Patterns and relationships around dog demographics, behaviour, and dog-human interactions.

Georgina Davies

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Abstract

With approximately 13.5 million dogs as pets in the UK, dogs play a central role in many of our lives. However, dog ownership isn't without its challenges. Undesirable behaviours, such as aggression, are present in approximately 80% of dogs and pose significant welfare issues. Understanding how these behaviours relate to dog demographics is essential for improving welfare, training strategies and legislation. These factors (dog behaviour and demographics) may also be related to how owners interact with their dogs. As play and training are fundamental to canine welfare, identifying how dog behaviour and demographic factors influence how owners play with/train their dog is crucial. A particular undesirable behaviour, dog bites, are an increasing public health concern and their likelihood is influenced by a multitude of factors. In aim of preventing dog bites, legislation was introduced to prohibit certain dog types, a decision likely driven by the mainstream media, which may adopt a narrative-driven approach.

This thesis explored the relationship between dog behaviour, dog demographics and how owners play with their dogs, by analysing questionnaire results from dog owners. Moreover, since articles on dog bites may influence dog-related legislation, it examined how variables related to dog bites are reported within newspapers and scientific literature within the UK.

Analyses of owner questionnaires revealed that whether a dog displayed potentially undesirable behaviour was related to certain aspects of demographics. However, aggression was not related to any demographics which suggests that dog bite related legislation focusing exclusively on breed is insufficient. It was also found that dog demographics predicted how often owners played with and trained their dogs, whereas behaviour did not. This may be because owners view play mainly as bonding or recreation rather than a tool for behaviour modification. Play frequency is likely influenced more by owner lifestyle factors than by the dog's behaviour. In terms of media reporting of dog bites, no significant associations were found between media type and the reporting frequency of different variables, meaning that article types were equally as informative. However, potential associations were found between media type and whether prevalence/statistics and psychological impact variables were discussed. It was also noted that there was a lack of discussion of preventative measures which is missed opportunity to educate the public.

Overall, this research highlights the complex interplay between dog demographics, behaviour, owner interactions, and public perceptions.

Declaration

I declare that the work contained in this thesis is entirely my own. No portion of the work within this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Chapter 1- General Introduction

1.0 Owner-dog relationship

With approximately 13.5 million dogs as pets in the UK, dogs play a central role in many of our lives (UK Pet Food, 2024). People choose to own dogs for many reasons, with companionship and encouraging regular exercise being among the most common (Holland *et al*., 2022). Dogs have been shown to improve the lives of their owners physically and mentally, for example by increasing physical activity, providing emotional support and a sense of purpose, and facilitating social connectivity (Allen, Blascovich and Mendes, 2002; Allen, 2003; Levine *et al*., 2013; Bennett *et al*., 2015; Wood *et al*., 2015; Brooks *et al*., 2016; Mubanga *et al.*, 2017; Pereira and Fonte, 2018; Westgarth *et al.,* 2019).

In addition to enriching the lives of dog owners, a strong bond between dogs and their owners has also shown to improve canine welfare, through having a stress-alleviating effect and promoting relaxation (Schöberl *et al*., 2012; Somppi *et al*., 2022). Owners can act as a 'secure base' similar to that found in human children, enabling dogs to explore their surroundings freely knowing they have a base to return to (Palmer and Custance, 2008; Horn, Huber and Range, 2013; Somppi *et al*., 2022). Owners are also a 'safe haven' where they act as a buffer against stress in threatening situations (Gácsi *et al*., 2013; Somppi *et al*., 2022).

An important hormone that plays a role in bond formation is oxytocin (Romero *et al*., 2014), which is released in dogs and owners when they interact (Odendaal and Meintjes, 2003; Handlin *et al*., 2011; Nagasawa *et al*., 2015). Interactions such as walks, play, training sessions, petting/ stroking dogs and talking to them have also been shown facilitate positive welfare in dogs through reducing stress levels (Coppola, Grandin and Enns, 2006; Handlin *et al*., 2011; Shiverdecker, Schiml and Hennessy, 2013; Csoltova *et al*., 2017; Hunt, Whiteside, and Prankel, 2022).

1.1 Undesirable Behaviours

Dog ownership also comes with its challenges such as financial cost, burden of responsibility, and dealing with behavioural issues (Merkouri *et al*., 2022). Undesirable behaviours are present in approximately 80% of dogs (Uchida *et al*., 1996; Dinwoodie *et al*., 2019; Yamada *et al*., 2019). Among these, aggression is a widespread issue, varying in severity from growling to snapping and biting (Farhoody *et al*., 2018). This aggression can be directed not only towards conspecifics but also towards strangers and familiar people (Farhoody *et al*., 2018). Undesirable behaviours such as whining, barking and jumping up are categorised as attention seeking behaviours. These are usually directed towards household members and are a frequent source of complaints for owners (Kobelt *et al*., 2003; Yeon, 2007; Pirrone *et al*., 2015). Owners also commonly seek help for dog reactivity, where a dog becomes over aroused by common stimuli and may display behaviours such as running and barking (Blackwell, Bradshaw and Casey, 2013; Hart and King, 2024). As well as being distressing for owners, this behaviour poses a significant welfare concern (Hart and King, 2024). These concerns also arise when dogs show signs of fear such as hiding, avoidance, and cowering (Hsu and Sun, 2010). Behavioural problem such as aggression are the most common cause for relinquishment to shelters and a substantial cause of euthanasia (Salman *et al*., 2000; Siracusa, Provoost and Reisner, 2017; Patronek, Bradley and Arps, 2022). Not only do these pose significant dog welfare issues, but aggression, and bites in particular, are a significant public health issue; statistics show that 1 in 4 people have been bitten by a dog, with 1/3 of these seeking medical treatment (Westgarth, Brooke and Christley, 2018).

1.2 Dog Demographics and Undesirable Behaviour

Previous research has demonstrated that undesirable behaviours can be related to a dog's demographics. For example, small size and adulthood in dogs are linked to tendencies towards mounting and hunting behaviours as well as fearfulness (Didehban *et al*., 2020). Fearfulness, along with withdrawal, has also shown to be more frequent in females than males. Moreover, age influences levels of activity and destructiveness, with puppies showing more excessive activity and destructiveness than adult dogs (Arhant, Winkelmann and Troxler, 2021). Furthermore, brachycephalic (flat-faced) breeds display more behaviours that may be interpreted as "helplessness" and dependence than mesocephalic

(intermediate skull shape) dogs and were reportedly more aggressive towards their owners (Ayrosa *et al*., 2022b; Ujfalussy *et al*., 2023).

Research has extensively focused on the link between dog demographics and aggressive behaviour towards humans, though findings can be conflicting. For example, while Farhoody *et al*. (2018) reported no association between neuter status and aggression toward familiar people, other studies have found that neutered dogs were actually more likely to show owner-directed aggression (Reisner, Houpt and Shofer, 2005; Hsu and Sun, 2010). Additionally, McGreevy *et al*. (2013) observed higher rates of owner-directed aggression in smaller dogs, whereas Didehban *et al*. (2020) identified this behaviour more commonly in larger dogs. However, it is regularly suggested that males are more likely to show human-directed aggression than females (Fatjo *et al*., 2007; Bollen and Horowitz, 2008; Hsu and Sun, 2010; Casey *et al*., 2014; Flint *et al*., 2017; Lord *et al*., 2017; Wallis, Szao and Kubinyi, 2020; Mikkola *et al*., 2021; Mcguire and Jean- Baptiste, 2023). Moreover, aggression has been frequently associated with old age (Guy *et al*, 2001b; Hsu and Sun, 2010; Martínez *et al*., 2011; McGreevy *et al*., 2013; Flint *et al*., 2017; Messam *et al*., 2018; Didehban *et al*., 2020; Mikkola *et al*., 2021; Ayrosa *et al*., 2022b). Additionally, a variety of breeds are indicated as showing the most aggression toward humans, including dachshunds and working breeds such as spaniels (Guy *et al*., 2001a, Fatjo *et al*., 2007; Duffy, Hsu and Serpell, 2008; Amat *et al*., 2009; Asp *et al*., 2015).

In terms of dog bites, Oxley, Christley and Westgarth (2018) found that most biting dogs within the UK were male, adults, medium or large and neutered. The most common dog breeds that were specified were German Shepherds, Border Collies and Jack Russells (Oxley, Christley and Westgarth, 2018). Outside of the UK, it has been found that male and intact dogs were more likely to have bitten (Shuler *et al*., 2008; Buso *et al*., 2016; Hasoon, Shipp and Hasoon, 2020). However, Guy *et al*., (2001b) concluded that females are more likely to have bitten owners than males and a global study found that most biting dogs were neutered (Dinwoodie *et al*., 2019). It has additionally been found in Oregon, USA, where dog bites are required to be reported to animal control, that the risk factors associated with biting dogs included being purebred and being terrier, working, herding, and nonsporting breeds (Shuler *et al*., 2008). In Texas, USA, Pit Bulls and Labrador retrievers had the highest frequency of bites (Hasoon, Shipp and Hasoon, 2020).

1.3 Dog Behaviour and Demographics on Human-Dog Interactions

How a dog acts may shape the way owners interact with them, including how much time an owner spends with their dog and types of activities they engage in. For example, dogs that have growled at household members are less likely to be walked daily (Westgarth, Christian and Christley, 2015); it has been proposed that such problematic behaviour weakens the dog-owner bond, resulting in the owner being less motivated for dog walking. Bennett and Rohlf (2007) discussed that, although causation was not certain, owners of obedient and friendly dogs were more likely to engage in training activities; it was suggested that perhaps these activities are more enjoyable when shared with a well-behaved dog. The authors additionally found that owners were less likely to share activities such as kissing, grooming, and sitting with their dog if their dog was considered to be aggressive, nervous, disobedient, or to bark excessively. This could be because owners of dogs with behavioural issues are unable to engage in these activities, or that the behaviours develop due to lack of shared activities, as the relationship between dog behaviour and owner behaviour is bidirectional (see Figure 1).

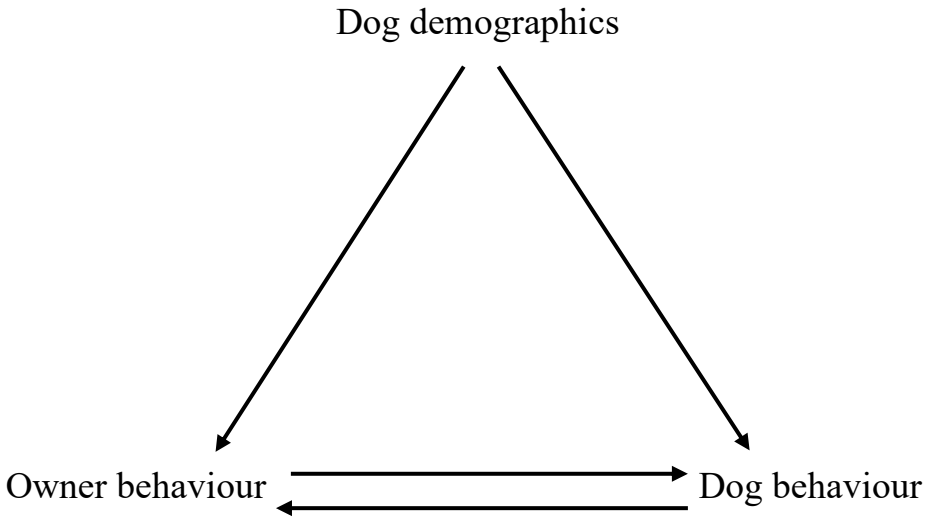

Figure 1. The relationship between dog demographics, owner behaviour, and dog behaviour. Arrow directions show which factor influences another factor. Owner behaviour towards their dogs is influenced by their dog's demographics, such as size, as well as the owner's perceptions of these (Bennett and Rohlf, 2007; Arhant *et al*., 2010; Meyer and

Forkman, 2014; Lim and Rhodes, 2016). In turn, owner behaviour affects dog behaviour (Rooney and Bradshaw, 2003; Tóth *et al*., 2008). This can create a cycle whereby owners interact with their dogs in a specific way as a result of the dogs' behaviour (Westgarth, Christian and Christley, 2015). Dog behaviour, such as aggression, can also be shaped by their demographics, including sex and age (Fatjo *et al*., 2007; Bollen and Horowitz, 2008; Hsu and Sun, 2010; McGreevy *et al*., 2013; Casey *et al*., 2014).

