ACC claims for DRIs and 3,456 hospitalisations during the five-year review period. The majority of injuries were dog bites (51%, n=54,754 ACC claims; 89%, n=3,084 hospitalisations). The all-age incidence of ACC claims for all DRIs significantly increased by 1.75% per year (p<0.001) during the period reviewed, with a significant increase in claims for dog bite injuries of 1.64% per year (p<0.001), a significant increase in DRI hospitalisations (2.43% per year, p=0.046), and a non-significant annual increase (p=0.217) in dog bite injury hospitalisations. Children aged 0–9 years had similar rates to adults of ACC claims for dog bite injuries; however, children 0–9 years were more likely to be hospitalised. Māori had a higher incidence of ACC claims and hospitalisations for dog bite injuries than non-Māori. ACC claims and hospitalisations for dog bite injuries were more likely to occur in areas of greater deprivation, with substantial regional variation across the country.

CONCLUSION: The incidence of injury from dogs in New Zealand is increasing. Inequity exists with substantial regional variation, in higher rates among those living in areas of greater deprivation, and with Māori in the setting of the ongoing effects of colonisation. Children aged 0–9 years are no more likely than other age groups to present for medical attention but are more likely to be hospitalised. Reasons for these disparities require further investigation.

Dog bites and other dog-related injuries (DRIs) are an ongoing cause of morbidity internationally and in New Zealand, with subsequent serious physical and psychological consequences for the victims. Injuries include wounds or crush injuries, with or without damage to other structures, fractures, head injuries, localised or systemic bacterial infections, rabies, or tetanus. Many hospitalisations for dog bites are severe, with two thirds of people admitted requiring a general anaesthetic.[1] There can also be serious non-bite injuries,[2,3] for example a cyclist who sustained a fatal head injury in 2011 after colliding with a dog.[4]

Psychological trauma for victims or caregivers can also have long-term consequences,[5–12] including the development of post-traumatic stress disorder,[5,8] a reduction in physical activity, or avoidance of public spaces,[13] and may result as much from the fear of being threatened by a dog as the injury.[12] A New Zealand study found that 72% of adult dog bite victims with a claim from Accident Compensation Corporation (ACC) reported psychological effects, with 36% of these being moderate or severe.[7] There may also be intangible costs from dog attacks such as concerns about neighbourhood safety.[14]

Despite ongoing attempts at prevention through policy and education, this is an increasing public health issue, with numbers shown to rise in multiple studies worldwide.[1,15–19] For example, hospitalisations for dog bite injuries in New Zealand have increased almost seven-fold from 1.74 per 100,000 in 1979 [17] to 12.3 in 2014.[1]

Children are particularly at risk of hospitalisation from dog bites, and also receive more serious bites to the head and neck.[1,15,20–24] Physical scarring in these areas are often highly visible, and can require multiple scar revisions.[25] Frequently, lacerations in children are deep, may require amputation or loss of tissue substance, and have been shown to have an average healing time of nearly

11 months.[10] Non-bite injuries including mid-shaft femur fractures, head injuries, or skull/facial fractures, can also be a cause of considerable injury in children and are frequently overlooked.[2] Injuries to children from dogs are particularly unacceptable, and differ from other causes of unintentional injury in children, in that the incident may involve an attack or aggression. The need for further investigation into this area within New Zealand has been further highlighted following the recent tragic death of an infant from a dog mauling.

Further at-risk groups are Indigenous cultures and those from areas of greater deprivation.[26–29] A New Zealand study demonstrated how Māori (New Zealand's Indigenous population) are overrepresented in the incidence of hospitalisations for dog bite injuries.[1] The same study found that as socio-economic deprivation increases, so does the incidence of hospitalisations for dog bite injuries.[1] While the reasons for this are unclear, this needs to be interpreted within the context of colonisation, and current systems existing within New Zealand that create an inequitable environment for Māori.[30]

A range of information sources are available in New Zealand, including ACC claims, emergency department presentations, animal management reported dog attacks, and hospitalisation rates. Non-bite injuries are rarely studied, and dog bite injuries are commonly investigated using data from hospitalisations. However, this likely only reflects a small proportion of dog bites that occur, and broader measures of dog bites are required.[31] For example, rates of dog bites measured predominantly from household surveys range from 1.80% to 7.95% in studies internationally.[22,32–36] The lifetime incidence of dog bites from cross-sectional studies is reported to be between 25% and 45%.[36–38]

Understanding the epidemiology of injury caused by dogs is crucial for investigating disparities in prevention strategies and policies, targeting injury prevention efforts, and monitoring their effectiveness. There are no contemporary published New Zealand studies describing the epidemiology of DRIs. Therefore, this study aims to address this gap.

Methods

This retrospective, observational, descriptive study reviewed new ACC claims for DRIs where medical attention was sought, and DRI hospitalisation data from the New Zealand Ministry of Health's National Minimum Dataset (NMDS) for the five-year period 1 July 2014 to 30 June 2019.

ACC data

Individuals with a new claim registered for a DRI were identified using the following search:

- Dog Bite A: Read Code TE60;
- Dog Bite B: [External agency 1="Live Dog"] AND [Contact 1="Kicked/Butted/Bitten by Animal"] AND [free text within the injury description contains the following non-case sensitive words "bite", "bit", "bitten", "biten"] AND [read code does not equal "TE60"];
- Other Dog Related Injuries: [External agency 1="Live Dog"] AND [Not Dog Bite A or Dog Bite B].

Secondary claims were excluded. Variables of interest included: fiscal year, age, prioritised ethnicity, read code, diagnosis description, location of injury on the body, contact type, external agency, event location by Territorial Authority (TA), residential location by TA (and if the residential location was within Auckland, further defined by the six regional areas that existed pre-2010), meshblock of residential address (decile), and provider type. For injury locations within Auckland, further information was given on provider board area and meshblock. Ethnicity (Stats NZ Level 1 or 2) was prioritised and classified as Māori or non-Māori.

