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Social and environmental predictors for dog bites in Wales: A retrospective study

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Summary *Aims:* Dog bites are a significant burden on the individual and NHS. This study aimed to identify social and environmental predictors to aid treatment, planning and prevention.
Methods: Data were collected for all incidences of people bitten/struck by dogs in Wales from April 2018 to March 2023, including age, sex, location, and socioeconomic status. Archived meteorological data for Wales was analysed, including maximum daily temperature, humidity, pressure and lunar phase. Finally, weekday/weekend, school holidays, season and COVID restrictions were also included as potential predictors.
Results: Overall, 3167 bites were identified (mean age = 40.2 years; 52.9% female). Poisson regression, ANOVA and Chi-squared tests were used to analyse different variables. An increase in dog bites was observed on weekends vs weekdays ($p=0.033$), during school holidays ($p < 0.001$), on days with higher temperatures ($p < 0.001$), when there were no COVID restrictions ($p < 0.001$), post-COVID ($p < 0.001$) and in summer vs winter and spring ($p=0.015$, $p < 0.001$). Primary school children were more likely to be bitten in the most deprived areas ($p < 0.001$), densely populated areas ($p=0.002$), and summer months ($p < 0.001$).
Conclusions: These findings suggest that public health campaigns aimed at awareness surrounding the higher risk of dog bites in socially deprived areas, on warmer days, school holidays, on weekends and during the summer may help to reduce the burden of dog bites in Wales.

Injuries are a major burden on public health and the patient, and their occurrence is often influenced by environmental and social factors. Changes in temperature and weather conditions have been linked to variations in trauma presentations, including those referred to plastic surgery. For example, Chotai et al.[1] found that warmer weather was associated with more plastic surgery trauma referrals, highlighting how environmental conditions can affect injury rates. Understanding these relationships helps predict healthcare demand and inform prevention strategies.

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Dog bites are a distinct but preventable type of injury that contribute considerably to this burden. They disproportionately affect children and can cause lasting harm.[2] One UK study found that one in four people had been bitten by a dog, though several did not seek medical care.[3] In Wales, hospital admissions due to dog bites increased from 16.3 per 100,000 in 2014 to 23.7 per 100,000 in 2022, an increase greater than that seen in England or Ireland.[4]

Dog bites can result in serious physical and psychological consequences. The 'hole and tear' pattern of injury carries a high risk of infection,[5] whereas psychological effects such as post-traumatic stress, phobias and anxiety are common.[6] They also carry a considerable financial burden, costing the NHS an estimated £25 million in 2017–2018.[7]

Several factors have previously been linked to increased risk of dog bites, such as breed and sex of the dog,[8] lower socioeconomic status,[9] summer months,[10] weekends[10] and warmer temperatures.[11,12]

Despite growing recognition that weather affects injury patterns, few studies have explored its role in dog bites, particularly within Wales. This study aimed to identify and synthesise key social and environmental risk factors for dog bites in Wales, to support the development of effective public health interventions and prevention strategies and inform service provisions to deal with an increased healthcare burden from dog bites.

Methods

This retrospective study examined hospital attendances for dog-related injuries in Wales from 01/04/2018 to 31/03/2023. The data were obtained from the NHS Wales Informatics Service, which includes all inpatient and day-case activity across all Welsh health boards. Admissions with an ICD-10 code of 'W54*', meaning 'bitten or struck by dog', were extracted using a structured SQL query. Variables extracted included age, sex, date of hospital attendance, socioeconomic deprivation quintile (1 = Most deprived, 5 = Least deprived) and rural-urban classification (Hamlet and isolated dwelling = Least densely populated and Urban over 10k = Most densely populated). Duplicate and transfer records were removed to retain unique episodes.

Weather data were obtained from VisualCrossing.com. The variables we looked at were maximum temperature (Celsius), precipitation (mm), humidity (%), wind speed (kph), pressure (mb), cloud cover (%), season and lunar phase. Each admission was linked to the weather on its admission date, using the national Welsh average for that day. Seasons were defined as spring (Mar–May), summer (Jun–Aug), autumn (Sep–Nov) and winter (Dec–Feb).