In addition to dog behaviour, dog demographics, such as age, sex, size, and breed, as well as owner perceptions of these, may also affect these interactions. For example, owners with smaller dogs are more inconsistent and play with/train their dogs less than owners of larger dogs (Arhant *et al*., 2010). Kobelt *et al.,* (2003) also reported that larger dogs were more likely to attend formal obedience training than small dogs, perhaps because behavioural problems are considered to be more serious in larger dogs. Furthermore, owners of larger dogs perform more moderate to vigorous dog walking compared to small-dog owners (Lim and Rhodes, 2016) and small dogs are less likely to be walked daily (Westgarth, Christian and Christley, 2015). A dog's breed also effects how often they are walked, with Gundogs such as the English and Irish setter being most likely to be walked once per day and terrier and toy groups the least likely to be exercised once per day (Pickup *et al*., 2017). Moreover, owners of larger and older dogs, as well as certain breeds such as the Danish Broholmer, have lower levels of shared activities/ interactions with their dogs, including activities such as kissing, grooming, and sitting with them (Bennett and Rohlf, 2007; Meyer and Forkman, 2014).

1.4 Dog bites, perceptions and legislation

A dog's demographics can also effect how behaviours such as biting are perceived. For example, bites by larger dogs and aggression in males are often viewed as more serious issues than bites or aggression in small and female dogs (Guy *et al*., 2001b). Kennel Club types are also perceived differently; classifying a dog as a 'terrier' elicits perceptions of increased aggression compared to categorizing the same dog as the 'toy' type (Clarke, Mills and Cooper, 2016).

These perceptions, combined with extensive media attention, prompted the introduction of the Dangerous Dogs Act 1991 within the UK. Section 1 of the act bans the pit bull terrier, Japanese tosa, fila Brasileiro and dogo Argentino and a recent addition to this list is the American XL Bully. This legislation determines the legality of a dog based on its physical appearance. It's controversy stems from the idea that any dog has the potential to be dangerous, with many believing that dog laws should be based on 'deed, not breed' (Oxley, 2012; Creedon and Ó Súilleabháin, 2017; Allcock and Campbell, 2021). Furthermore, it has been consistently demonstrated that legislated dogs are not more likely to cause greater injuries and do not have an elevated risk of biting compared to non-legislated dogs (Collier, 2006; Creedon and Ó Súilleabháin, 2017). Accordingly, there is a lack of evidence to support the effectiveness of breed-specific legislation (Creedon and Ó'Súilleabháin, 2017). The act has, however, driven negative perceptions of legislated breeds.

The media coverage of dog bites was likely a key driver in the implementation of the DDA; the press focused on severe dog attacks, particularly those involving children, such as six-year-old Rucksana Khan who was 'savaged' by a pit bull terrier (Allcock and Campbell, 2021). This sparked public panic and led to the House of Commons Dangerous Dogs debate in May 1991. During the debate the pressure generated by the media was acknowledged and a quote from the front page of a local newspaper was read out: "Rucksana was tossed about like a rag doll by the ferocious dog for 15 minutes while onlookers struggled to free her from its vice-like grip" (Cryer, col.1059). Following the debate, the DDA passed through the House of Commons within one day.

In summary, it is clear that dogs play a significant role in our lives and the bond and interactions shared between owners and their dogs enrich the lives and welfare of both. However, ownership is not without its challenges as undesirable behaviours shown by dogs, such as aggression, can be distressing for owners, pose dog welfare and public health concerns and strain the dog-owner relationship. These behaviours, including dog bites, can be linked to dog demographic factors such as age and sex, though findings are contradictory. Both dog behaviour and demographics also influence the way owners interact with their dogs, such has how they are walked and played with, which in turn can affect dog welfare. Given the bidirectional nature of the relationship between dog

behaviour and human behaviour, how owners interact with their dog may also affect how the dog behaves. Human-dog dynamics are further shaped by societal perceptions and legislation, which is likely influenced by the media that frames certain demographics (such as breed types) more negatively than others. Given the significant welfare implications of the bond and interactions shared between humans and dogs, it is important to explore patterns across dog demographics, behaviour, and human-dog interactions.

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Chapter 2- Relationship Between Dog Demographics and Behaviour

2.0 Introduction

It is evident that demographics such as size, age, and cephalic index (the ratio between the width and length of skull, O'Neill *et al*., 2020) are linked to the way that dogs behave. For example, small dogs are more likely to jump up on their owners compared with large dogs (Martino, 2017), while brachycephalic breeds have been reported to show more dependence on their owners than mesophilic and dolichocephalic (long-skulled) breeds (Ujfalussy *et al*., 2023). Much of the existing research, however, has focused primarily on aggression, with less attention given to behaviours such as fearfulness or attention-seeking. Additionally, findings regarding the influence of demographic factors on aggressive behaviour can be contradictory, for example, in the effects of neuter status and size (Reisner, Houpt and Shofer, 2005; Hsu and Sun, 2010; McGreevy *et al*., 2013; Farhoody *et al*., 2018; Didehban *et al*., 2020).

Finding the true link between a dog's demographics and aggression, along with other undesirable behaviours, is crucial for implementing effective legislation. Current legislation, which targets specific breed types perceived as having a greater risk of biting, has been shown to be ineffective in reducing dog bites and may divert attention from more effective measures like responsible ownership education (Creedon and Ó'Súilleabháin, 2017). Understanding how demographics influence behaviour can also lead to more tailored and effective training and management strategies. In turn, this could foster positive relationships between dogs and owners, ultimately reducing relinquishment levels.

I aim to utilise a questionnaire sent to dog owners to explore a wide range of dog demographics and potentially undesirable behaviours, thereby building on existing research to elucidate the relationship between dog demographics and undesirable behaviour. Based on previous research, I predict that all behaviour types will be related to varying demographics. In particular, older males will be most likely to show aggression (Guy *et al*, 2001b; Bennett and Rohlf, 2007; Fatjo *et al*., 2007; Bollen and Horowitz, 2008; Hsu and Sun, 2010; Martínez *et al*., 2011; Casey *et al*., 2014; Flint *et al*., 2017; Lord *et al*., 2017; Messam

et al., 2018; Didehban *et al*., 2020; Wallis, Szao and Kubinyi, 2020; Mikkola *et al*., 2021; Ayrosa *et al*., 2022b; Mcguire and Jean- Baptiste, 2023). Additionally, small female dogs will be more fearful and small dogs will show more behaviour related to attachment/ attention seeking issues and aggression (Tóth *et al*., 2008; Martínez *et al*., 2011; McGreevy *et al*. 2013; Serpell and Duffy, 2014; Asp *et al*., 2015; Stone *et al*., 2016; Zapata, Serpell, and Alvare, 2016; Didehban *et al*., 2020).

2.1 Methods

2.1.0 Data collection

Data was collected between the 4th and 12th May through dog owners participating in an online survey using 'SmartSurveyTM' software. The survey was advertised through social media, including paid Facebook advertisements, a Dogs Trust e-newsletter, New Scientist magazine and emails sent to dog owners involved in the Generation Pup study (www.generationpup.ac.uk) or the Dogs Trust Post Adoption study who have previously consented to be contacted via email. Additionally, individuals who had taken part in an earlier survey conducted by the Dogs Trust research team and had agreed to be approached for future research were also invited to participate. This survey was originally carried out for a previous study which aimed to explore the impact of the COVID-19 lockdown restrictions in the United Kingdom on the welfare of pet dogs (Christley *et al*., 2020). Participants provided information on their dogs' behaviour and management during the last 7 days (i.e., during the first phase of lock-down) and during an average week in February 2020 (before the UK's lockdown). My study used data from February 2020 only and only utilised the data regarding dog demographics, play/training, and dog behaviour.

2.1.1 Inclusion Criteria

Study participants were required to be at least 18 years of age, to live in the UK and to currently own a dog. Participants were required to complete the survey for the dog that most recently joined their household. If multiple dogs joined at the same time, owners were instructed to choose the dog whose name came first alphabetically. The responses were

checked for duplicates based on IP addresses and were subsequently removed, keeping the survey with the fewest missing data points.

2.1.2 Ethics

The study was approved by the Dogs Trust Ethical Review Board (ERB036).

2.1.3 Questionnaire

A questionnaire was developed containing 99 variables regarding dog demographics, dog behaviour and training and games played with owners. Within this chapter, I explore the variables related to dog demographics and behaviour. Responses to questions concerning the dogs age (Q11), sex (Q15), neuter status (Q16) and breed (Q18) were either selected from a predefined list or written by the participant (see Appendix. 1). Furthermore, potentially unwanted behaviour (PUB) that the dogs have shown towards human adults living in the household was determined by asking participants to select from predefined responses (Q52 and Q59).

2.1.4 Categorisation

Dog Demographics

To understand the association between behaviour and dog demographics (age, size, Kennel Club group, cephalic index, sex, neuter status), dogs were assigned to a life stage, roughly based on research by Harvey (2021): puppies were 0-6 months, juveniles 6 months- 1 year, young adults 1-2 years, adults 2-7 years, early seniors 7-9 years, late seniors 9-12 years and geriatrics were 12 years and over. Moreover, dogs were categorised into small, medium and large based on their breed using information from The Kennel Club (TKC) (2021) or were estimated by experts at Dogs Trust if the breed was not recognised by TKC. For example, a Jack Russell terrier was classed as small, a springer spaniel was classed as medium, and a German shepherd was classed as large. Using their breed information, dogs were also allocated to a Kennel Club group (KCG) where possible (see Table 1.) Also using breed information, dogs were assigned a cephalic index (CI) using the breed average ratio between the width and length of skull to determine if they are brachycephalic (flat-faced = 1), mesocephalic (medium proportions = 2) or dolichocephalic (long-faced = 3), sourced from

O'Neill *et al*., (2020). For analyses concerning KCG, CI and size, only pedigree dogs were used as both TKC and O'Neill *et al*., (2020) do not provide information on mixed breeds.

Table 1. Kennel Club Groups and definitions.

Gundog	Dogs that were originally trained to find live game and/or to retrieve game that had been shot and wounded.
Hound	Breeds originally used for hunting either by scent or by sight.
Pastoral	Herding dogs that are associated with working cattle, sheep, reindeer and other cloven-footed animals.
Terrier	Dogs originally bred and used for hunting vermin.
Toy	Small companion or lap dogs.
Utility	The name 'utility' essentially means fitness for a purpose, most breeds having been selectively bred to perform a specific function not included in the sporting and working categories.
Working	Over the centuries these dogs were selectively bred to become guards and search and rescue dogs.

Behaviour

To investigate the relationship between demographics and dog behaviour, behaviours were grouped into 5 categories: aggressive towards humans in the household, attachment/attention seeking (AAS) related, fear towards humans in the household, reactive, and potentially unwanted behaviour (PUB). Dogs were classed as having any PUB if the owner answered 'yes' to any option in Q52 (apart from the last option: 'None of the

above') which comprised list of behaviours that their dog may have displayed. Dogs were classed as having shown aggressive behaviour if the owner answered 'yes' in Q52 to their dog having shown the following behaviour(s) towards adults living in the household: 'growled, snapped or nipped when approached or handled', 'growled, snapped or nipped around food (human or own)', or 'bitten someone'. Using the same question, dogs were also classed as having attachment/attention seeking (AAS) issues if they answered 'yes' to any of these options: 'whined or barked if shut behind a door or stairgate', 'whined or barked when someone was working or busy', or 'jumped up when someone was working or busy'. If the owner answered 'yes' to either: 'hidden or moved away when approached', or 'pulled away, cowered or trembled when handled', then the dog was classed as showing fear towards humans living in the household. Lastly, dogs were classed as reactive if they answered 'yes' to any option in Q59.

2.1.5 Data Analyses

RStudio, version 1.3.1093 (R Core Team, 2022) was utilised for statistical analysis and figure creation. Any questionnaire questions that were left unanswered, resulting in NAs, were removed for each analysis.

Initial Data Exploration

To inform the main data analysis and investigate patterns in the data, preliminary analyses of the data were conducted. To explore the association between dog demographic factors and whether a dog displayed any potentially unwanted behaviour, individual chi-square tests of independence were carried out for six dog demographic factors: sex, neuter status, age category, size, Kennel Club group and cephalic index, with five categories of PUB: any potentially unwanted behaviour (PUB), aggression, attachment/attention seeking (AAS), fear towards humans in the household, and reactivity. For each analysis, the values that would be expected if there was no association between the variables were calculated. If any of these values were less than 1, or 20% or more of the values were less than 5, a chi-square test was considered unsuitable and a Fisher's exact test would have been utilised. However, was not the case for any of the tests. 30 statistical tests were performed, so the Holm-Bonferroni correction was carried out on all p-values to reduce the chances of false positives

due to multiple tests being conducted. Standardised residuals were calculated for any significant associations between variables ($p<0.05$). Variable combinations were classed as driving the significant association if the standardised residuals were 2 or above or -2 or below (Agresti, 2012).