NMDS data

Individuals who had a publicly funded hospital discharge (from public or private hospitals) with an external cause of injury ICD-10-AM code W54 (W540: Bitten by dog, W541: Struck by dog, W548: Other contact with dog) were included. To maintain consistency with previous research in the field,[1] and to align with Ministry of Health recommendations,[39] short stay events (where length of stay is zero or one midnight spent in hospital) were removed.[39] For cases in which there was more than one DRI during the review period, only the first event was considered. Variables of interest included: ethnicity, age, domicile area level deprivation, hospital, date of presentation to hospital, diagnosis including location of injury on the body, procedure codes, and length of stay. Ethnicity (Stats NZ Level 1 or 2) was classified as Māori or non-Māori. Patient domiciles were assigned an area level deprivation score based on the 2018 NZ Deprivation (NZDep18) score.[40]

Statistical analysis

Age was grouped into three categories: 0–9 years was used due to the higher incidence of DRIs previously found in this group,[1] and was compared with older children (10–14 years) and adults (15 years and over). Māori was compared to non-Māori. For each geographical region (TA), the proportion of people living in decile 9 and 10 (most deprived) was used as an area measure of deprivation.

Data on the geographical location of injury was collated by each of the 67 TAs of New Zealand, which are the second tier of locally governed areas in New Zealand. The TA of the hospital was used for hospitalisations. Given that Auckland Council comprises 29% of the New Zealand population, data were also grouped into four main areas of Auckland Central, North, South East and West, closely matching the four current areas serviced by Auckland animal management services (Table 1). ACC data were provided by the six sub-Council regions, which existed prior to the 2010 formation of the Auckland "Supercity". For claims identified as occurring in "Auckland City", it was unclear if the location of injury was "Auckland City Central" area or "Auckland City" as a whole region. In these cases, the Local Board of the provider was used. If there was no provider location, they were not included in the analysis of geographical area to reduce bias.

Denominator data for 2014 to 2017 were calculated using the interpolation method, using 2013 and 2018 census data.[41] Numerator data for the calculation of local area incidence rates used annual estimates derived from the total numbers of injury in a specific area over the five-year period of interest. Of note, areas were defined slightly differently in each census. Population estimates of the pre-2010 Auckland areas were not available; however, a close estimate of these was available by local board.

Data were analysed using a generalised linear model, modelling the observed categorical data as having a Poisson distribution. A p-value of <0.05 was considered to be statistically significant. Statistical analyses were carried out using SAS 9.4,[42] Open-Epi version 3.01[43] and "R" version 4.1.1.[44] Maps were created with ArcGIS Pro version 2.7.1.

Results

ACC claims

Between 2014 to 2018 there were a total of 108,324 ACC claims nationally for DRIs where medical attention was sought (Table 3), with over half of these dog bites (51%, n=54,754).

ACC claims for DRIs significantly increased by 1.75% per year ($p<0.001$) during the period reviewed. The average annualised rate was 479.7 per 100,000 people (95% CI 476.8, 482.5), (Table 2), with the lowest rate in 2014/15 (459.9 per 100,000; 95% CI 453.6, 466.3), and highest in 2017/18 (497.8 per 100,000; 95% CI 491.4, 504.3), (Figure 1).

ACC claims for dog bite injuries alone significantly increased by 1.64% per year ($p<0.001$). The average annualised rate was 242.5 per 100,000 (95% CI 240.4, 244.5), (Table 2), with the lowest rate in 2014/15 (234.4 per 100,000; 95% CI 229.9, 239) and highest in 2017/18 (249.7 per 100,000; 95% CI 245.1, 254.3), (Figure 2).

Hospitalisations

Across the five-year study period there were 3,456 hospitalisations nationally for DRIs (Table 3), which were predominantly dog bites (89%, n=3,084).

Hospitalisations for DRIs significantly increased by 2.43% per year ($p=0.046$) during the period reviewed, with an average annual incidence of 15.3 per 100,000 (95% CI 14.8, 15.8), (Table 2), with the lowest rate in 2014/15, (14.0 per 100,000; 95% CI 12.9, 15.1), and highest in 2017/18 (16.3 per 100,000; 95% CI 15.2, 17.5), (Figure 3).

There was a non-significant annual increase in hospitalisations for dog bite injuries of 1.59% ($p=0.217$), with an average annual incidence of 13.7 per 100,000 (95% CI 13.2, 14.1), (Table 2). This was lowest in 2014/15 (12.6 per 100,000; 95% CI 11.5, 13.7), and highest in 2017/18 (14.6 per 100,000; 95% CI 13.5, 15.8), (Figure 4).

Age

Children aged 0–14 years had a total of 14,346 DRIs over the five years, of which 75% were dog bites (n=10,801). There were 857 DRI hospitalisations in this age group, which were predominantly dog bites (95%, n=813), (Table 3).

In children aged 0–9 years, both ACC claims and hospitalisations had a non-significant decrease across the five years for both dog-related injuries (ACC by 0.94%, $p=0.242$; hospitalisations by 2.46%, $p=0.364$) and dog bite injuries (ACC by 2.12%, $p=0.422$; hospitalisations by 1.26%, $p=0.075$), (Figures 1–4).

In contrast, adults had a significant increase in both ACC claims and hospitalisations for both DRIs (ACC by 4.16%, $p<0.001$, hospitalisations by 6.16%, $p<0.001$) and dog bite injuries (ACC by 4.74%, $p<0.001$, hospitalisations by 5.20%, $p<0.001$).

ACC claims for dog bite injuries among young children (0–9 years of age) (255.8 per 100,000; 95% CI 250.1, 261.5) were similar to adults (260.4 per

100,000; 95% CI 257.9, 262.8, p=0.155). However, hospitalisations among children aged 0–9 years (22.0 per 100,000; 95% CI 20.3, 23.7) were significantly higher than the 10–14-year age group (10.1 per 100,000; 95% CI 8.4, 11.7, p<0.001), and adults (13.5 per 100,000; 95% CI 12.9, 14.0, p<0.001), (Table 2).

Adults had significantly higher ACC claim rates for all DRIs (556.7 per 100,000; 95% CI 553.1, 560.2), compared to children aged 0–9 years and 0–14 years (328.7 per 100,000; 95% CI 322.2, 335.2, p<0.001; and 298.5 per 100,000; 95% CI 289.7, 307.3, p<0.001, respectively), (Table 2). However, hospitalisation rates were significantly higher among children aged 0–9 years (23.2 per 100,000; 95% CI 21.5, 24.9) than other age groups, (Table 2).

Ethnicity

Tamariki (children) Māori of both younger and older age groups (0–9 and 10–14 years) had significantly higher rates of both ACC claims and hospitalisations for dog-related and dog bite injuries compared to non-Māori children (p<0.001 for all comparisons), with tamariki Māori being 2.47 (0–9 years) and 2.17 (10–14 years) times more likely to be hospitalised for a dog bite injury (Table 2).