Social variables included weekend vs weekday, school holidays, and COVID-19 restriction periods. School holidays were coded using the Welsh government academic calendar which is consistent across all regions. COVID-19 restriction periods were classified as pre-COVID (before 23/03/2020), during COVID (23/03/2020–31/03/2022), and post-COVID (after 01/04/2022). The lockdown and easing phases were distinguished using Welsh government timelines.

Statistical tests were conducted using JASP (version 0.19.3). The demographics and social variables were summarised using means ($\pm$SD) for continuous variables and proportions for categorical variables. Poisson regression was used with the daily counts of hospital attendances for dog-related injuries as the dependent variable. Independent variables included temperature, precipitation, and weekend and school holiday status. ANOVA was used to analyse independent variables such as phase of the lunar cycle, season and level and timing of COVID restrictions. The Chi-squared tests were used to assess associations between categorical variables, such as age group vs sex. Standardised residuals of $>+2$ or <-2 were considered significant contributors to the association. A p-value of <0.05 was considered statistically significant.

Results

A total of 3167 incidences of people attending hospital having been bitten or struck by dogs from 01/04/2018 to 31/03/2023 were identified. The mean age of patients was 40.2 years (SD 23.9 years), with 52.9% being female. The most affected age group was children aged 0–11 years (18.3%). Most bites happened in urban areas with a population over 10,000 (Urban over 10k) (68.0%) and in the most socioeconomically deprived areas (25.8%) (Figure 1).

Poisson regression identified several independent predictors of higher daily admission counts for dog-related injuries, as identified by an asterisk in Table 1: higher maximum daily temperature ($p<0.001$), summer compared to winter or spring ($p=0.015$, $p<0.001$), when there were no or easing COVID restrictions compared to lockdown ($p<0.001$, $p<0.001$), post-COVID compared to pre-COVID and during COVID ($p=0.008$, $p<0.001$), on school holidays ($p<0.001$) and on weekends compared to weekdays ($p=0.011$).

Using ANOVA to look specifically at admissions for dog bite injuries to Morriston Hospital, Wales's tertiary centre, it was found that across all age groups ($F=7.587$), there was a decrease in dog-related injuries during COVID compared to pre-COVID ($p=0.013$) and post-COVID ($p<0.001$). In the paediatric population, this decrease in admissions during COVID compared to pre-COVID ($F=3.081$, $p=0.039$) was also observed.

Chi-squared analysis of age by sex showed that in children, more males were bitten or struck by a dog, but in adults more females were bitten or struck by a dog (Figure 2). This difference was found to be statistically significant in the 0–11 years and 70–79 years age groups ($p<0.001$).

Important significant associations between categorical variables (Table 2) include increased frequency of dog bites among children aged 0–11 years in the most socioeconomically deprived areas, in the most densely populated areas and in summer months; a decreased frequency of bites for children aged 0–11 years after COVID; an increased frequency of bites for older adults in the least socioeconomically deprived areas and the least densely populated areas; and women being bitten more in the least deprived areas.

Discussion

This study identified several significant risk factors for dog bites, including higher temperatures, weekends compared