Modelling

Binary logistic regression models were created for each behavioural category to explore which demographic variables predict whether dogs display potentially unwanted behaviours, when accounting for confounding effects of variables and to identify possible interactions between variables. To determine which predictor variables to initially include in models the chi-square tests were used. A stepwise approach was then utilised. Predictor variables were initially evaluated based on their p-values to reduce the number of variables included in the model and the Akaike Information Criterion (AIC) was used to decide whether to introduce variables. Models were considered to perform equally as well if they had an AIC within 6 units of each other (Richards, 2005). Interactions were added to the final model (lowest AIC) based on author led biological decisions. One interaction was between size and age as large dogs have earlier onset of age-related behaviours than smaller dogs (Turcsán and Kubinyi, 2025). An interaction between sex, neuter status and KCG was also tested as the effect of neuter status on behaviour depends on a dog's breed and sex (Serpell and Hsu, 2005; Arroube and Pereira, 2025.) The goodness of fit of the final model was tested using the Hosmer-Lemeshow test and the area under the ROC curve was used to measure the model's accuracy. Predictor variables were assessed using p-values and by calculating odds ratios and 95% confidence intervals. For each final model, to visually represent how variables predict whether dogs displayed the behaviour, dot and whisker plots of predicted probabilities were created for each significant predictor variable.

2.2 Results

2.2.0 Participants and Dogs

9386 dog owners responded to the survey. 38% of dogs were female and 43% were male (19% 'NA'). 31% were neutered females, 3% were intact females, 34% were neutered males and 6% were intact males (26% were either missing sex or neuter status). The dogs were on

average 5.36 ± 3.77 years old (N=7697). 41% of dogs were pedigree breeds recognised by TKC, <2% (1.7%) were single breeds not recognised by TKC or the participant had answered the single breed questions with a mixed breed. The rest were mixed breeds or were not specified.

46% of owners reported their dog displaying PUB (selected any option from Q52) shown towards adults living in the household, 3% reported behaviour that I classed as aggressive, 32% of owners reported behaviour that I classed as showing AAS, 2% reported fearful behaviour, and 59% reported their dog as being reactive on an average weekday.

2.2.1 Chi-square results

See Appendix 2. for the exploratory chi-square results regarding the association between dog demographic factors and behaviour. In general, all behaviours apart from aggression were associated with varying demographics.

2.2.2 Binary Logistic Regression Models

Any Potentially Unwanted Behaviour (PUB)

The top performing model for predicting whether dogs displayed PUB comprised the demographics: size, sex, neuter status, age category, cephalic index, and KCG. The model had an AIC of 5436.5 which was 199.2 units less than the null model (null model AIC= 5635.7) and fit well with the observed data (χ^2 (8) = 11.77, p=0.16). The area under the ROC curve was 0.63. The significant demographic variables were the dog's size, cephalic index, age and KCG (see Table 2 and Figure 1.). See Table 3. for the AICs of all models developed.

Table 2. Odds ratio estimates and their confidence intervals, and p-values of predictor demographic variables within the final model predicting whether dogs displayed PUB. Significant results are in bold. *= p<0.05 **= p<0.01 *** =p<0.001. Odds ratios are presented relative to the reference categories: large, CI 1, female, intact, adult, Gundog.

Predictor Variables	Odds Ratio Estimate	Lower Confidence Interval	Upper Confidence Interval	P-Value
Small	**1.51**	**1.23**	**1.86**	**<0.001 *** **
Medium	**1.24**	**1.02**	**1.51**	**0.03 ***
CI 2	**1.53**	**1.16**	**2.03**	**0.003 ****
CI 3	**1.64**	**1.18**	**2.30**	**0.004 ****
Male	1.06	0.93	1.20	0.40
Neutered	1.10	0.93	1.31	0.28
Puppy	**0.24**	**0.15**	**0.35**	**<0.001 *** **
Juvenile	**1.91**	**1.38**	**2.68**	**<0.001 *** **
Young adult	**1.50**	**1.21**	**1.87**	**<0.001 *** **
Early senior	**0.57**	**0.47**	**0.70**	**<0.001 *** **
Late senior	**0.51**	**0.42**	**0.62**	**<0.001 *** **
Geriatric	**0.50**	**0.38**	**0.64**	**<0.001 *** **
Hound	0.75	0.56	1.00	0.05
Pastoral	**0.74**	**0.59**	**0.93**	**0.01 ***
Terrier	0.89	0.70	1.12	0.32
Toy	0.91	0.66	1.25	0.55
Utility	1.09	0.81	1.46	0.57
Working	1.06	0.76	1.48	0.73

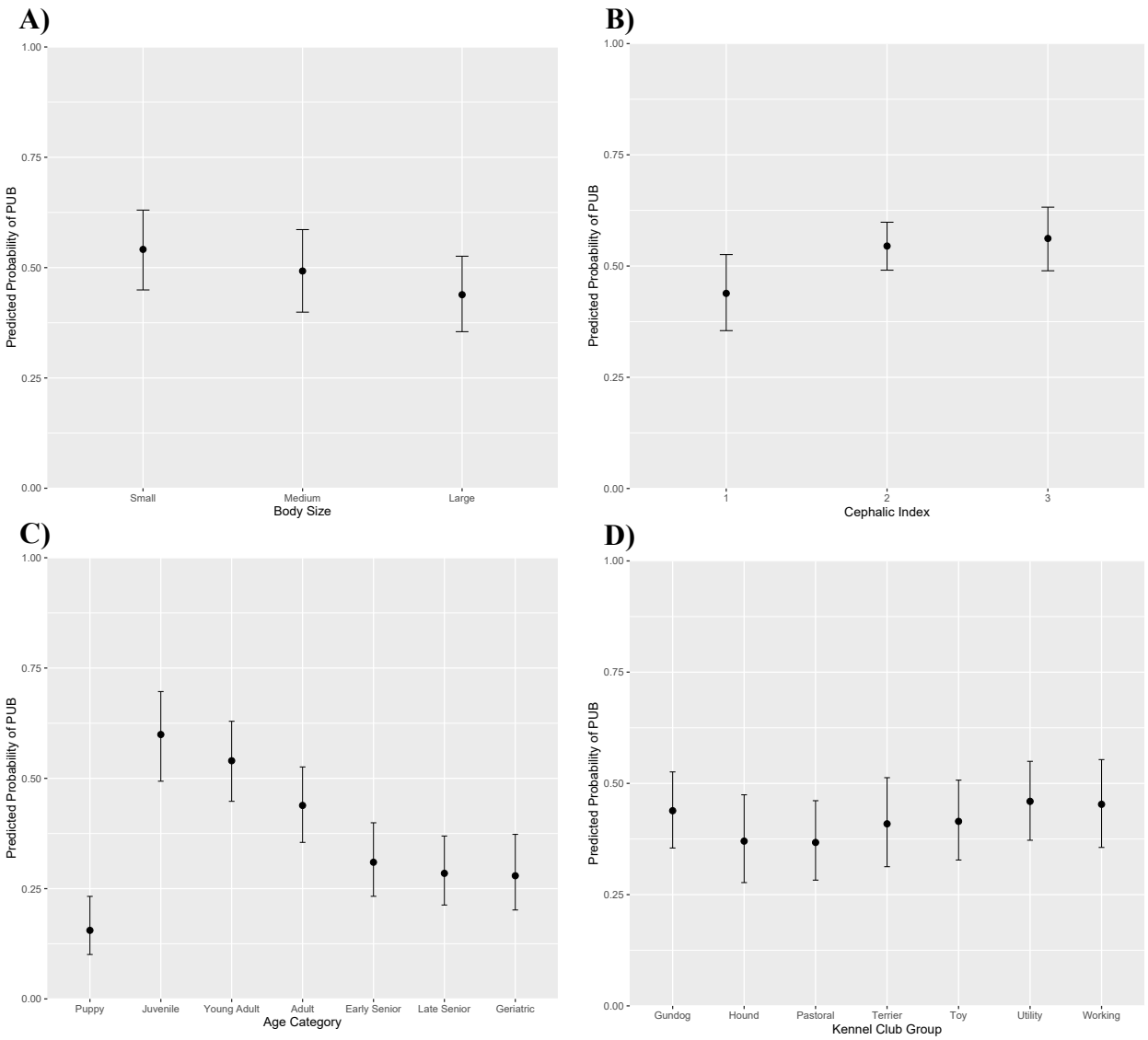

Figure 1. Predicted probability of dogs displaying potentially unwanted behaviour according to their **(A)** body size, **(B)** cephalic index, **(C)** age category, and **(D)** Kennel Club group, when all other predictors in the model are kept constant. Error bars represent 95% confidence intervals.

Table 3. The Akaike Information Criterion (AIC) of the models created using PUB as a response variable. *= interactions between variables. The model number shows the order in which the models were made.

Model **Displays PUB ~**	**AIC**	**Δ AIC**
Size + Cephalic Index + Sex + Neuter Status + Age Category + Kennel Club Group	5436.5	-
Size * Age Category + Cephalic Index + Sex + Neuter Status + Kennel Club Group	5446.6	10.1
Size * Age Category + Cephalic Index + Sex * Neuter Status * Kennel Club Group	5448.3	11.8
Size + Cephalic Index + Neuter Status + Age Category + Kennel Club Group	5453.4	16.9
Size + Cephalic Index + Sex + Age Category + Kennel Club Group	5453.5	17
Size + Cephalic Index + Sex + Neuter Status + Age Category	5461.4	24.9
Size * Age Category + Cephalic Index + Sex * Neuter Status + Kennel Club Group	5470.6	34.1
Size + Cephalic Index + Age Category + Kennel Club Group	5474.6	38.1
Size + Age Category	5504.6	68.1

Attachment/ Attention-Seeking (AAS) related behaviour

To predict whether dogs display AAS, the top performing model comprised the demographics: size, age category, sex, KCG, neuter status and cephalic index which were all significant predictors apart from neuter status (see Table 4. and Figure 2). The model had an AIC of 5333.5 which was 116.6. units less than the null model (null model AIC= 5450.1). It fit well with the observed data ($\chi 2$ (8) =4.48, p=0.81) and the area under the ROC curve was 0.61. One other model was also considered equally as supported and contained the same variables without cephalic index (see Table 5.).

Table 4. Odds ratio estimates and their confidence intervals, and p-values of predictor demographic variables within the final model predicting whether dogs displayed AAS. Significant results are in bold. *= p<0.05 **= p<0.01 *** =p<0.001. Odds ratios are presented relative to the reference categories: large, female, adult, gundog, intact.

Predictor Variables	Odds Ratio Estimate	Lower Confidence Interval	Upper Confidence Interval	P-Value
Small	**1.83**	**1.49**	**2.26**	**<0.001 *** **
Medium	**1.34**	**1.09**	**1.63**	**0.005 ** **
Male	**1.19**	**1.04**	**1.35**	**0.0095 ** **
Puppy	**0.32**	**0.20**	**0.51**	**<0.001 *** **
Juvenile	1.24	0.91	1.68	0.16
Young Adult	**1.35**	**1.09**	**1.66**	**0.005 ** **
Early Senior	**0.73**	**0.59**	**0.90**	**0.004 ** **
Late Senior	**0.69**	**0.56**	**0.84**	**<0.001 *** **
Geriatric	0.81	0.62	1.05	0.11
Hound	**0.70**	**0.52**	**0.94**	**0.02 * **
Pastoral	**0.60**	**0.47**	**0.76**	**<0.001 *** **
Terrier	**0.78**	**0.62**	**0.98**	**0.03 * **
Toy	0.85	0.62	1.17	0.32
Utility	0.86	0.64	1.14	0.28
Working	0.99	0.70	1.39	0.97
Neutered	1.13	0.95	1.35	0.17
Cephalic Index 1	1.18	0.90	1.56	0.23
Cephalic Index 3	**1.41**	**1.01**	**1.96**	**0.04 * **