Likewise, Māori adults had higher rates of ACC claims and hospitalisations for dog bite injuries than non-Māori adults (p<0.001 for all comparisons), being 2.50 times more likely to be hospitalised for a dog bite injury. However, Māori adults had significantly lower rates of DRI ACC claims compared to non-Māori (p<0.001), (Table 2).

Deprivation

ACC claims and hospitalisations for dog bite injuries were higher in areas of greater deprivation (Figures 5 and 6), with ACC claims 3.38 times higher in areas of greatest deprivation (decile 10) than in the least deprived areas (decile 1). Similarly, hospitalisations were 3.97 times greater in areas of greatest deprivation (decile 10) compared to the least deprived areas (decile 1)

Regional variation

The maps displayed in Figures 7–9 illustrate the geographical distribution of ACC claims for dog-related and dog bite injuries, relative to deprivation within each TA. In the North Island, TAs with the highest incidence of ACC claims for all dog-related and dog bite injuries (>550 per 100,000; and >350 per 100,000, respectively) were spatially clustered around the Northern, Eastern and Central areas, and aligned with having >25% of the population living in areas of higher deprivation (decile 9/10 areas), (Figure 9).

This pattern was not as evident for the South Island, where several TAs with a low level of deprivation (<10% living in decile 9/10 areas) had high rates of DRIs and dog bites (>550 per 100,000; and >250 per 100,000, respectively).

Within the Auckland Region dog bite injury ACC claims were highest in South East Auckland (276.1 per 100,000; 95% CI 269.7, 282.6), and lowest in Central Auckland (145.6 per 100,000; 95% CI 140.8, 150.5), and hospitalisations over five times higher in South East Auckland (31.64 per 100,000; 95% CI 29.5, 33.89) compared to Central Auckland (5.72 per 100,000; 95% CI 4.81, 6.64, p<0.001), (Table 4).

Within the seven most heavily populated areas of New Zealand (Auckland, Christchurch, Wellington, Hamilton, Tauranga, Lower Hutt and Dunedin), both ACC claims and hospitalisations for dog bite injury within each age group largely remained stable (no significant change) or had a significant increase. An exception to this was in Dunedin, where there was a significant decrease in the 0–9-year age group only (18.7%, p=0.001).

Figure 1: Annual incidence of DRI ACC claims.

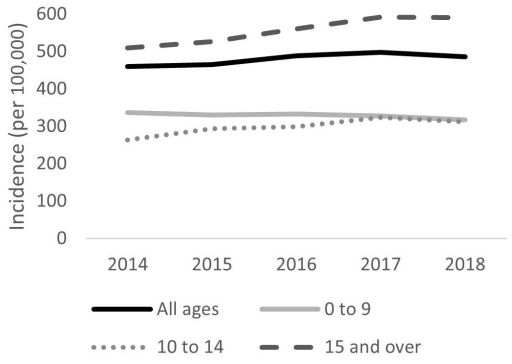
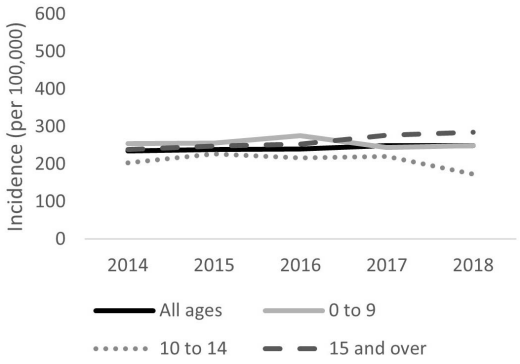


Figure 2: Annual Incidence of dog bite injury ACC claims.



Severity

Almost three quarters (72%, 2,220/3,084) of people hospitalised for a dog bite injury required at least two procedures while in hospital, with a further 7% (n=216) requiring only one procedure. The average length of stay in hospital was 2.3 days.

Only one third (33%, n=18,296/54,754) of ACC claims for dog bite injury had the location of injury recorded. Injury to the head/neck region was more common among children (0–9 years) (54%, n=1,428/2,664). Children aged 10–14 years and adults were more commonly bitten on the limbs/torso (72%, n=698/969; and 87%, n=12,807/14,663, respectively, p<0.001).

Similar results were found for hospitalisations of dog bite injury, where the majority (95.9%, n=2,957) had the location of injury recorded. Children aged 0–9 years who were hospitalised received a far greater proportion of injury to the head/neck region (75%, n=488/653, p<0.001), with the 10–14-year age group and adults more likely to be bitten on the limbs/torso (53%, n=78/147, p<0.001 and 89%, n=1,926/2,157, p<0.001, respectively).

Injury descriptions were provided for hospitalisation data only. Dog bite injuries (coded W540) were consistently described as lacerations or open wounds. Detailed information regarding depth or size of wound, wound location, injury to important structures, or development of complications (eg local or systemic infection) were not reliably reported in the datasets reviewed.

Non-bite DRIs that were hospitalised were predominantly fractures (52%, n=195/372) or wound lacerations or infections (30%, n=111/372), with a small number of head injuries (4%, n=14/346) or other injuries (15%, n=52/346). Fractures included tibial plateau (28% 55/195), femoral neck or shaft (20%, 39/195), with seven pelvic, seven humeral shaft, 16 bi/tri-malleolar, 51 other distal limb, and 19 "other" fractures.

Figure 3: Annual incidence of DRI hospitalisations.

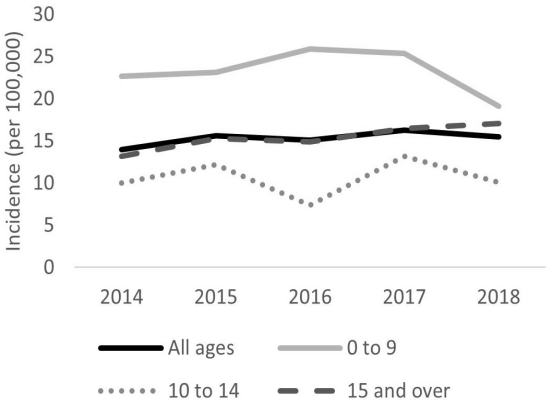


Figure 4: Annual incidence of dog bite injury hospitalisations.