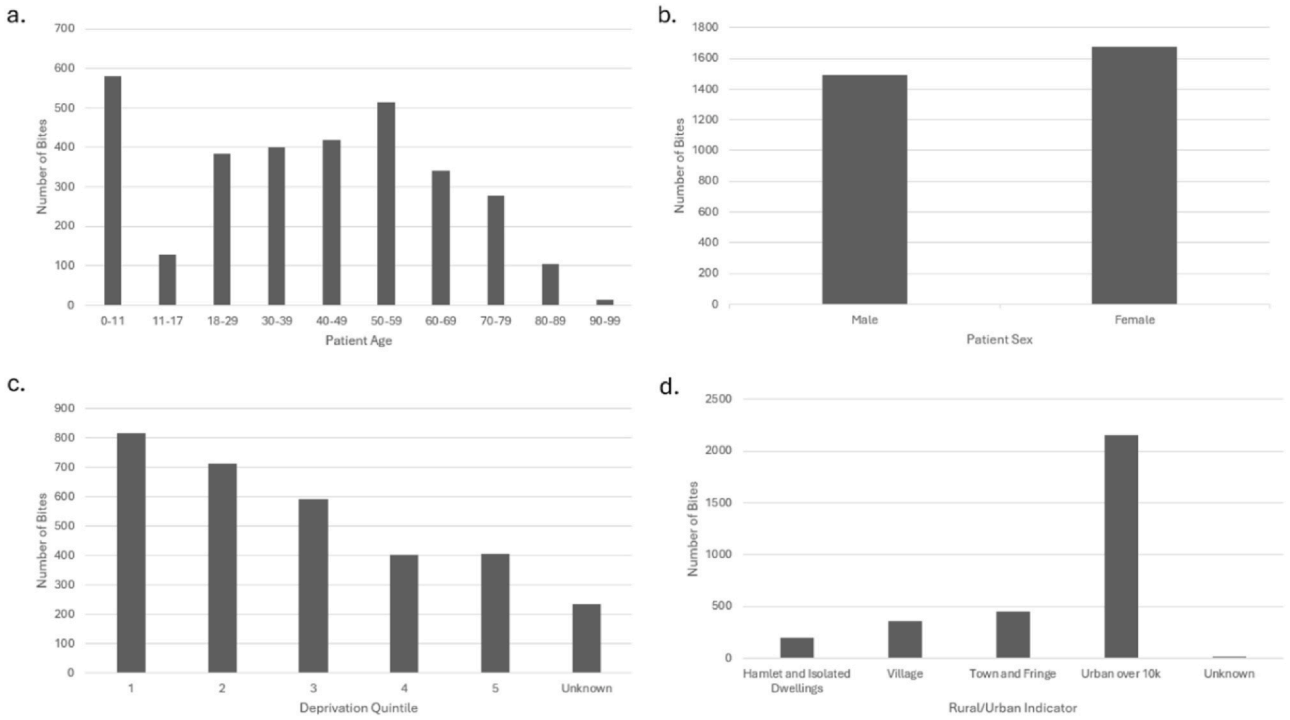

Figure 1 **a**–**d**. Demographics of the patients bitten or struck by dogs (n=3167). **a**. Number of people bitten or struck by dogs in different age groups. **b**. Number of male (n = 1493, 47.1%) and female (n = 1674, 52.9%) patients bitten or struck by dogs. **c**. Number of patients bitten or struck by dogs by social deprivation of the area where the bite occurred (1 = Most deprived, 5 = Least deprived). **d**. Number of patients bitten or struck by dogs by population density of the area where the event occurred (Hamlet and Isolated Dwellings = least densely populated, Urban over 10k = most densely populated).

Table 1 Social and Environmental Predictors for Dog Bites.

Predictor	Test Statistic	p-value
Maximum daily temperature (Celsius)	Estimate = 0.013	$p < 0.001$*
Precipitation (mm)	Estimate = −0.001	$p = 0.822$
Humidity (%)	Estimate = 4.976×10^{-4}	$p = 0.855$
Wind speed (kph)	Estimate = −0.004	$p = 0.064$
Pressure (mb)	Estimate = 2.080×10^{-4}	$p = 0.918$
Cloud cover (%)	Estimate = 4.868×10^{-4}	$p = 0.589$
Phase of the lunar cycle	F = 1.449	$p = 0.204$
Season	F = 8.739	$p < 0.001$*
Level of COVID restrictions	F = 14.340	$p < 0.001$*
Pre/During/Post-COVID	F = 10.073	$P < 0.001$*
School holiday	Estimate = 0.178	$p < 0.001$*
Weekday or weekend	Estimate = 0.099	$p = 0.011$*

to weekdays, school holidays, post-COVID compared to pre and during COVID, no COVID restrictions, and summer months (especially children aged 0–11 years).