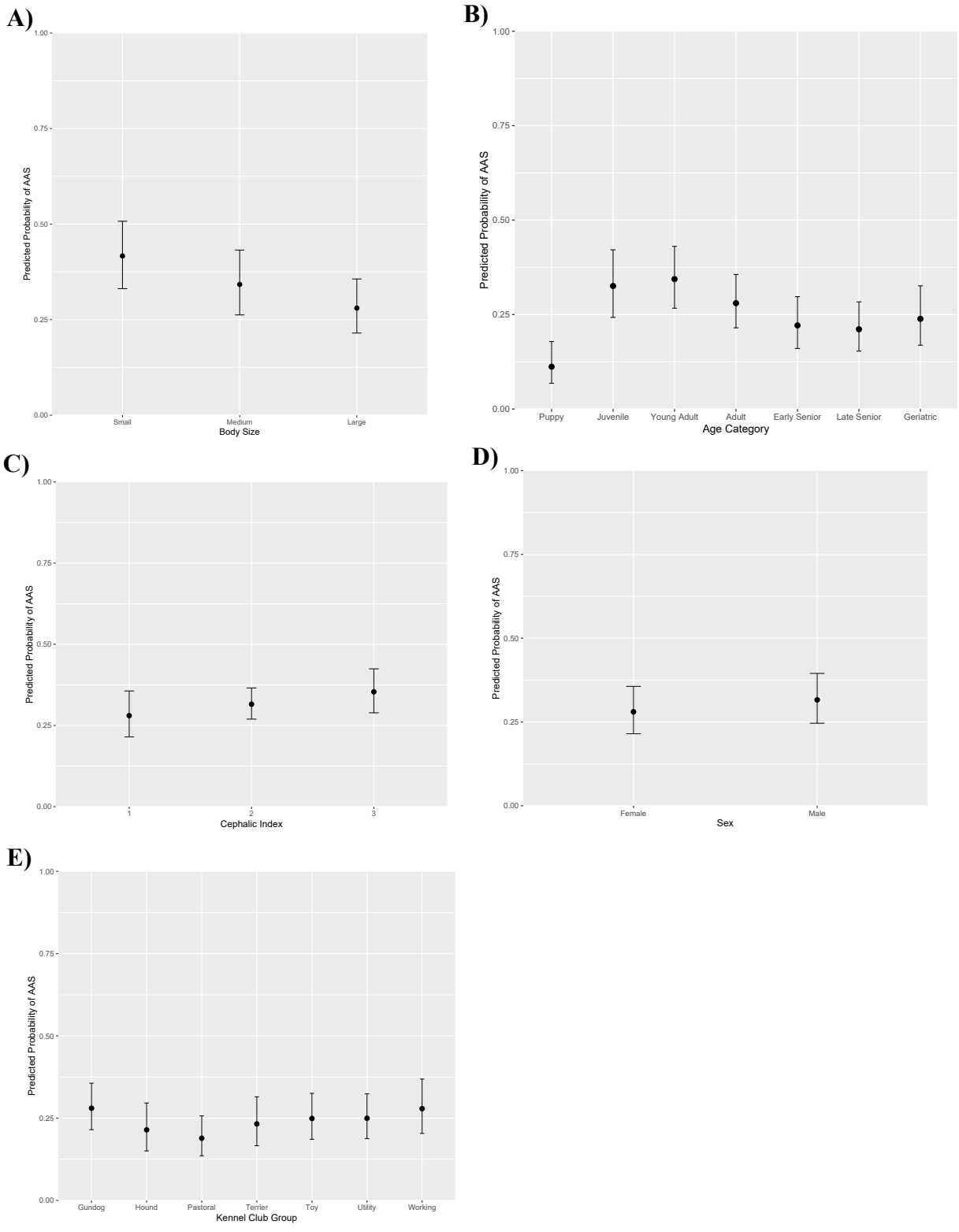

Figure 2. Predicted probability of dogs displaying attachment/attention-seeking related behaviour according to their **(A)** body size, **(B)** age category, **(C)** Kennel Club group, **(D)** sex, and **(E)** cephalic index, when all other predictors in the model are kept constant. Error bars represent 95% confidence intervals.

Table 5. The Akaike Information Criterion (AIC) of the models created using AAS as a response variable. Models with an AIC within 6 units of the top model are in bold. *= interactions between variables. The model number shows the order in which the models were made.

Model **Displays AAS ~**	**AIC**	**Δ AIC**
Size + Age Category + Sex + Kennel Club Group + Neuter Status + Cephalic Index	**5333.5**	-
Size + Age Category + Sex + Kennel Club Group + Neuter Status	**5333.6**	0.1
Size * Age Category + Sex + Kennel Club Group + Neuter Status	5346.7	13.2
Size + Age Category + Sex * Kennel Club Group * Neuter Status	5351.4	17.9
Size + Age Category + Sex + Kennel Club Group	5351.8	18.3
Size * Age Category + Sex * Kennel Club Group * Neuter Status	5363.5	30
Size + Age Category + Kennel Club Group	5377	43.5

Fear Towards Humans in Household

The top performing model contained the demographic variables: age category, sex, KCG and neuter status. The model had an AIC (688.82) that was 13.62 units less than the null model (702.44) and fits well with the observed data (χ^2 (8) =4.38, p=0.82). The area under the ROC curve was 0.71. The KCG predictor variable was significant (see Table 6. And Figure 3.). Within the data used for this model, no dogs from the working KCG displayed fear. This resulted in complete separation for this category, leading to unstable coefficient estimates, so the effect of the working KCG on whether a dog displays fear should be interpreted with caution. Three other models were considered to be equally supported according to their AIC values (see Table 7.). These models were similar to the best performing model; one additionally had an interaction between sex and neuter status, one additionally contained cephalic index as a predictor variable and one additionally contained size and cephalic index.

Table 6. Odds ratio estimates and their confidence intervals, and p-values of predictor demographic variables within the final model predicting whether dogs displayed fear. Significant results are in bold. *= p<0.05 **= p<0.01 *** =p<0.001. Odds ratios are presented relative to the reference categories: female, adult, gundog, intact.

Predictor Variables	Odds Ratio Estimate	Lower Confidence Interval	Upper Confidence Interval	P-Value
Male	0.78	0.48	1.27	0.32
Puppy	0.43	0.25	3.65	0.87
Juvenile	0.38	0.56	4.05	0.34
Young Adult	1.61	0.66	2.65	0.37
Early Senior	0.58	0.13	1.08	0.11
Late Senior	1.11	0.22	1.29	0.22
Geriatric	1.37	0.06	1.27	0.19
Hound	**3.96**	**1.61**	**9.98**	**0.003 ******
Pastoral	**3.20**	**1.40**	**7.74**	**0.007 ******
Terrier	2.22	0.85	5.77	0.1
Toy	**5.39**	**2.20**	**13.56**	**<0.001 *******
Utility	**5.46**	**2.40**	**13.16**	**<0.001 *******
Working	0.00	0.00	202.46	0.98
Neutered	1.05	0.56	2.09	0.88

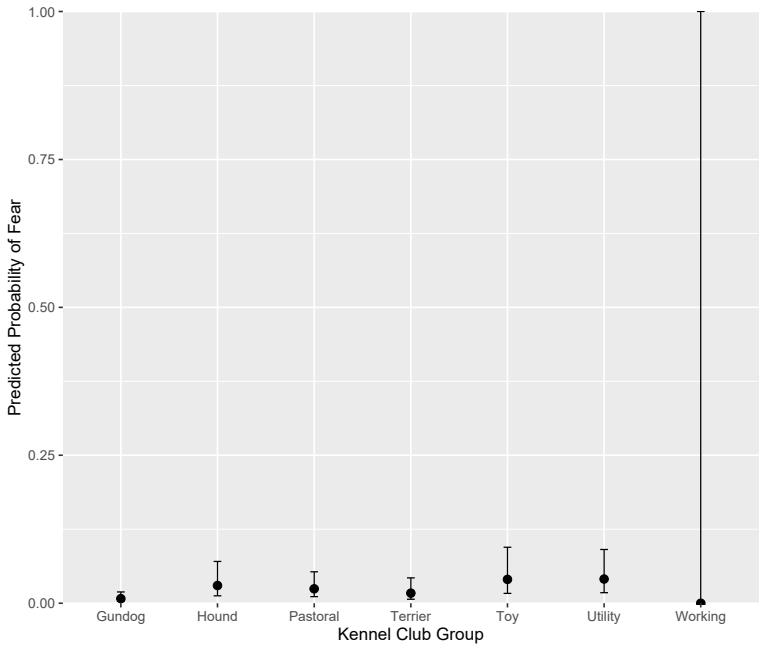

Figure 3. Predicted probability of dogs displaying fearful behaviour according to Kennel Club group when all other predictors in the model are kept constant. Error bars represent 95% confidence intervals.

Table 7. The Akaike Information Criterion (AIC) of the models created using fear as a response variable. Models with an AIC within 6 units of the top model are in bold.*= interactions between variables. The model number shows the order in which the models were made.

Model **Displays Fear ~**	**AIC**	**Δ AIC**
Age Category + Sex + Kennel Club Group + Neuter Status	**688.82**	**-**
Age Category + Sex * Neuter Status + Kennel Club Group	**690.06**	**1.24**
Age Category + Sex + Kennel Club Group + Neuter Status + Cephalic Index	**691.47**	**2.65**
Size + Age Category + Sex + Kennel Club Group + Neuter Status + Cephalic Index	**694.19**	**5.37**
Age Category + Sex + Kennel Club Group	695.33	6.51
Age Category + Kennel Club Group	695.44	6.62
Size + Age Category + Sex + Kennel Club Group	698.11	9.29
Age Category + Sex * Neuter Status * Kennel Club Group	709.69	20.87

Reactivity

To predict whether dogs display reactivity on an average weekday, the top performing model contained all demographic variables measured (size, age, sex, KCG, neuter status and cephalic index). The model's AIC was 4771.9 which was 224.6 units less than the null model (AIC= 4996.5). The model additionally fit well with the observed data (χ^2 (8) =6.21, p=0.62) and the area under the ROC curve was 0.63. Size, neuter status, age, KCG, and CI were significant predictors (see Table 8. And Figure 4.) This model without cephalic index as a predictor was also considered equally as supported (see Table 9.).

Table 8. Odds ratio estimates and their confidence intervals, and p-values of predictor demographic variables within the final model predicting whether dogs displayed reactivity. Significant results are in bold. *= p<0.05 **= p<0.01 *** =p<0.001. Odds ratios are presented relative to the reference categories: large, female, intact, adult, gundog, intact.

Predictor Variables	**Odds Ratio Estimate**	**Lower Confidence Interval**	**Upper Confidence Interval**	**P-Value**
Small	**1.51**	**1.21**	**1.90**	**<0.001 *** **
Medium	1.16	0.94	1.43	0.17
Male	1.06	0.92	1.22	0.42
Neutered	**1.33**	**1.10**	**1.59**	**0.002 ** **
Puppy	**0.11**	**0.07**	**0.17**	**<0.001 *** **
Juvenile	0.82	0.60	1.14	0.24
Young adult	0.95	0.76	1.20	0.68
Early senior	1.06	0.84	1.33	0.65
Late senior	0.85	0.69	1.06	0.15
Geriatric	**0.61**	**0.46**	**0.80**	**<0.001 *** **
Hound	**0.57**	**0.42**	**0.77**	**<0.001 *** **
Pastoral	1.01	0.79	1.29	0.94
Terrier	1.13	0.86	1.47	0.38
Toy	0.86	0.61	1.23	0.42
Utility	**1.41**	**1.01**	**1.96**	**0.04 ** **
Working	0.93	0.65	1.32	0.67
Cephalic index 2	1.34	0.98	1.82	0.06
Cephalic index 3	**1.49**	**1.03**	**2.17**	**0.03 ** **