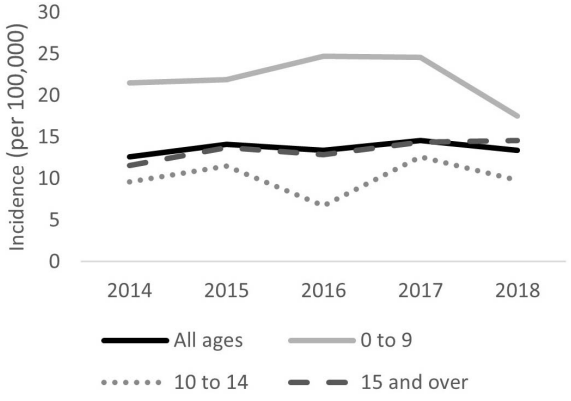


Figure 5: Incidence of hospitalisations for dog bite injuries by NZDep2018 (per 100,000 people).

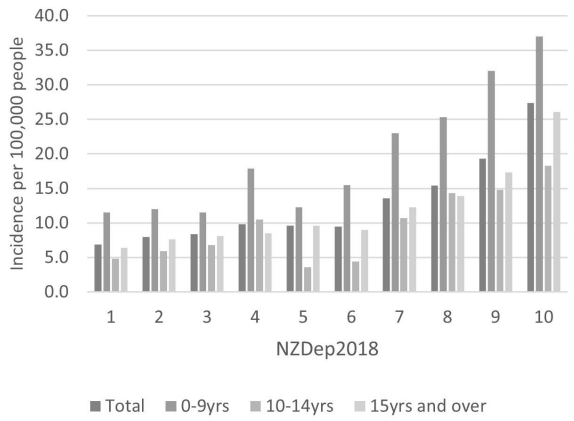
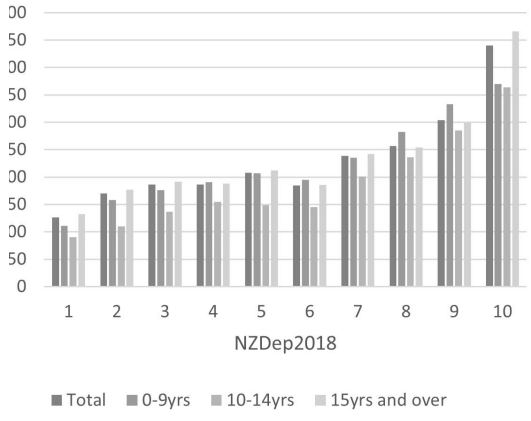


Figure 6: Incidence of ACC claims for dog bite injuries by NZDep2018 (per 100,000 people).



Discussion

The high incidence of DRIs in New Zealand is cause for concern, particularly given the apparent inequities and increasing injuries over time. There is a nearly eight-fold increase in the risk of hospitalisation from a dog bite injury compared to forty years ago, with an incidence of 1.7 per 100,000 in 1979[17] rising to 13.4 per 100,000 in 2018/19. The reliability of this finding is strengthened by other New Zealand studies demonstrating increasing rates over time,[1,15,17,45] with similar results found in a recent UK study.[19] This increase has come about despite regional attempts by each TA at addressing this worsening problem.

This study also revealed an increasing incidence of ACC claims for all DRIs at a rate of 1.75% per year ($p<0.001$), and for dog bite injury specifically at a rate of 1.64% per year ($p<0.001$). While a broader definition for DRIs was used in this study, the incidence of 485.7 claims per 100,000 in 2018/19 (95% CI 479.4, 492.0) is nearly three times that stated in a Governmental report with an approximate incidence of 164 per 100,000 people (n=6,300) in the 1999/2000 year.[45] Similar results in both the review of ACC and NMDS datasets provide strong evidence that DRIs are increasing.

It is uncertain whether rates are increasing due to an increase in injuries or in an increase in presenting for medical attention, either due to severity of injuries or for other reasons. However, given that the number of dog bites that present for medical attention in other countries represent only a small proportion of all dog bites,[22,32–36,46] ACC claims and hospitalisations are already indicators of the more severe end of the spectrum of injuries.

A finding that contrasts to previous studies both nationally[1] and internationally[47] is that in the current study children were *equally* as likely as adults to present for medical attention due to a dog bite. This finding only became evident when analysing ACC claim data, rather than hospitalisation data alone. However, children were more likely to be hospitalised, consistent with previous studies.[1,15,45] This is likely a reflection of the greater severity of the injuries in children, which occur more frequently on the head or neck regions.[1,48–51]

Almost half (49%) of ACC claims for injuries caused by dogs were non-bite related. This may have implications for policy or other prevention strategies. A previous US study highlighted non-bite injuries as an overlooked injury in children, caused either through direct contact with a dog, or adults holding a child tripping over a dog.[2]

The present study found higher rates of injury occurred in individuals living in areas of higher deprivation. This finding is consistent with many other health conditions, independent of factors such as income, education or car access.[52,53] Regional variation in injury rates was evident, with a nearly seven-fold difference in the incidence of dog bites between TAs with the highest and lowest rates of dog-bite injury. The relationship between low socio-economic area and dog bite injuries has also been described in studies in the US,[29] Canada[28,54] and the UK.[55]

Higher rates of injury among Māori must be interpreted within the historical and current context of the ongoing effects of colonisation, including discrimination and institutional racism.[30,56] Māori continue to live within a dominant non-Māori culture, and also have lesser levels of socio-economic security than non-Māori.[57] Further research is needed in New Zealand to investigate additional systemic factors behind the inequities, including regional differences in dog ownership, funding, or culturally appropriate prevention strategies and policies that empower Māori.