Important interactions between categorical variables showing a higher frequency of dog bites include male children aged 0–11 years and female adults aged 70–79 years, children aged 0–11 years in the most socioeconomically deprived areas, and in the least deprived areas, females or adults and 50–59 and 70–79 years.

Firstly, higher temperatures have previously been linked to increased rates of dog bites.[11–13] It has been speculated that this may be due to changes in canine behaviour on hot days, with them potentially becoming more aggressive due to the impacts on their stress response.[13] Moreover, humans may become more aggressive on warmer days as well.[14] However, the most significant factor is likely the fact that there are simply more people and dogs outside on warm days. This is also a possible explanation for the increased number of bites on weekends, school holidays and days with no COVID restrictions.

It has long been known that children are disproportionately affected by dog bites.[2] Suggested explanations for this include difficulty interpreting canine body language and increased likelihood to approach fearful or angry dogs.[15,16] The sex of the children bitten by dogs has been found to be significant in some studies,[17,18] but not in

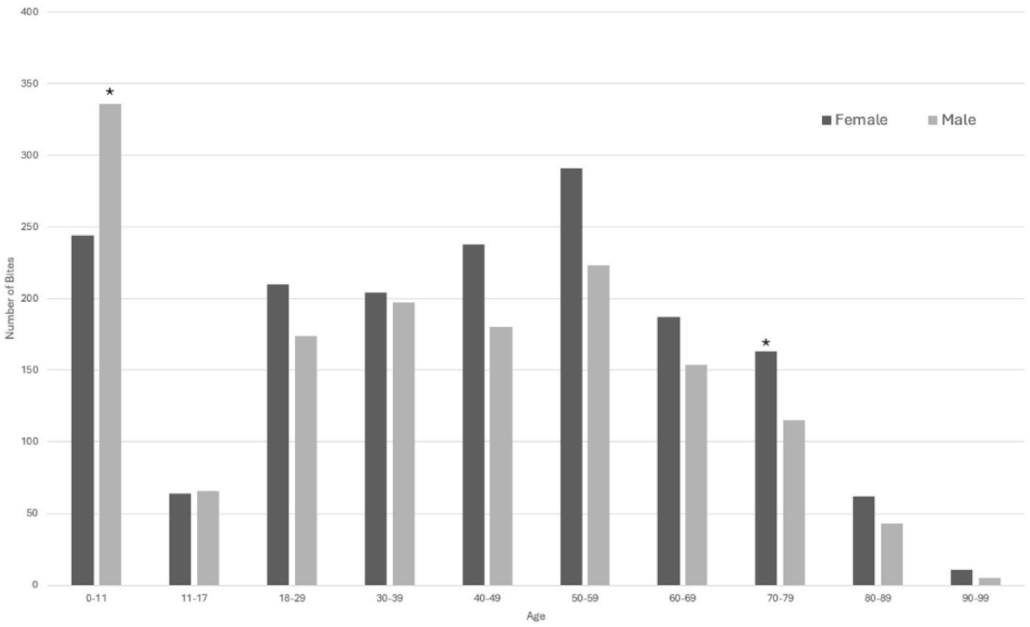

Figure 2 Number of events of patients bitten or struck by dogs by the age and sex of patients. * = Standardised residuals indicate a significant difference.

Table 2 Relationship Between Categorical Variables and Their Statistic Significance Regarding the Risk of Dog Bites.