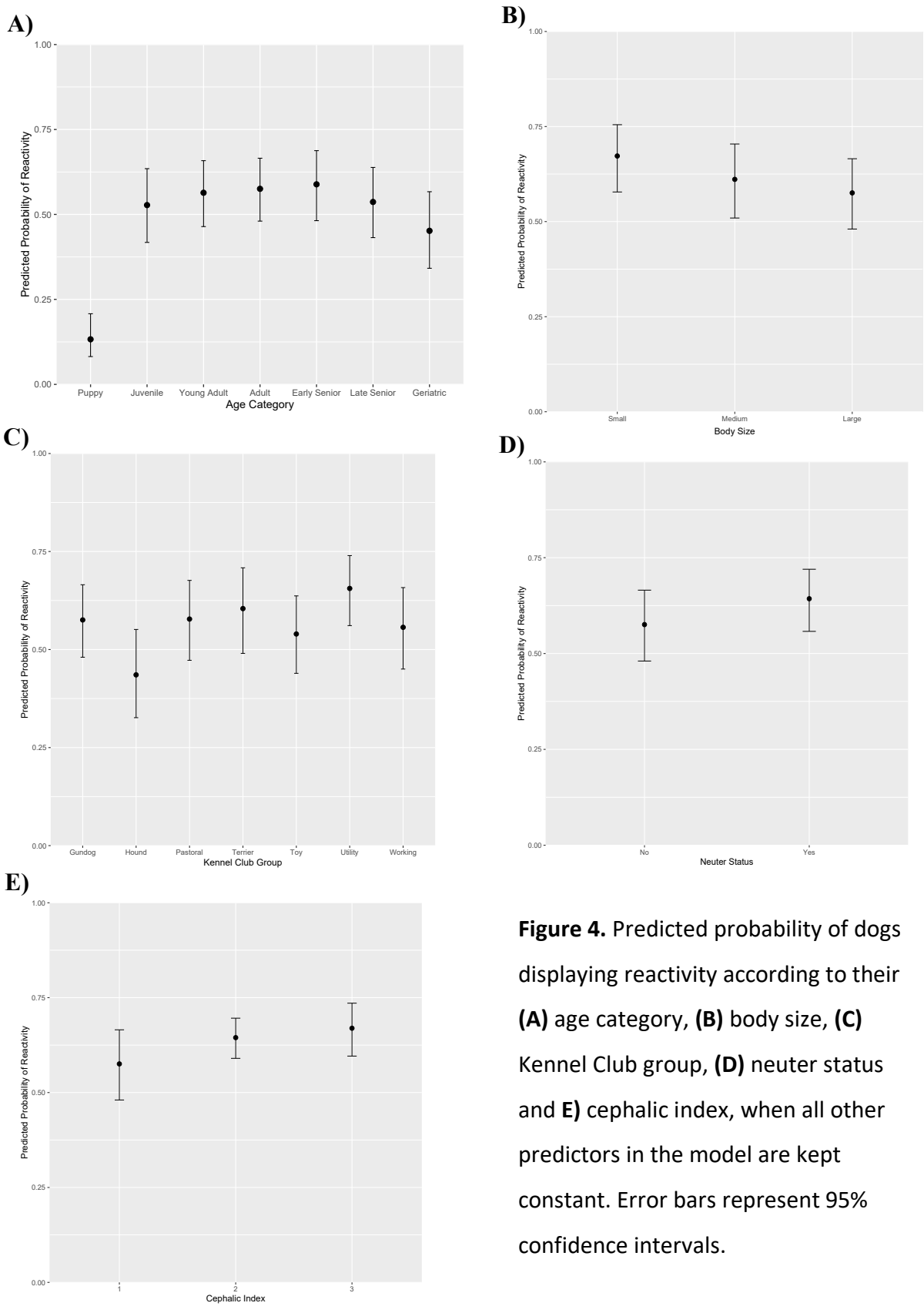

Figure 4. Predicted probability of dogs displaying reactivity according to their **(A)** age category, **(B)** body size, **(C)** Kennel Club group, **(D)** neuter status and **E)** cephalic index, when all other predictors in the model are kept constant. Error bars represent 95% confidence intervals.

Table 9. The Akaike Information Criterion (AIC) of the models created using reactivity as a response variable. Models with an AIC within 6 units of the top model are in bold. *= interactions between variables. The model number shows the order in which the models were made.

Model **Displays Reactivity ~**	**AIC**	**Δ AIC**
Size + Age Category + Kennel Club Group + Neuter Status + Sex + Cephalic Index (model 3)	**4771.9**	-
Size + Age Category + Kennel Club Group + Neuter Status + Sex (model 2)	**4772.6**	0.7
Size * Age Category + Kennel Club Group + Neuter Status + Sex+ Cephalic Index (model 6)	4787.2	15.3
Size + Age Category + Kennel Club Group + Neuter Status (model 1)	4787.4	15.5
Size * Age Category + Kennel Club Group + Neuter Status * Sex+ Cephalic Index (model 5)	4788.3	16.4
Size * Age Category + Neuter Status * Kennel Club Group * Sex + Cephalic Index (model 4)	4810.6	38.7

Aggression

The top performing model (AIC= 1085.6) for predicting whether dogs display aggression had a higher AIC than the null model (1078.8) did not fit well with the observed data (χ^2 (8) = 18.13, p=0.02) and had an area under the ROC curve of 0.64. The model comprised the variables CI, sex, age, KCG and neuter status. Age and KCG were significant predictors. Since the model did not perform well, the chi-square results, which were carried to initially explore the data, will be focused on. These tests revealed that aggression was not significantly related to any dog demographic factors (age (χ2 (6) =6.84, p=1.00); size (χ2 (2) =7.57, p=0.36); KCG (χ2 (6) = 10.44, p=1.00); CI (χ2 (2) =0.92, p=1.00); sex (χ2 (1) =3.09, p=0.94); combination of sex and neuter status (χ2 (3) =6.67, p=0.94)).

2.3 Discussion

Overall, all potentially undesirable behaviours apart from aggression, were related to varying demographics. Therefore, potential owners need to consider a dog's demographic variables when choosing a dog. For example, if a prospective owner is particularly concerned about dogs jumping up (a behaviour classed as AAS) they may need to consider a large sized dog. Moreover, future efforts to prevent and discontinue undesirable behaviour need to take into consideration a dog's breed, size, neuter status, age, and CI and sex.

2.3.0 Aggression

Whether dogs display aggression was not predicted by any demographic variables. Svartberg (2006) also found no differences between breed groups in aggression levels, although the study included additional forms of aggression than only towards household members. Conversely, utility and hound breeds have shown an increased risk of aggression to family members compared to crossbreeds (Casey *et al*., 2014). Bradshaw *et al*., (1996) also found differences between KCGs in aggression, with working dogs and terriers showing significantly more aggression than other KCGs. Aggression towards household members is commonly associated with breed in general (Guy *et al*., 2001a; Duffy, Hsu and Serpell, 2008; Serpell and Duffy, 2014; Asp *et al*., 2015). This may be because historically certain breeds have been selected for traits such as guarding, hunting or fighting ability which may contribute to aggressive dispositions. For example, terriers were bred to hunt and kill vermin which may explain the findings of Bradshaw *et al*. (1996) (The Kennel Club, 2021). More recently, in certain breeds such as guarding dogs, specific loci associated with aggression may have been selected for (following the selection of reduced fearfulness/aggression during domestication) making these dogs more aggressive (Zapata, Serpell, and Alvarez, 2016). However, unlike these findings, no demographic variables in the current study were associated with aggression, highlighting potential variability in how these factors influence aggressive behaviour.

Whilst this study focuses on aggression to adult household members and the dog's KCG rather than individual breeds or bite incidents, it nevertheless has implications for legislation such as the Dangerous Dogs Act 1991. The act is based on the premise that

aggression is tied to certain types of dogs. These findings challenge that logic as they indicate that breed types are not associated with aggressive behaviour in this context. It is likely that other factors such as the dog's early experience and ownership factors are associated with aggression towards household members (Baslington-Davies *et al*., 2023). While I cannot rule out the possibility that aggression/bites in other contexts (such as to unfamiliar people), may be associated with breed, and so cannot suggest that legislation should not focus on breed type at all, these findings suggest that focusing exclusively on breed is insufficient. Therefore, Legislation and preventative measures need to expand their scope beyond breed type and include these additional factors.

The relationship between aggression and size varies within literature and with size measurement such as weight, BMI, and height. Ayrosa *et al*., (2022b) found that as dog weight alone increases so does the likelihood of nonaggression, but BMI does not affect behaviour. Similarly, McGreevy *et al*. (2013) found that aggression towards owners increases with decreasing height. This could be due to aggression in smaller dogs being more tolerable. Additionally, Zapata, Serpell and Alvare (2016) revealed that fear/aggression alleles (found on chromosomes 18 and X) are linked with short legs and small size alleles; this is referred to as linkage disequilibrium and means that the alleles tend to be inherited together. Therefore, smaller dogs may be genetically predisposed to fear/aggression, and it is surprising that my results do not coincide with this. Conversely, in Iran, aggression towards owners was seen more in large dogs, perhaps due to their use as bodyguards/ protection in this area (Didehban *et al*., 2020).

Our finding that age was not associated with aggression was also unexpected as previous findings show that that aggression towards familiar people increases with age (Bennett and Rohlf, 2007; Hsu and Sun, 2010; Didehban *et al*., 2020).

I also did not find a difference in aggression between sexes or neuter status. This was the case for Bennett and Rohlf (2007), although their 'aggressive' category additionally included aggression directed to strangers and dogs, which may not reflect sex/neuter status differences in aggression towards household members. However, my findings do not support other conclusions that females are least likely to be aggressive to household members compared to males or that females were more likely to have bitten household

members than male dogs (Hsu and Sun, 2010; Casey *et al*., 2014; Ayrosa *et al*., 2022b). Furthermore, my findings do not coincide with research by Hsu and Sun (2010), who found that neutered males were most aggressive towards their owners, or Casey *et al*. (2014) who found that neutered females were the least likely to display aggression to family members. Guy *et al*. (2001a) revealed that that neutered male dogs of at least 1 year of age were most likely to show biting behaviour towards members of the household, followed by neutered female dogs and intact males, while intact male dogs and neutered dogs of both sexes were more likely to show growling behaviour. These results partly support Hsu and Sun (2010) but do not concur with both my results or those of Casey *et al*. (2014). Taken together, the inconsistency across studies suggests that the role of sex and neuter status in aggression is complex, context dependent, such as who it is directed towards, and dependent on how it is measured. In practice, interventions for aggression in male dogs often involve neutering, with the rationale of reducing testosterone levels. However, the findings of this study, along with other research, suggests that interventions should not rely solely on neuter status (or sex).

Our results also differ from previous findings that brachycephalic dogs are more aggressive towards their owners than mesocephalic dogs (Ayrosa *et al*., 2022b). The difference may stem from my CI analyses exclusively using purebred dogs, while Ayrosa *et al*. also included crossbreeds, which are typically mesocephalic.

2.3.1 Attachment/ Attention-Seeking (AAS) Behaviour

All demographic factors, apart from neuter status were associated with AAS. Relative to large dogs, small and medium dogs were more likely to display AAS. This was expected as it has been previously found that as the dogs' size increased, their fear of loneliness decreased, and owners of small and dogs are more likely to report attention-seeking behaviours (Martínez *et al*., 2011; McGreevy *et al*. 2013; Serpell and Duffy, 2014; Stone *et al*., 2016). Moreover, small dogs more frequently perform exaggerated jumping up-on their owners, becoming excessively excited when owners return home; this behaviour can even be encouraged in small dogs but may be indicative of separation anxiety (Martino, 2017). I also found that male dogs were more likely to display AAS. This contrasts with Takeuchi and Mori (2006), who reported no sex differences in affection demand, which is likely due to the

differences in how these behaviours were defined/ measured. In terms of KCG, pastorals, hounds and terriers were less likely to display AAS behaviour than other KCGs. It has previously been revealed that toy breeds score higher for AAS behaviour than other breeds and that working breeds show more of this behaviour than non-working breeds (Serpell and Duffy, 2014; Asp *et al*., 2015). Dogs with a CI of 3 (dolichocephalic) were more likely to show AAS. Conversely, brachycephalic breeds have been reported to show more dependence on their owners than mesophilic and dolichocephalic breeds (Ujfalussy *et al*., 2023), but this context involves orienting towards humans and relying on their human assistance during tasks rather than asking for attention within the household.

A novel finding was that young adult dogs were more likely to display AAS, whereas puppies and seniors were less likely. It is therefore suggested that such behaviour requires early and maintained intervention. An additional novel finding is that neuter status does not predict whether dogs display AAS suggesting that AAS behaviours are not influenced by hormonal status.

Overall, as well as early intervention, management to prevent AAS needs to consider demographic factors such as sex, cephalic index, KCG and size.

2.3.2 Fear Towards Household Members

The single demographic variable associated with fear towards household members was KCG. Fear in this context has not previously been examined in relation to dog demographics. However, studying fear towards people and general fearfulness has revealed that working breeds are less fearful towards strangers than non-working dog breeds, and breeds with higher-than-average stranger directed fear levels are Sheltland sheepdogs, lagotto Romagnolos and Chihuahuas (Asp *et al*., 2015). Chihuahuas having high fear levels coincides with my findings that toy dogs may be more fearful.

Whilst small breeds such as chihuahua may have a genetic predisposition to fearfulness due to linkage disequilibrium between size-related loci and those influencing fear traits (Zapata, Serpell, and Alvare, 2016), it is likely that the stereotype of these small breeds being more fearful may reinforce it. An owner expecting a fearful dog may inadvertently reinforce such behaviour by excessively comforting it. Therefore, fearfulness is likely shaped

by both their demographics/genetics as well as the environment, so interventions need to consider this.

It was unexpected that I did not find small or female dogs to be the most fearful as this is usually the case and has been suggested that this may relate to small female dogs that tend to sit being more towards the shy end of the boldness scale (Tóth *et al*., 2008; Starling *et al*., 2013; Asp *et al*., 2015; Didehban *et al*., 2020). It is likely that this difference in findings is also due to the fear being directed towards household members within my study, rather than strangers.

2.3.3 Reactivity

Whilst fearfulness (such as hiding/ avoiding, escaping, shaking) towards varying stimuli has been heavily researched (King, Hemsworth and Coleman, 2003; Blackwell, Bradshaw and Casey, 2013; Asp *et al*., 2015; Wallis, Szabó and Kubinyi, 2020), reactivity (running/barking) towards stimuli and its relationship with dog demographics is relatively under researched. However, my findings do generally align with related research.