The circumstances surrounding dog bites and other DRIs needs further investigation to guide both in-home and public policies and interventions. Differences in injury rates between public and private, urban and rural, or higher and lower density areas were difficult to determine in the current study, due to how geographical location of injury is recorded by ACC. Likewise, because injuries frequently occur in public or on a property not owned by the victim,[1,7] using the victims address would not be an appropriate way to investigate this. A New Zealand survey of 535 adults with an ACC claim for a dog bite injury found that over one third (36%) occurred in public places, with only 21% occurring in the victim's home, and 43% on other private property. Of note, 56% were reported as occurring in urban areas.[7]

Dog aggression may be influenced by intrinsic factors such as breed, size, jaw-size, gender; or environmental factors such as training, exercise, weaning time, early socialisation, medication, or food.[58,59] There is an absence of appropriately designed epidemiological dog bite studies exploring risk factors for DRIs. Injury studies commonly make claims regarding risky breeds or dog gender which can be unfounded due to the absence of a control/comparison group. In addition, more commonly owned breeds are more likely to be involved in injury statistics.[59,60] Furthermore, breed is frequently poorly identified.[59,61] A recent

large Finnish study (n=9,270) investigating risk factors for dog aggression comparing household pure-bred dogs with or without aggressive behaviour found a relationship with breed; however, not with the breeds often considered dangerous.[62] For example, miniature poodles were more aggressive, and Staffordshire bull terriers, less so. Older age, and being male, of small body size, lacking the company of other dogs, and being the owners' first dog, were all associated with dog aggression. There was no difference in weaning age, daily exercise, time spent alone, sterilisation, family size, or living in an urban area. Of note, dog aggressiveness is also not the only factor involved in whether an injury will occur, as environmental barriers such as fencing, leashes or in-home gates or kennels also likely prevent injury.[63]

The strengths of this study are its novel nature as it is the first published, in-depth study of the epidemiology of DRIs in New Zealand. However, findings need to be considered in light of some limitations. While some indices of severity were included in this study, further measures were not investigated such as: wound depth, size, or type;[64] injury to tendons, arteries, nerves or other important functional structures such as eyes, ears, lips, nose or genitals; amputations; fractures;[65,66] head injuries; spinal cord injury;[67] infections including cellulitis, necrotising fasciitis or sepsis; loss of function; development of arthritis; cosmetic consequences; circumstances surrounding the injury; "bite style" the dog used;[68]or the psychological impact.[7] Wake et al reported only 12% of adults with an ACC claim for a dog bite had a minor injury (drawing little/no blood),[7] with an Austrian study also describing a predominance of severe injuries with 85% of paediatric dog bites presenting to hospital being deep wounds.[50] This has not been studied in children in New Zealand.

Additional limitations include the accuracy of clinical diagnoses in hospital and ACC data. Injury rates only represent those presenting for medical attention (ACC claims), and rates are likely higher.[9,32,36,37] ACC changed their coding processes in September 2018, which may result in differences in incidence from that year. Hospitalisation rates require careful interpretation by area, as they used population data from the TA in which the hospital was located rather than DHB data. They have also assumed little migration between areas over time, and patients can be referred to plastic surgical centres within larger hospitals. The hospitalisation rates used in this study are also exclusive of short stay events and therefore not representative of presentations to hospital, as many injuries are treated within the emergency department and discharged. A further limitation of this study was the use of an ecological area-based measure of deprivation (NZDep18),[40] producing a deficit framing of results.[69] The use of subjective wellbeing and other capability-based approaches[70,71] would offer a strengths-based narrative exploring protective rather than risk factors.[72] This preliminary research has created a foundation from which further research areas can be explored, and intervention strategies can be trialled with clear injury outcome measures specific to New Zealand. Future researchers or organisations can monitor their progress by using the described search strategy for dog bites and all DRIs, within ACC (new claims) and NMDS (hospitalisation) datasets.

Conclusion

The incidences of injury from dogs in New Zealand is increasing. Inequity exists with substantial regional variation, and higher rates among those living in areas of greater deprivation and Māori in the setting of the ongoing effects of colonisation. Children aged 0–9 years are no more likely than other age groups to present for medical attention but are more likely to be hospitalised. Reasons for these disparities require further investigation.

Figure 7: Distribution of ACC claims for DRIs, by TA.

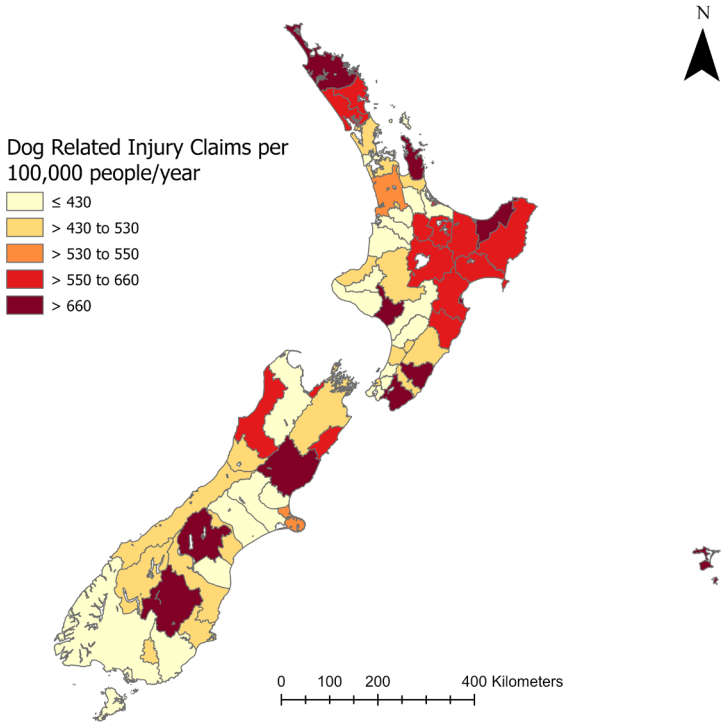


Figure 8: Distribution of ACC claims for dog bite injuries, by TA.