Relationship between categorical variables	Significant Groups (and Standardised Residuals)	p-value
Age and Socioeconomic Status	1st Quintile: 0-11 years (4.324), 50-59 years (−2.066), 70-79 years (−4.276) 5th Quintile: 0-11 years (−3.600), 50-59 years (2.492), 70-79 years (2.341)	$p < 0.001$
Age and Population Density	Hamlet and Isolated Dwellings: 0-11 years (−2.297), 60-69 years (2.561), 70-79 years (2.004) Urban over 10 k: 0-11 years (2.351), 60-69 years (−2.667), 70-79 years (2.535)	p=0.002
Age and Season	Summer: 0-11 years (3.994) Winter: 0-11 years (−2.214), 90-99 years (2.409)	$p < 0.001$
Age and Level of COVID Restrictions	No restrictions: 18-29 years (−3.558), 70-79 years (2.424), 80-89 years (2.515) Easing restrictions: 18-29 years (3.373), 70-79 years (−2.228) Lockdown: 80-89 years (−2.032)	p=0.001
Age and Pre/During/Post COVID	Pre-COVID: 0-11 years (2.249), 30-39 years (−2.961), 70-79 years (2.135) During COVID: 18-29 years (3.541), 70-79 years (−2.435), 80-89 years (−2.521) Post-COVID: 0-11 years (−2.235), 60-69 years (2.154)	$p < 0.001$
Sex and Socioeconomic Status	5th Quintile: Female (3.297), Male (−3.297)	p=0.023

Contributors: The idea for this study was developed by NWJ and RD. The data were collected by RD and analysed by LP. The first draft of the manuscript was written by LP as part of Cardiff University Medical School's year 4 student selected component (SSC) under the supervision of NWJ. Further drafts were written by LP with advice from NWJ and RD. The paper was prepared for submission by LP. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. Research Checklist: The STROBE Guidelines were adhered to.

others.[19,20] Our data showed that male children aged 0–11 years were at higher risk of dog attacks, which could be due to younger males engaging more in risky behaviours than their female counterparts,[21] potentially putting them in more dangerous situations with dogs.

Socioeconomic status has also been associated with dog bites in the past, with more bites occurring in the most deprived areas.[9,22] Our study found that this difference was most significant in children aged 0–11 years, with those in the most deprived areas being bitten significantly more than those in the least deprived areas. One reason for this could be less access to education about safety around dogs. Moreover, dogs in more deprived areas may not receive the same level of obedience training and may be more prone to bite.[8] A study in the US proposed that dog bite injuries occurring in low-income areas were due to large numbers of children playing outdoors, inferior dog control, fewer homes with adequate fencing and a greater proportion of large-breed dogs which were owned for protective purposes.[23]

Conversely, our data showed that in the least deprived areas, older adults (aged 50–59 or 70–79 years) were more likely to be bitten by dogs. It also showed that females were more likely to be bitten in the least deprived areas. One study found that most dog bites occurred at home [7] and, given the shift towards working from home in recent years, adults in more affluent areas who can work from home may be at a higher risk of being bitten. An explanation for females being more likely to be bitten in affluent areas is that according to the Office for Nation Statistics (ONS),[24] females are more likely to work from home than males; therefore, it is possible that females in affluent areas may have more interaction with dogs at home. They may possibly interact more with dogs outside of their home as well, as one study reported that females were more likely to have the intention of walking their dog than men.[25]

During the COVID pandemic, dog bites were less likely to occur according to our data. There was a significant decrease in paediatric and adult dog bites across the nation as a whole, and at Wales's tertiary centre for dog bites (Morriston Hospital), which is contrary to what other studies have found. At Alder Hey's Children's Hospital, it was noted that paediatric emergency department admissions for dog-related injuries increased threefold during the pandemic.[26] A study in France similarly found that there was an increase in paediatric dog bites, specifically to the face, during the COVID lockdown.[27]

This increase was thought to be due to the increase in pet dogs adopted during the COVID lockdown. However, our data showed that children aged 0–11 years, although more likely to be bitten pre-COVID, were not bitten more during COVID and were less likely to be bitten post-COVID. Some children who were bitten during COVID possibly did not undergo treatment in a hospital due to uncertainty around A&E attendance during COVID, as we know that A&E attendance in the UK decreased during COVID.[28] This altered health-seeking behaviour may have continued after COVID, leading to continued underreporting. Moreover, children raised with dogs during COVID may be safer and more aware around dogs and have higher levels of parental supervision with more people switching to working from home more frequently.