I found that hound KCGs were less likely to show reactivity, while utility breeds were more likely than other groups. One reason for the lower levels of reactivity in hound breeds may be their historical selection. Although hounds can be highly responsive when tracking or chasing prey, scent hounds in particular were selected for controlled, task-focused arousal so likely show better inhibitory control towards other stimuli rather than general reactivity to everyday occurrences (Mellor *et al*., 2024; Salamon *et al*., 2025). In contrast the higher reactivity of utility breeds may relate to their diverse origins, with some historically bred for alerting or guarding roles that favoured heightened environmental sensitivity. Previous research has also shown that reactivity differs between breeds. Breeds used by the Mira Foundation (for guide/assistance dogs) in its early years, such as royal poodles and golden retrievers, show higher levels of fear/ reactivity, including towards people, noises, and traffic, compared to other breeds (particularly Labrador retrievers who had low levels of fear/reactivity issues) (Dollion *et al*., 2019). Additionally, German shepherds show less noise reactivity than Australian shepherds and Border collies (Overall, Dunham and Juarbe-Diaz, 2016). Interestingly, reactivity manifested differently within these breeds (pacing versus panting and hiding), meaning that owners in my study may not have classed their dog as

reactive if it was showing reactive behaviour other than running and barking. It is also worth mentioning that mixed breeds were not included in this analysis, but noise reactivity may have been higher in mixed breeds than purebreds as was found by Pirrone *et al*., (2015).

Small dogs were more likely to be reactive relative to large dogs which aligns with the finding that lighter dogs are more reactive to negative stimuli (Ayrosa *et al*., 2022a). This may be explained by both biological and environmental mechanisms. Due to their size, they need to be able to react quickly in threatening situations and owners may tolerate or even comfort small barking dogs, which reinforces the behaviour. However, Pirrone *et al*., (2015) suggest that noise reactivity is more likely to occur in medium/ large dogs. This may be due to different types of stimuli, as ours additionally includes visual stimuli.

My results regarding puppies and geriatric dogs being the least likely to display reactivity only party supports findings that reactivity to negative stimuli is greater in younger dogs (Ayrosa *et al*., 2022a). Older dogs being less likely to display reactivity may reflect habituation over time or perhaps age-related hearing or vision loss (reducing stimulus detection). Geriatric dogs may also be less physically able to display behaviours such as running and barking. Conversely, Pirrone *et al*. (2015) concluded that noise reactivity is more likely to occur in adults and seniors. The authors suggested that this may be due to fearful behaviours developing over time due to sensitization and generalization of stimuli. This difference in finding may also stem from differing stimulus type, as well as the descriptions of behaviour being subject to bias. Differencing stimulus types and behaviour descriptions may also explain why my findings that dogs with a CI of 3 were more likely to display reactivity, do not coincide with those by Ayrosa *et al*. 2022a) that long snouted dogs are less reactive to negative stimuli.

My results suggest that neutered dogs were more likely to show reactive behaviour than intact dogs, which appears to be a novel finding. Further research is needed to determine causality as this may have important implications for veterinary advice.

My finding that reactivity is not related to sex does not correspond with the observation that males have fewer fear/reactivity issues than females (Dollion *et al*., 2019). This may be

down to Dollion *et al*. only utilising dogs of 1 year of age, whereas I aimed to include all age ranges.

2.3.4 Potentially Unwanted Behaviour (PUB)

Dogs were more likely to display PUB (including AAS, aggression, fearfulness, and stealing) if they were juveniles or adults, small or medium, and have a CI 2 or 3. Belonging to the pastoral KCG and being a puppy, senior or geriatric makes them less likely to display PUB. The relationship between age and PUB may reflect younger dogs having higher energy/activity levels than older dogs, which may lead to stealing or attention seeking behaviour for example (Wallis, Szao and Kubinyi, 2020). The reason puppies may be less likely to display PUB is that they spend more time sleeping than adults and during their first few months they are still developing so may lack the hormones and experiences that lead to behaviours such as aggression (Battaglia, 2009). Findings by Kobelt *et al*. (2003) also reflect the lack of relationships between PUB and dog demographics such as sex and neuter status. However, different behaviours were classified as being problematic. For example, Kobelt *et al*. (2003) included chasing people, digging, and inappropriate elimination.

2.3.5 Limitations

An important consideration is that the study design does not allow causal inferences. While varying dog demographics were found to be significant predictors for certain behaviours, it is not certain that these demographics cause the behaviours.

An additional limitation is the potential for sampling bias as it relies on volunteer respondents. Those who choose to participate are likely to spend more time with their dogs and generally have more positive interactions, which may not represent the broader population. Respondents may also underreport problematic behaviours (*or overreport play/training- Chapter 3*) to present themselves as responsible dog owners, as this is more socially acceptable, particularly when responding to a questionnaire for a welfare charity. Moreover, no demographic information about the owners was collected in the questionnaire so it is not possible to determine whether the sample of respondents has any demographic bias. However, previous research shows that those who respond to surveys are disproportionately women and women also tend to report a stronger concern for animal

welfare issues, so it is likely that the respondent sample may be skewed towards being female (Randler *et al*., 2021; Becker, 2022). A further bias may have occurred as the questionnaire was filled out retrospectively (completed in May about an average week February), leading to recall bias; owners may be more likely to remember extreme or unusual events meaning that their answers may not accurately reflect the dogs' usual behaviour.

The questionnaire also relies on owners accurately identifying behaviours. However, in my questionnaire, behaviours such as 'aggression' were broken down into objectively described individual behaviours within clear contexts to avoid misinterpretation e.g., 'growled, snapped or nipped when approached or handled'. Additionally, it has been shown that novices are able to give the same behaviour ratings as expert observers (Munch *et al*., 2019). Additionally, doing a questionnaire rather than behavioural tests enables a deeper insight into the dogs' everyday behaviour as well as low-frequency behaviours (Duffy, Hsu and Serpell, 2008; Gobbo and Zupan, 2020).

Dogs may display behaviours such as growling and snapping when fearful but these were classified within this study as aggression. Therefore, cases of aggression may be overestimated, and cases of fear underestimated. Moreover, a dog was classed as displaying PUB if the owner answered 'yes' to any option in Q52, which comprised behaviours that I classed as aggression, AAS and fear. This question did not include behaviours what were classed as reactive, as reactivity was described in Q59. Therefore, analysis concerning whether dogs displayed behaviour classed as PUB did not include dogs that only displayed reactivity and therefore the results of these analysis cannot be generalised to such dogs.

Additionally, the results concerning CI and size and KCG are not representative of the most common type of dog living in the UK (non-designer crossbreed) since only pedigree dogs were used (O'Neill *et al*., 2023). These demographics were also breed averages. Using breed averages does not consider sexual dimorphism or the effect of age (Thuller *et al*., 2015). For example, a small Great Dane puppy will be classified as large. Moreover, using breed averages to determine a dog's CI has been criticized as it can be highly variable within a breed (Bognár *et al*., 2021). Furthermore, using cut off values for CI has been deemed arbitrary as it is a continuous variable and dogs such as the chihuahua and pug can have a

similar CI despite their different head shapes (Georgevsky *et al.,* 2014). Therefore, it would be useful to further investigate behaviour (*and play/training - Chapter 3*) relating to these demographics using mixed breeds and measuring CI individually and as a continuous variable.

It would also be useful to collect data on confounding factors to better elucidate the relationship between dog demographics and potentially unwanted behaviour. These factors include environmental aspects such as family size, garden size and presence of conspecifics within the household (Kubinyi, Turcsán and Miklósi, 2009; Mikkola *et al*., 2021; Sulkama *et al.,* 2022), owner related factors such as their demographics, behaviour and previous experience (Kobelt *et al*., 2003; Kubinyi, Turcsán and Miklósi, 2009; Mikkola *et al*., 2021; Powell *et al*., 2021; Sulkama *et al.,* 2022; Ayrosa *et al*., 2022b; Baslington-Davies *et al*., 2023; Turcsán and Kubinyi, 2025) and the dogs experiences such as training experience, age of acquisition, maternal care in early life , and the source of the dog (Kobelt *et al*., 2003; Kubinyi, Turcsán and Miklósi, 2009; Foyer, Wilsson, and Jensen, 2016; McMillan, 2017; Ayrosa *et al*., 2022b; Baslington-Davies *et al*., 2023; Turcsán and Kubinyi, 2025).

2.3.6 Conclusion

In conclusion, the demographics of dogs are related to whether they display certain potentially unwanted behaviours within the household, but causality is not certain.

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2.5 Appendix 1: Questions used in this study as they were originally presented in the questionnaire.

Q11. How old is <DOG_NAME>? Please give <DOG_NAME>'s age in years and months. If unsure, please give an estimate.

Q18 What breed is <DOG_NAME>? (Categorical, or text if not listed)

Q15 What sex is <DOG_NAME>? (binary)

Q16 Has <DOG_NAME> been neutered (e.g. castrated or spayed)? (categorical)

Q52 I have noticed that <DOG_NAME> has shown the following behaviour(s) towards adults living in the household...

Been very clingy or followed around the house
Whined or barked if shut behind a door or stairgate
Whined or barked when someone was working or busy
Hidden or moved away when approached
Pulled away, cowered or trembled when handled
Jumped up during a game or when excited
Jumped up when someone was working or busy
Growled, snapped or nipped when approached or handled
Snapped or nipped during play
Barked when approached or handled
Growled, snapped or nipped around food (human or own)
Stolen items belonging to members of the household
Grabbed hold of sleeves or trouser legs during play
Grabbed hold of sleeves or trouser legs **not** during play
Bitten someone
None of the above

Q59 - On an average weekday, <DOG_NAME> is reactive (e.g. barking, running about) when...

q59_1_reactive_hears	He/she hears normal things outside (e.g. the postman coming, other dogs barking)
q59_2_reactive_sees	He/she sees things outside (e.g. people walking past, birds in the garden)
q59_3_reactive_family	Family members are excited or noisy
q59_4_reactive_noises	There are unusual or loud noises (e.g. thunder, gunshots)
q59_5_reactive_none_above	None of the above

Q66 - What games (with people) or training did <DOG_NAME> take part in?

Fetch or retrieve
Tug of war or 'ragger'
Wrestling/rough and tumble games
Chasing games (person chases <DOG_NAME> or <DOG_NAME> chases the person)
Searching or 'find it' games
Scent work (asking <DOG_NAME> to find things using his/her nose)
Obedience training (e.g. sit/stay/walking to heel)
Training to do tricks
Agility training
Don't know/can't remember
question(11360388)] did not take part in any games or training

Q68 - When would you have usually played games with or trained <DOG_NAME>? Please select all that apply.

At a specific time of day (pre-planned)
When I have a break
When <DOG_NAME> is nudging or pawing me
When <DOG_NAME> is barking or whining
When <DOG_NAME> seems bored
When I feel bored
When <DOG_NAME> seems restless/agitated
When <DOG_NAME> is trying to initiate play with me
When <DOG_NAME> is full of energy
To distract <DOG_NAME> when he/she is misbehaving
At the time we would typically go for a walk
Ad hoc – no real pattern
<DOG_NAME> did not take part in any games or training

Q67 In a week, how often have you, or someone else in your household, played games with or done some training with <DOG_NAME>?

Less than once a week
Once or twice
3-4 times
5-6 times
Once a day
More than once a day

2.6 Appendix 2. Results of chi-square test of independence analyses of relationships between dog demographics and behaviours. Standardised residuals are given for significant relationships.