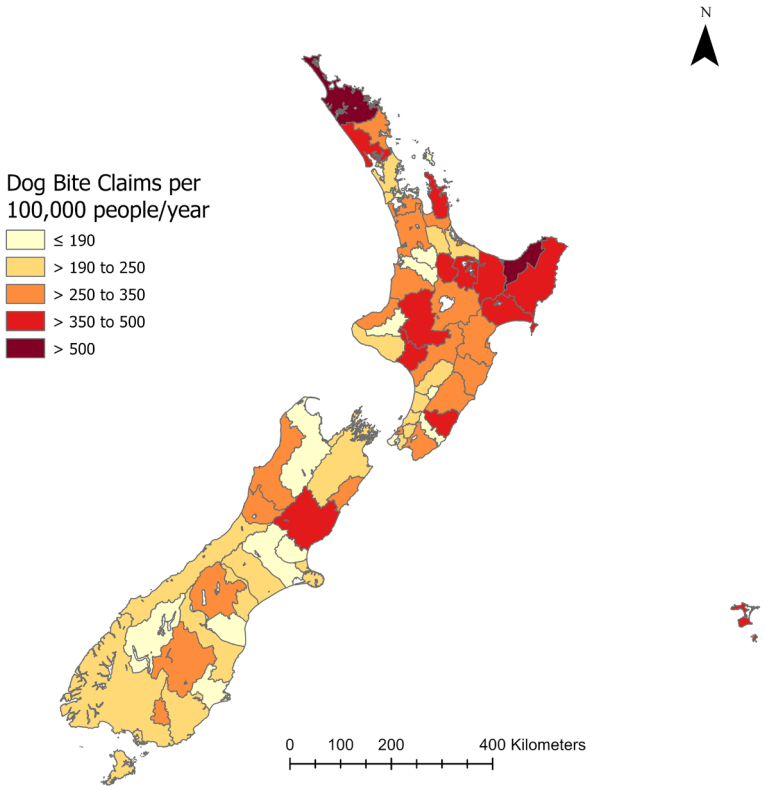
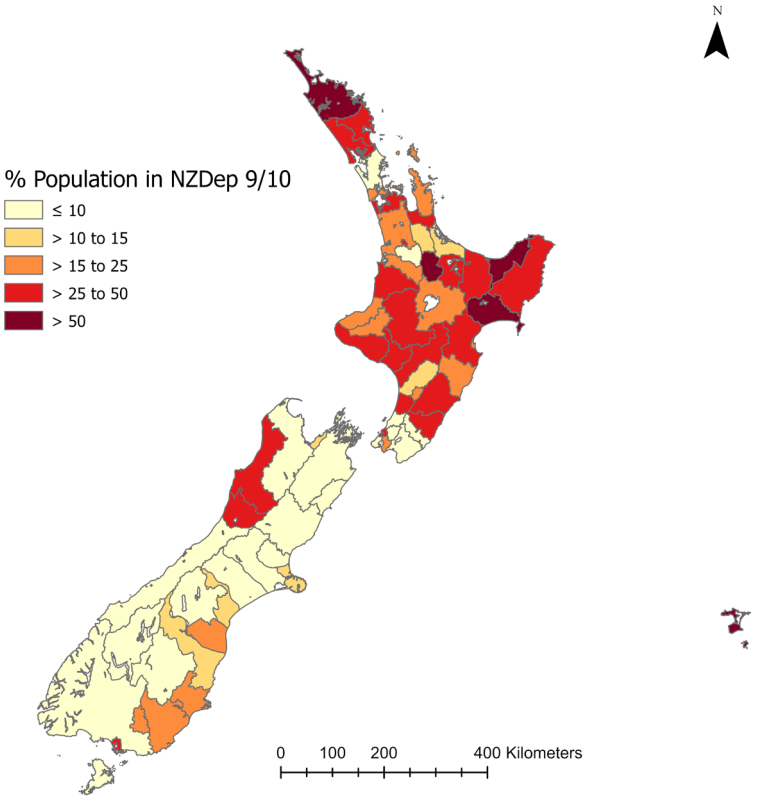


Figure 9: Proportion of people living in areas with NZDep2018 scores 9–10, by TA.



COMPETING INTERESTS
Nil.

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Table 1: Geographical divisions of the Regional Auckland area.

	Auckland Central	West Auckland	South East Auckland	North Auckland
Regional areas (pre-2010)	Auckland City	Waitākere City	Manukau City Franklin District Papakura District	Rodney District North Shore City
Local board (post-2010)	Whau Puketāpapa Albert–Eden Waitematā Ōrākei Maungakeikei–Tāmaki Waiheke Great Barrier	Henderson–Massey Waitākere Ranges	Otara–Papatoetoe Māngere–Ōtāhuhu Franklin Manurewa Papakura Howick	Upper Harbour Kaipatiki Devonport–Takapuna Hibiscus and Bays Rodney
Public Hospital	Auckland	Waitākere	Middlemore	North Shore
District Health Board (approximate)	Auckland	Waitematā	Counties Manukau	Waitematā

Table 2: Annualised national incidence (per 100,000 people) of DRIs and dog bite injuries during 2014 to 2018 by age and ethnicity.

	Dog-related injuries per 100,000 people (95% CI)						Dog bite injuries per 100,000 people (95% CI)					
	ACC claims			Hospitalisations			ACC claims			Hospitalisations		
	Total	Māori	non-Māori	Total	Māori	non-Māori	Total	Māori	non-Māori	Total	Māori	non-Māori
All ages	479.7 (476.8,482.5)	468.7 (461.6,475.9)	481.7 (478.6,484.8)	15.3 (14.8, 15.8)	30.5 (28.6,32.3)	12.5 (12.0,13.0)	242.5 (240.4,244.5)	340.9 (334.8,347.0)	224.2 (222.1,226.4)	13.7 (13.2,14.1)	29.1 (27.4, 30.9)	10.8 (10.3,11.3)
0– 9	328.7 (322.2,335.2)	426.4 (412.0,440.9)	294.3 (287.2,301.5)	23.2 (21.5, 24.9)	41.6 (37.1,46.1)	16.8 (15.1,18.5)	255.8 (250.1,261.5)	359.2 (345.9,372.4)	219.5 (213.3,225.6)	22.0 (20.3,23.7)	39.3 (34.9, 43.7)	15.9 (14.3, 17.6)
10–14	298.5 (289.7,307.3)	372.3 (352.5,392.0)	274.4 (264.7,284.0)	10.6 (8.9, 12.2)	17.1 (12.9, 21.4)	8.5 (6.8, 10.2)	207.9 (200.6,215.2)	309.7 (291.7,327.7)	174.6 (166.9,182.3)	10.1 (8.4, 11.7)	16.9 (12.7, 21.1)	7.8 (6.2, 9.5)
≥15	556.7 (553.1,560.2)	497.7 (488.7,506.6)	566.3 (562.5,570.2)	15.4 (14.8, 16.0)	28.9 (26.7, 31.0)	13.2 (12.6, 13.8)	260.4 (257.9,262.8)	339.7 (332.3,347.1)	247.4 (244.8,249.9)	13.5 (12.9,14.0)	27.7 (25.6,29.8)	11.1 (10.6,11.7)

Table 3: Total national number of DRIs and dog bite injury during 2014 to 2018 by age and ethnicity.