Our data also found that during COVID, especially when COVID restrictions were easing, young adults aged 18–29 years were bitten disproportionately more than other age groups. This could due to young people adhering less strictly to COVID guidelines,[29] meaning they may have been more likely to encounter aggressive dogs. Adults aged 70–89 years being less likely to be bitten during COVID makes sense as they were part of a higher risk group; therefore, they were more likely to adhere to the guidelines and stay home,[29] away from aggressive dogs.

An important finding related to COVID is that there was a significant increase in dog bites post-COVID compared to pre and during COVID. This is consistent with the findings in other studies.[30] The rapid increase in pet ownership during the pandemic, estimated to be around 2.5 million new dogs acquired by mostly first-time pet owners,[31] is considered an important contributing factor. These dogs, having been raised under abnormal circumstances with limited access to obedience courses and less opportunities to socialise with other dogs, may have developed longer term behavioural issues which were only revealed when the dogs were exposed to the world without COVID restrictions.[32]

One study calculated dog population in Wales in 2019 to be 733,714,[33] mostly in the most populous areas in South Wales. This gives a ratio of approximately 1 dog for every 4 people across the country as a whole when compared with the Welsh population of 3,087,732 in the same year.[34] However, this is likely to have increased since COVID.

Most dog bites in our study occurred in urban areas. This is likely due to a higher population of dogs in urban areas in the UK.[33] Conversely, a study in Canada found that hospitalisations related to dog bites occurred more in rural areas,[35] suggesting that this may be due to higher rural dog populations as was observed in Ireland.[36] Patients bitten by dogs in rural areas in Wales were less likely to attend hospital, but there have been no studies to investigate this.

There was also an association with age, with children aged 0–11 years being more likely to be bitten in urban areas and less likely to be bitten in rural areas, which fits with the overall trend. It also fits known population data, as cities tend to have higher populations of young people than rural areas according to the Office for National Statistics.[37] This report also found that rural areas had much higher older populations, which fits with our finding that adults aged 70–79 years were more likely to be bitten in rural areas.

Moreover, dog bites are known to occur more in the summer months,[38] likely due to children being at home and spending more time with their dogs. It also fits with the increase in dog bites on warmer days. There was also an association with age, with children aged 0–11 years being more likely to be bitten in the summer, which is consistent with the findings from previous studies.[38]

Despite the strengths of our study, there are some limitations that should be noted. Firstly, the data was taken from records of the Welsh Centre for Burns and Plastic Surgery of patients who attended hospital for dog-related injuries, which excludes the dog bites which were treated in primary care or did not receive any treatment. Secondly, we collected the meteorological data for Wales overall; therefore, there was likely variability depending on the part of the country where the bite occurred. Despite the large sample size over an extended period, we are uncertain whether our findings would be generalisable in other parts of the world. There may also have been confounding variables, such as canine factors, such as breed, sex and neutering status, and further information about the incident, such as whether the bites occurred at home or whether the dog was known to the patient. These factors may limit the generalisability of our findings to broader populations or underreport certain contributing factors. Thus, future research should aim to include community-based data collection and include more information about the circumstances of the bites to enhance data reliability.

Conclusions

This study aimed to identify the risk factors associated with dog bites. Our findings indicate that factors such as warmer temperatures, summer months, school holidays, weekends,

lower socioeconomic status and higher population density may be significant. These findings emphasise the need for targeted educational public health campaigns focusing on the increased risk of dog bites, particularly focused towards young children and their care takers.

Although meteorological factors may not be of use in preventing dog bites, they may help with service provisions in preparation for more dog bite injuries. For example, an additional plastic surgeon on call may be beneficial on sunny summer bank holidays, where there is a higher risk of dog bites.

Further longitudinal studies across diverse populations are needed to develop predictive models and test the effectiveness of specific prevention strategies. By better understanding the complex factors behind dog bite incidents, we can implement more effective prevention measures and reduce their public health burden.

Ethical approval

Not required.

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Conflicts of interest

None declared.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.bjps.2025.11.059.

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