Demographic	Attachment/attention seeking (Y/N)	Reactive (Y/N)	Fearful (Y/N)	PUB (Y/N)	Aggression (Y/N)
Kennel Club group	$\chi2$ (6) =32.38, p<0.001 pastorals, no: 4.86 pastorals, yes: -4.86	$\chi2$ (6) =52.47, p<0.001 hound, no: 4.93 hound, yes: -4.93 terrier, no: -4.45 terrier, yes: 4.45 utility, no: -3.50 utility, yes: 3.50	$\chi2$ (6) =28.98, p=0.0014 gundog, no: 3.62 gundog, yes: -3.62 toy, no: -2.20 toy, yes: 2.20 utility, no: -3.14 utility, yes: 3.14	$\chi2$ (6) =12.88, p=0.63	$\chi2$ (6) = 10.44, p=1.00
Age	$\chi2$ (6) =100.65, p<0.001 puppy, no: 6.41 puppy, yes: -6.41 juvenile, no: -2.97 juvenile, yes: 2.97 young adult, no: -5.00 young adult, yes: 5.00 adult, yes: 2.91 adult, no: -2.91 early senior, no: 3.73 early senior, yes: -3.73 late senior, no: 4.01 late senior, yes: -4.01	$\chi2$ (6) =334.86, p<0.001 puppy, no: 17.54 puppy, yes: -17.54 juvenile, no: 3.16 juvenile, yes: -3.16 adult, no: -5.04 adult, yes: 5.04 early senior, no: -3.06 early senior, yes: 3.06 late senior, no: -2.07 late senior, yes: 2.07	$\chi2$ (6) =16.53, p=0.20	$\chi2$ (6) =292.55, p<0.001 puppy, no: 9.62 puppy, yes: -9.62 juvenile, no: -6.17 juvenile, yes: 6.17 young adult, no: -7.89 young adult, yes: 7.89 adult, no: -6.26 adult, yes: 6.26 early senior, no: 5.39 early senior, yes: -5.39 late senior, no: 7.22 late senior, yes: -7.22	$\chi2$ (6) =6.84, p=1.00)

				geriatric, no: 4.75 geriatric, yes: -4.85	
Size	χ2 (2) =44.15, p<0.001 small, no: -6.58 small, yes: 6.58 medium, no: 2.74 medium, yes: -2.74 large, no: 4.63 large, yes: -4.63	χ2 (2) =33.26, p<0.001 small, no: -5.53 small, yes: 5.53 large, no:4.56 large, yes: -4.56	χ2 (2) =7.37, p=0.38	χ2 (2) =12.20, p=0.04 small, no: -3.34 small, yes: 3.34 large, no: 2.79 large, yes: -2.79	χ2 (2) =7.57, p=0.36
Sex	χ2 (1) =15.22, p=0.002 female, no: 3.92 female, yes: -3.92 male, no: -3.92 male, yes: 3.92	χ2 (1) =0.28, p=1.00	χ2 (1) =2.32, p=1.00	χ2 (1) =5.30, p=0.36	χ2 (1) =3.09, p=0.94
Sex & neuter status	χ2 (3) =12.82, p=0.10	χ2 (3) =15.15, p=0.04 female intact, no: 2.62 female intact, yes: -2.62 male intact, no: 2.70 male intact, yes: -2.70	χ2 (3) =4.19, p=1.00	χ2 (3) =5.20, p =1.00	χ2 (3) =6.67, p=0.94
Cephalic index	χ2 (2) =2.52, p=1.00	χ2 (2) =6.11, p=0.63	χ2 (2) =4.34, p=1.00	χ2 (2) =3.37, p=1.00	χ2 (2) =0.92, p=1.00

Chapter 3- How Owners Play with and Train Their Dog Depending on Their Dog's Demographics and Behaviour

3.0 Introduction

It is imperative to understand the factors that shape human-dog interactions to foster a strong owner-dog bond and ensure the optimal well-being of both owners and dogs. A key type of interaction in nurturing a dog's welfare is play (Sommerville, O'Connor and Asher, 2017). Play is defined as engaging in activity for enjoyment and recreation rather than a serious or practical purpose (Oxford Dictionary of English, 2010). In dogs, play dogs involves the voluntary performance of actions usually performed in other contexts, but with variable intensity and unpredictable sequencing, and the goal in the usual context, such as consuming prey, is not reached (Bekoff, 2014). Driven by distinct motivations, dogs frequently play with conspecifics, humans, and objects (Rooney, Bradshaw and Robinson, 2000; Horowitz and Hecht, 2016; Burghardt, Albright and Davis, 2016). This playful behaviour likely serves multiple functions, such as supporting the development of motor skills and improving the ability to cope with stressful events (Sommerville, O'Connor and Asher, 2017). Moreover, it releases pleasurable neurochemicals, such as oxytocin and dopamine, in both dogs and humans (Odendaal and Meintjes, 2003); this rewarding nature may facilitate the formation and strengthening of bonds between dogs and their owners and serves as a valuable form of positive reinforcement in training activities (Bradshaw, Pullen and Rooney, 2015).

Owners play with their dogs in different ways (Rooney, Bradshaw and Robinson, 2000; Horowitz and Hecht, 2016). They may engage in differing play activities, such as tug-of-war, fetch, chasing and searching games, and play with varying levels of frequency and consistency. The type and frequency of dog-owner play likely has an influence on dogs' behaviour. For example, it has been proposed that rough-and-tumble games reduce separation-related-behaviour (Rooney and Bradshaw, 2003). Additionally, research by Tóth *et al*., (2008) may suggest that active interaction reduces fearful behaviour of dogs in unfamiliar situations.

Additionally, training is key in modifying behaviour and has considerable welfare implications. Operant conditioning is usually used, whereby voluntary behaviour is reduced or increased through the provision of consequences (Skinner, 1938). This can be done through the use of positive reinforcement (providing a pleasant stimulus such as treats, praise and play), negative punishment (removal of a pleasant stimulus such as stopping stroking), negative reinforcement (removal of an unpleasant stimulus such as removal of physical restraint) or positive punishment (such as verbal reprimands or physical correction) (Skinner, 1938; Blackwell *et al*., 2008; Fernandes, Olsson, and de Castro, 2017; de Castro *et al*., 2020). It has been shown that engagement in training activities was predictive of reduced prevalence of undesirable behaviours (Bennett and Rohlf, 2007) and the use of positive reinforcement during training was significantly associated with the lowest amount of problematic behaviours including attention-seeking, fear and aggression (Blackwell *et al*., 2008). Additionally, dogs that have had obedience training have been found to be more likely to obey commands than those that did not (Kobelt *et al*., 2003). Reward based training and training by owners who had a more playful and patient approach to training may also improve a dog's subsequent ability to learn (Rooney and Cowan, 2011). Moreover, having the opportunity to problem solve and engage their cognitive abilities has a positive effect on dog mood (McGowan *et al*., 2014). Certain methods of training, such as the use of aversive techniques, have also been shown to have negative effect effects on dog behaviour and mood and consequently their welfare (Blackwell *et al*., 2008; Ziv, 2017; de Castro *et al*., 2020). In summary, it is evident that owner behaviour, such as how they play with and train their dogs, impacts dog welfare and likely their behaviour.

Whist the effect of owner behaviour on dog behaviour has been largely explored, the reverse relationship remains relatively under researched, which is a knowledge gap that this thesis aims to fill (Bennet and Rohlf, 2007; Arhant *et al*., 2010; Rooney and Cowan, 2011). How owners interact with their dog may be influenced by how their dog acts. For example, owners of dogs who have displayed aggression are less likely to walk them daily or share activities such as kissing and grooming them (Bennett and Rohlf 2007; Westgarth, Christian and Christley, 2015). This may be explained by problematic behaviour straining the owner dog bond, making the owners less inclined to spend time with their dog. Comprehending the role of dog behaviour in influencing interaction types, such as play and training, is

essential as a feedback loop could form whereby certain dog behaviours determine interactions, such as the amount of owner-dog play, which may discourage or reinforce behaviours from the dog (see Figure 1. in Chapter 1.)

It has also been shown that dog demographics and owner perceptions of these influence how dogs are played with/ trained (Kobelt *et al.*, 2003; Arhant *et al*., 2010). However, the relationship between dog demographics and the type and amount of play/training that owners undertake with their dogs appears largely unexplored. Nevertheless, we do know that age, size and breed is related to other types of owner-dog interactions such as owners walking their dogs (Westgarth, Christian and Christley, 2015; Lim and Rhodes, 2016; Pickup *et al*., 2017). Since play/training contributes to optimal welfare, it is critical to understand how it is related to factors such as dog demographics and therefore warrants further investigation.

This study endeavours to develop an evidence-base on how dogs are played with and trained depending on their demographics and behaviour. The evidence-base can be used to develop recommendations on best practices for owner-dog play/training and guide interventions aimed at improving behavioural outcomes and dog welfare. To do this, the study aims to determine how dog demographics, such as age and cephalic index, and behaviour, such as aggression and fear, relate to the amount that dogs are played with/trained by their owners as well as when they are played with and the type of such play and training activities, such as games involving toys or agility training.

It is predicted that smaller dogs will be played with and trained by owners less frequently, as owners appear to consistently share activities such as playing, training, walking, kissing, grooming, and sitting with small dogs less than large dogs (Kobelt *et al.,* 2003; Bennet and Rohlf 2007; Arhant *et al*., 2010; Westgarth, Christian and Christley, 2015). Moreover, I expect that brachycephalic dogs may be played/trained with less than other dogs due to their health conditions (O'Neill *et al.,* 2020). Lastly, since undesirable behaviour may weaken the owner-dog bond, I expect that dogs which display potentially unwanted behaviour will be played/trained with less frequently than dogs who do not display such behaviour.

3.1 Methods

See Chapter 2 for how data was collected and categorised. Within the questionnaire, respondents were also asked what games (with people) or training their dog takes part in (Q66), in addition to when the owners would usually play with or train their dogs (Q68). To ascertain how often the owner, or someone else in the household, played games with or trained their dog per week, a categorical question was utilised (Q67).

3.1.0 Games and Training Categorisation

To explore how a dog's behaviour and demographics are related to how they are played with/ trained, play was defined as taking part in any of the games: Fetch/ retrieve, tug of war/'ragger', chasing, wrestling/ 'rough and tumble', searching/'find it' or scent work. Dogs were classed as being trained if they took part in obedience training, agility training, or training to do tricks. Two measures of play/training were utilised: how often they are played/trained with per week (Q67) and the types of games/training played (whether each game/training type is played, and the number of different types played). Games and training were categorised into 4 categories (see Table 1.). The options 'Don't know/can't remember' and 'did not take part in any games or training' were not included in the analysis as I was interested in what game types/training they do play. The number of game/training types played was determined by how many of the 4 categories (toys, owner-dog, finding, training) were selected (Q66).

To further explore dog behaviour and play/training, it was investigated whether displaying any of the five categories of behaviour, such as aggression and AAS, is associated with the reasons that owners give for when they play with or train their dog (Q68).

Table 1. Game/training types and definitions

Toys	Fetch or retrieve and/or tug of war or 'ragger'
Owner-dog	Chasing games and/or wrestling/rough and tumble games
Finding	Scent work and/or searching or 'find it' games
Training	Obedience training, and/or agility training and/or training to do tricks

3.1.1 Data Analyses

Statistical analysis and figure creation were undertaken using RStudio, version 1.3.1093 (R Core Team, 2022). For each analysis, NAs, where the data has not been filled in for a specific question, were removed.

Initial Data Exploration

To explore patterns and inform modelling decisions, preliminary analyses were carried out. Associations between dog demographic factors and play/training, were tested using separate chi-square tests of independence for six demographic measures (sex, neuter status, age category, size, Kennel Club group, cephalic index) with two metrics of play and training: the amount that dogs are played/trained with by owners as well as number of game and training types played. The same two metrics of play/training were also tested for association with whether the dogs have displayed certain behaviours: any PUB, aggression towards humans in the household, AAS behaviour, fear towards humans in the household, and reactivity, using the chi-square test of independence. The dogs' demographics and behaviours were also tested for association with whether each game/training type was played by using a chi-square test for each game type separately, since the game types are not mutually exclusive categories. To further investigate play/training and behaviour, individual chi-square tests of independence were also performed for each behaviour type

with each (non-mutually exclusive) reason that owners gave for when they play/train with their dog (Q68).

To first determine whether a chi-square test was suitable, expected values were calculated. If 20% or more of expected values were less than 5 or any were less than 1, Fisher's test would have been used, however this was not the case for any of the tests. Due to the large number of statistical analyses being undertaken, Holm-Bonferroni corrections were performed on the p-values three separate times by grouping the statistical tests into three groups. One group consisted of the 36 tests for associations between dog demographics and play/training-related factors (play/training amount and types). The 30 tests for associations between dog behaviour and play/training -related factors were also grouped together. Thirdly, the 50 tests regarding dog behaviour and when the dog would be played/trained with were grouped together for the corrections. If the test revealed a significant association ($p<0.05$), then standardised residuals were calculated. If standardised residuals were larger than absolute values of 2, that combination was judged to have a strong effect on the association between variables (Agresti, 2012).

Modelling

Ordinal logistic regression models were developed to determine which variables predict the variation in one response variable: amount that owners play with/train their dog per week. The purpose of this model was to understand how each predictor variable predicts play and training amount whilst accounting for potentially confounding relationships between other variables. The categories for the response variable were those used in the questionnaire and were treated as ordered (Q67: Less than once a week, once or twice, 3-4 times, 5-6 times, once a day, more than once a day). The chi-square tests were utilised to inform which variables were initially used for the models. To create the final model, a stepwise approach was used. Approximate p-values of the predictor variables categories were calculated using t-values. Predictor variables were evaluated based on their p-values to reduce model size, and the AIC was used to decide whether to introduce variables. Models with AICs within 6 units of each other were considered to be equally supported (Richards, 2005). Model fit of the final model was assessed using a likelihood ratio test comparing the full model to a null model. The proportional odds assumption was evaluated using the Brant

test. McFadden Pseudo R^2 was calculated to provide a descriptive measure of model fit. Predictor variables were assessed using p-values and by calculating odds ratios and 95% confidence intervals. Interactions between variables were not added as they did not seem plausible enough or backed up by literature.