	Dog-related injuries						Dog bite injuries					
	ACC claims			Hospitalisations			ACC claims			Hospitalisations		
	Total	Māori	non-Māori	Total	Māori	non-Māori	Total	Māori	non-Māori	Total	Māori	non-Māori
All ages	108,324	16,522	91,802	3,456	1,074	2,382	54,754	12,016	42,738	3,084	1,027	2,057
0–9	9,895	3,341	6,554	699	326	373	7,701	2,814	4,487	663	308	355
10–14	4,451	1,368	3,083	158	63	95	3,100	1,138	1,962	150	62	88
≥15	93,977	11,813	82,164	2,599	685	1,914	43,953	8,064	35,889	2,271	657	1,614

Table 4: Estimated annual incidence per 100,000 people dog bite injuries by Territorial Authority (ordered from highest to lowest all-age incidence of ACC claims).

	Dog bite injury ACC claims per 100,000 people (95% CI)			Hospitalisations (95% CI)	
Territorial Authority	**0–9 years**	**10–14 years**	**15 and over**	**All-ages**	**All-ages**
Ōpōtiki	561.2 (402.8–762.4)	713.0 (467.4–1045.0)	720.5 (635.1–814.2)	695.7 (621.6–776.4)	
Kawerau	546.4 (377.8–766.1)	726.2 (456–1102.0)	652.5 (559.2–756.9)	641 (560.3–730.3)	
Far North	541.3 (475.7–613.4)	329.9 (261.8–410.7)	505.8 (478–534.9)	497.7 (473.2–523.1)	5.85 (3.58–9.08)
Thames–Coromandel	484.6 (380–609.6)	540.5 (394.6–723.8)	389.8 (355.7–426.4)	407.6 (375.4–441.9)	
Rotorua	385.5 (334.9–441.7)	320.9 (258.0–394.9)	410.0 (386.3–434.8)	399.5 (378.9–421)	25.71 (20.77–31.49)
Whakatāne	323.6 (259.4–399.1)	493.9 (385.8–623.3)	396.2 (363.4–431.1)	393.1 (364.3–423.5)	38.84 (30.34–49.02)
South Waikato	459.5 (368.8–566.0)		378.6 (339.8–420.6)	380.2 (345.9–416.9)	
Whanganui	408.9 (340.0–487.9)	320.4 (238.9–421.3)	378.2 (350.3–407.7)	378.2 (353.2–404.6)	15.89 (11.24–21.86)
Gisborne	356.5 (299.2–421.6)	258.6 (192.8–340.0)	388.4 (360–418.5)	372.8 (348.5–398.4)	13.49 (9.33–18.91)
Wairoa	481.8 (335.2–672.0)		350.5 (289.2–421.1)	369.4 (313.9–431.9)	
Masterton	328.3 (247.8–427.2)	356.6 (245–502.7)	369.2 (332.8–408.5)	363.1 (330.6–397.9)	20.26 (13.40–29.47)
Kaipara	425.7 (328–545.3)	214.1 (124.4–345.3)	354.9 (316.7–396.5)	354.8 (320.4–392)	
Ruapehu	417.8 (302.6–563.4)	146.2 (59.26–304.1)	353.7 (302.9–410.6)	349.7 (305–399.3)	
Hurunui	369.2 (252–523.4)		359.6 (309.4–415.8)	347.4 (302.9–396.7)	
Taupo	357.2 (288.5–437.4)	279.8 (196.9–386.6)	349.1 (319.2–381)	345.5 (319–373.7)	
Whangārei	361.1 (315.6–411.3)	298.4 (241–365.4)	328.8 (309.8–348.6)	331.2 (314.3–348.9)	24.60 (20.22–29.65)
Central Otago	286.8 (200.7–398.1)	351.8 (223.6–528.5)	332.5 (295–373.6)	328.5 (294.4–365.4)	
Waitomo	360.6 (238.5–524.5)		345.0 (286.9–411.7)	325.9 (276.6–381.5)	
Mackenzie	403.7 (229.8–661.3)		275.8 (208.1–358.9)	318.6 (251.5–398.3)	

Table 4 (continued): Estimated annual incidence per 100,000 people dog bite injuries by Territorial Authority (ordered from highest to lowest all-age incidence of ACC claims).

	Dog bite injury ACC claims per 100,000 people (95% CI)			Hospitalisations (95% CI)	
Territorial Authority	**0–9 years**	**10–14 years**	**15 and over**	**All-ages**	**All-ages**
Buller	295.4 (177.9–463.4)	374.1 (196.7–650.3)	309.5 (259.1–367.0)	311.8 (265.5–363.8)	
Hastings	350.0 (304.0–401.2)	291.7 (234.8–358.5)	299.5 (280.5–319.4)	306.3 (289.3–324.0)	25.82 (21.14–31.25)
Central Hawke's Bay	335.1 (233.1–467.4)	284.2 (158.0–473.7)	290.2 (247.3–338.6)	296.2 (257.3–339.3)	
Napier City	336.5 (283.0–397.2)	212.7 (155.8–283.8)	294.4 (273.3–316.7)	294.5 (275.6–314.3)	
Porirua City	304.2 (256.2–358.6)	267.1 (203.7–344.3)	288.3 (265.9–312.1)	289.3 (269.6–310.0)	
South Wairarapa	331.0 (210.3–497.3)	161.3 (59.1–357.6)	288.0 (239.6–343.3)	285.5 (241.8–335.0)	
Auckland South East	333.0 (315.5–351.2)	301.2 (277.4–326.5)	261.9 (254.7–269.1)	276.1 (269.7–282.6)	31.64 (29.5–33.89)
Waikato	304.5 (260.7–353.5)	168.6 (126.1–221.0)	270.0 (250.9–290.1)	267.0 (250.3–284.4)	
Rangitīkei	243.5 (161.0–354.1)		276.8 (236.4–322.3)	265.3 (229.9–304.7)	
Hamilton City	286.1 (256.2–318.6)	223.1 (184.9–267.0)	256.3 (243.8–269.4)	258.5 (247.3–270.1)	50.66 (45.80–55.89)
Tauranga City	273.6 (240.4–310.2)	173.1 (137.1–215.8)	263.1 (249.3–277.4)	258.4 (246.2–271.1)	13.13 (10.54–16.17)
New Plymouth	276.9 (234.8–324.5)	215.8 (164.9–277.5)	257 (239.6–275.3)	256.9 (241.4–273.2)	12.81 (9.61–16.75)
Gore	246.8 (153.0–378.3)		267.6 (224.8–316.3)	256.3 (218.5–298.8)	
Grey	239.5 (152.2–359.8)		265.9 (224.9–312.3)	256.1 (219.8–296.7)	
Tararua	285.0 (202.7–390.3)	326.6 (207.6–490.8)	239.4 (204.8–278.3)	252.5 (220.8–287.4)	
Hauraki	201.9 (132.3–295.8)	285.3 (174.4–442.2)	256.8 (222.9–294.4)	251.9 (221.6–285.2)	
South Taranaki	240.7 (180.6–314.8)	149.3 (86.8–240.8)	257.3 (227.9–289.4)	246.8 (221.4–274.3)	
Westland	221.8 (116.6–385.5)		250.5 (202.1–307.1)	242.2 (198.7–292.5)	
Christchurch City	230.3 (210.5–251.6)	178.4 (154–205.7)	241.8 (233.9–249.8)	236.8 (229.7–244)	19.94 (17.95–22.10)

Table 4 (continued): Estimated annual incidence per 100,000 people dog bite injuries by Territorial Authority (ordered from highest to lowest all-age incidence of ACC claims).

	Dog bite injury ACC claims per 100,000 people (95% CI)			Hospitalisations (95% CI)	
Territorial Authority	**0–9 years**	**10–14 years**	**15 and over**	**All-ages**	**All-ages**
Nelson City Council	211.6 (163.6–269.5)	170.2 (113.6–245.9)	243.9 (223–266.2)	235.4 (216.8–255.2)	10.59 (7.07–15.30)
Marlborough	195.6 (148–253.8)	182.3 (119.5–267.1)	243.9 (222.4–267)	234.6 (215.4–255.1)	
Horowhenua	231.6 (170.9–307.1)	154.6 (91.54–245.8)	233.5 (208.3–260.9)	228.2 (205.6–252.5)	
Matamata–Piako	269.5 (208.4–343.2)	225.6 (150.5–325.8)	220.9 (196.6–247.3)	227.9 (205.8–251.8)	
Kāpiti Coast	237.5 (186.9–297.9)	155.5 (102.9–226.2)	224.6 (205.2–245.4)	221.8 (204.2–240.5)	
Southland	173.4 (124.5–235.5)	139.6 (81.13–225.1)	227.4 (201.5–255.8)	213.4 (191.1–237.6)	
Waitaki	216.1 (146.5–308.2)	101.1 (44.24–200.1)	221.0 (191.6–253.6)	212.7 (186.6–241.5)	
Auckland total	239.7 (230.4–249.2)	216.4 (203.7–229.6)	206.2 (202.6–209.8)	211.4 (208.2–214.7)	15.17 (14.31–16.07)
Auckland West	160.3 (139.5–183.2)	158.6 (128.3–194.1)	216.5 (205.3–228.2)	203.7 (194.1–213.6)	1.58 (0.88–2.63)
Timaru	195.7 (147.7–254.6)	126.7 (77.48–196.4)	211.9 (191.7–233.6)	203.7 (185.8–223)	
Auckland North	186.2 (169.1–204.5)	97.0 (83.86–116.6)	218.6 (211.2–226.3)	202.2 (195.9–208.7)	10.32 (8.95–11.85)
Western Bay of Plen	111.5 (80.95–158.9)	108.6 (66.39–168.3)	249.6 (226.9–274)	200.5 (183.3–219)	
Lower Hutt City	183.1 (153.7–216.5)	195.0 (152.0–246.5)	203.9 (190.3–218.1)	200.4 (188.4–212.9)	50.19 (44.3–56.63)
Clutha	204.4 (132.7–301.9)	133.5 (62.02–253.6)	218.0 (183.9–256.6)	195.9 (168.1–227.1)	
Ashburton	198.0 (146.2–262.6)	123.2 (68.51–205.3)	199.9 (176.6–225.4)	194.6 (174.1–217)	
Invercargill City	232.6 (185.9–287.6)	97.84 (58.9–153.5)	194.1 (176.1–213.4)	192.9 (176.7–210.1	13.91 (9.94–18.97)
Upper Hutt City	182.2 (137.1–237.7)	164.3 (106.7–242.6)	193.2 (173.1–214.9)	189.8 (172–209.1)	
Dunedin City	201.4 (168.9–238.3)	138.1 (102.6–182.1)	185.5 (174.1–197.5)	184.6 (174.1–195.5)	12.6 (10.02–15.64)

Table 4 (continued): Estimated annual incidence per 100,000 people dog bite injuries by Territorial Authority (ordered from highest to lowest all-age incidence of ACC claims).

	Dog bite injury ACC claims per 100,000 people (95% CI)			Hospitalisations (95% CI)	
Territorial Authority	**0–9 years**	**10–14 years**	**15 and over**	**All-ages**	**All-ages**
Waimate			198.4 (153.7–252.1)	184.3 (145–231.1)	
Carterton	125.6 (54.9–248.4)	102.4 (26.04–278.6)	194.0 (152.1–244.0)	179.3 (142.9–222.3)	
Tasman	149.0 (109.6–198.2)	78.0 (44.42–127.8)	181.4 (163.6–200.6)	170.2 (154.5–186.9)	
Queenstown–Lakes	204.1 (149.6–272.4)	169.0 (98.2–272.4)	156.3 (136.9–177.7)	162.7 (144.6–182.5)	
Ōtorohanga	157.9 (85.6–268.5)		154.7 (118.6–198.6)	162.6 (129.6–201.5)	
Stratford	162.5 (85.5–282.5)		192.7 (151.4–242.0)	153.0 (120.4–191.9)	
Waipa	136.5 (101.5–180.0)	81.2 (47.2–130.9)	153.4 (136.9–171.3)	145.8 (131.5–161.3)	
Auckland Central	185.9 (170.3–202.4)	164.4 (143.7–187.3)	138.7 (133.5–144)	145.6 (140.8–150.5)	5.72 (4.81–6.64)
Waimakariri	103.8 (73.8–142.1)	115.3 (74.86–170.3)	143.4 (128.3–159.7)	136.5 (123.2–150.7)	
Wellington City	115.6 (96.7–137.0)	80.1 (64.0–113.5)	118.1 (110.9–125.7)	116.0 (109.5–122.9)	7.37 (5.82–9.22)
Palmerston Nth City	75.6 (55.2–101.2)	75.3 (47.28–114.2)	111.8 (100.8–123.6)	104.6 (95.06–114.8)	16.91 (13.28–21.23)
Selwyn	86.3 (60.7–119.2)		96.8 (84.22–110.8)	94.5 (79.65–102.3)	

Note: Areas with populations of ≤5,000, and any categories with ≤10 dog bite injuries over the five years were not included.