To visually represent how variables predict play/training amount, stacked proportional bar charts were created for each significant predictor variable.

3.2 Results

38% of dogs were played with or trained at least once a day and 32% were not (the rest were NA). Dogs were most commonly played with/trained once a day (26%) and least commonly played with 5-6 times a week (5%). 56% of dogs played toy games with people, 37% of dogs played owner-dog games, 37% dogs played finding games and 44% of dogs did training sessions. Out of the dogs that were played with /trained at least once a day, 69% displayed PUB (the rest did not).

3.2.0 Chi-Square Tests of Independence Analyses

Appendix 1. presents the results for associations between play/training and demographics and Appendix 2. presents the results for play/training and behaviour analyses. Overall, whether dogs took part in each game/training type (toys, owner-dog, finding, training) showed various associations with all demographic and behaviour variables. In particular, for every behaviour and game type, more dogs that displayed the behaviour played the game than expected by chance (apart from whether the dog was fearful and played finding games).

The variables showing significant associations with play/training amount were age, PUB and AAS; therefore, these were used as predictor variables for the initial ordinal logistic regression model during model creation.

When Dogs Would Be Played With and Trained

The most common reasons owners gave for when they would play with/ train their dog was when the 'dog is trying to initiate play' with them (32%), followed by '*ad hoc*- no real

pattern' (31%). The least common reason was when the dog 'is barking or whining' (3%), followed by 'to distract' the dog 'when he/she is misbehaving' (9%). Out of the dogs that displayed PUB, the most common reason was also when the 'dog is trying to initiate play' with them (51%) and the least common reason was when the dog is 'barking or whining' (6%) (See Table 2.)

Table 2. Owners' reasons for playing with or training their dog, by presence of potentially unwanted behaviours

Reason that owners have usually played games with or trained their dog	**% of dogs that have displayed PUB**	**% of dogs that have not displayed PUB**
At a specific time of day (pre-planned)	19%	7%
When I have a break	33%	9%
When <DOG_NAME> is nudging or pawing me	25%	6%
When <DOG_NAME> is barking or whining	6%	1%
When <DOG_NAME> seems bored	36%	10%
When I feel bored	19%	4%
When <DOG_NAME> seems restless/agitated	17%	3%
When <DOG_NAME> is trying to initiate play with me	51%	16%
When <DOG_NAME> is full of energy	48%	12%
To distract <DOG_NAME> when he/she is misbehaving	17%	2%
At the time we would typically go for a walk	18%	7%
Ad hoc – no real pattern	46%	19%

There was a significant association between whether the owners reported their dog displaying PUB towards adults living in the household and when the dog would be played with and trained (for every test $p<0.001$) (see Appendix 2.) More dogs than expected by chance that had displayed PUB played/trained with their dog for every reason listed. This

was also the case for dogs that displayed aggression, AAS behaviour, or fear towards adults in the household, as well as dogs that displayed reactivity on an average weekday ($p<0.001$ for every test, apart from the relationship between aggression and the 'time specific' option where $p=0.01$, and the relationship between displaying fear and owners selecting the '*ad hoc*' option where $p=0.01$).

How Often Dogs Are Played with and Trained

3.2.1 Ordinal Logistic Regression Model

The top performing model for predicting how often dogs are played with /trained per week had an AIC of 9988.11 and contained the following predictors relating to the dog: their age category, KCG, neuter status and sex (see Table 3. and Figure 1.). The Brant test (χ^2 (56) = 70.73, p =0.09) indicated that the odds assumption was met. Examination of individual predictors suggested that the effect of age category (particularly late senior dogs and geriatric dogs) may vary across levels of weekly games/training amount, whereas all other predictors met the assumption. The model performed significantly better (χ^2 (14) = 76.73, $p<0.001$) than the null model, which had an AIC of 8792.84. McFadden's pseudo-R^2 was 0.008, meaning that the predictors explain only a small portion of the variation within the data. The predictor variables that were significant were their age category, and KCG. Multiple models had AICs within 6 units of the top performing model (see Table 4.).

Table 3. Odds ratio estimates and their confidence intervals, and approximate p-values of predictor variables within the final model predicting how often dogs are played with or trained per week. Odds ratios are presented relative to the reference categories: female, Intact, adult, Gundog KCG. Significant results are in bold. *= p<0.05 **= p<0.01 *** = p<0.001

Predictor Variables	**Odds Ratio Estimate**	**Lower Confidence Interval**	**Upper Confidence Interval**	**Approx. P-Value**
Male	1.10	0.97	1.25	0.14
Neutered	1.13	0.95	1.33	0.17
Puppy	**3.02**	**1.60**	**6.00**	**<0.001 *** **
Juvenile	**1.60**	**1.19**	**2.16**	**0.002 ***
Young adult	**1.23**	**1.05**	**1.57**	**0.01 ***
Early Senior	**0.72**	**0.58**	**0.88**	**0.001 ****
Late Senior	**0.77**	**0.63**	**0.94**	**0.009 ****
Geriatric	**0.63**	**0.48**	**0.84**	**0.001 ****
Hound	0.80	0.64	1.01	0.06
Pastoral	**1.38**	**1.14**	**1.67**	**<0.001 *** **
Terrier	**1.26**	**1.05**	**1.52**	**0.01 ***
Toy	1.19	0.94	1.53	0.19
Utility	1.08	0.86	1.35	0.52
Working	0.97	0.70	1.34	0.85

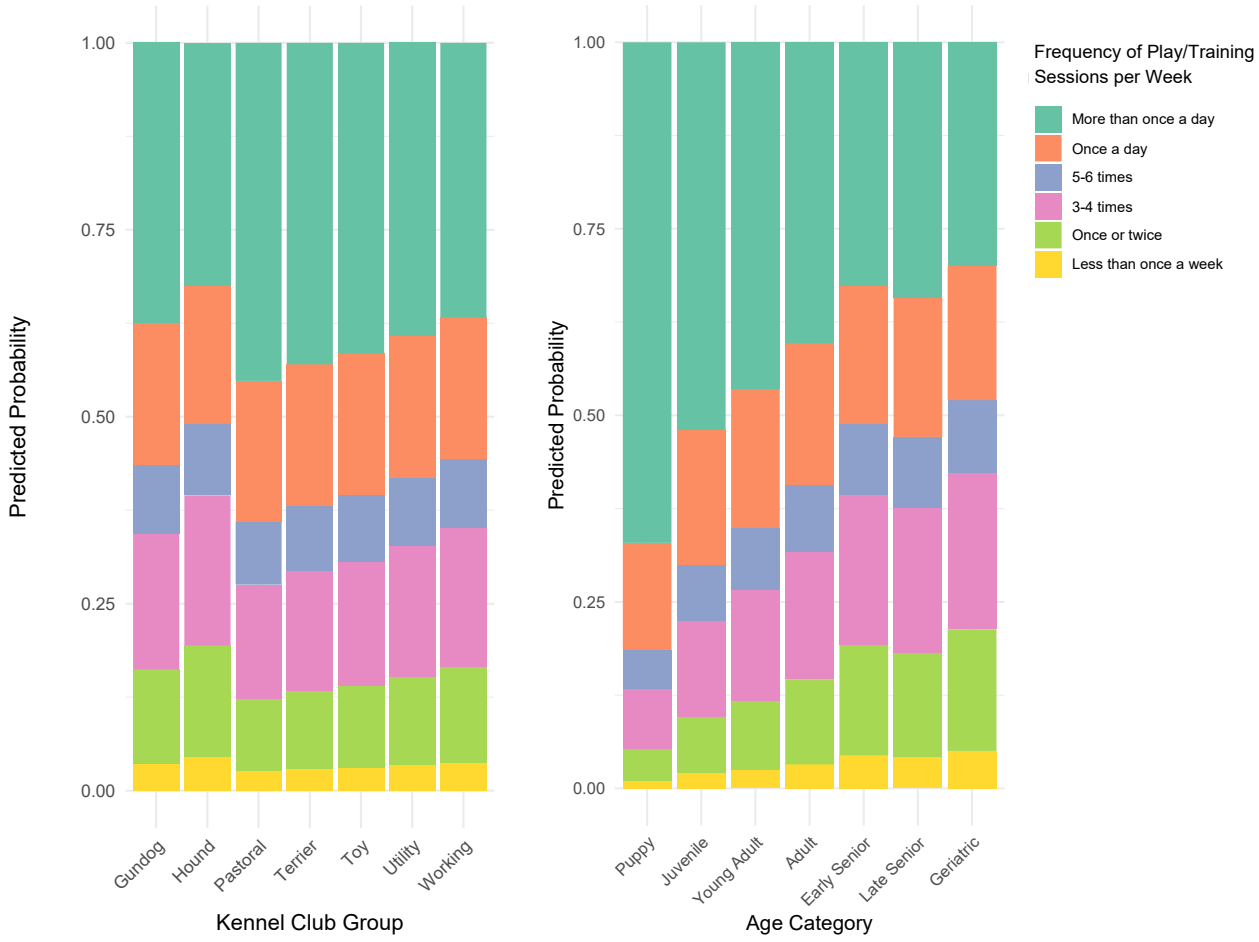

Figure 1. Predicted probabilities of how dogs are played with/ trained per week according to their **(A)** Kennel Club group and **(B)** age category, when all other predictors in the model are kept constant.

Table 4. The Akaike Information Criterion (AIC) of the models created using play/training amount as a response variable. Models with an AIC within 6 units of the top model are in bold. The model number shows the order in which the models were made.

Model **How often the dogs are played and trained with per week ~**	**AIC**	**Δ AIC**
Age Category + Kennel Club Group + Neuter Status + Sex	**9988.11**	-
Age Category + Kennel Club Group + Neuter Status + Sex + Aggression	**9989.70**	**1.59**
Age Category + Kennel Club Group + Neuter Status + Sex + Reactivity	**9989.93**	**1.82**
Age Category + Kennel Club Group + Neuter Status + Sex + Fear	**9990.044**	**1.93**
Age Category + Kennel Club Group + Neuter Status + Sex + Body Size	**9990.766**	**2.66**
Age Category + Kennel Club Group + Neuter Status + Sex + Cephalic Index	**9991.02**	**2.91**
Age Category +Kennel Club Group + Neuter Status + Sex + Cephalic Index + Body Size + Aggression + Fear + Reactivity	9998.70	10.59
Age Category + Kennel Club Group + Neuter Status	10023.71	35.60
Age Category + PUB	18792.13	8804.02
Age Category + AAS behaviour + PUB	18793.91	8805.80
Age Category	18794.94	8806.83

3.3 Discussion

Overall, dog demographics including age and KCG were significant predictors of how often owners play with/ train their dog per week. This suggests that a dog's demographics may influence how owners play with and train their dog, although causality is not certain. Surprisingly, play/training amount was not significantly predicted by any behavioural categories according to the top performing model.

3.3.0 Dog Demographics

How Often Dogs Are Played with and Trained

Age

According to the model, younger dogs (puppies, juveniles or young adults) were more likely to be in a higher category of weekly play/training amount compared to adults, whereas older dogs (early seniors, late seniors, geriatrics) had lower odds of playing/training frequently. This supports research by Wallis *et al*., (2018) who found that older dogs are played with and trained less. This was expected as playfulness with humans as well as activity has been shown to decrease as dogs get older (Salvin *et al*., 2011; Wallis, Szabó and Kubinyi, 2020; Bognár *et al*., 2021; Griss *et al*., 2021). However, trainability has been shown to remain high until 10 years onwards, with responsiveness to training peaking in dogs aged 3-6 (Wallis, Szabó and Kubinyi, 2020). It is possible that owner perceptions of older dogs influenced them to spend less time training their dog rather than being a result of a decrease in trainability, while the decrease in dog playfulness led owners to play with their dog less often.

Kennel Club Group

I additionally found that, relative to gundogs, dogs belonging to the pastoral or terrier KCG were more likely to be played with and trained more often. Within literature, breed differences have been found in the timing of onset of play, amount of time playing with objects, and playfulness, but the differences in playfulness were not related to breed groupings (Svatsberg, 2006; Takeuchi and Mori, 2006; Burghardt, Albright and Davis, 2016). However, working dog breeds have been found to show more interest in playing with

humans and have higher levels of trainability than non-working dog breeds, with non-working dog breeds showing lower levels of energy and excitability (Asp *et al*., 2015). Therefore, it was surprising that working dogs were not played with or trained more than other groups.

Cephalic Index

A significant welfare aspect that varies across KCGs is CI. I did not find that a dog's cephalic index was related to the amount that they were played/trained with. This was surprising as I expected that brachycephalic dogs (CI 1) may be played with the least due to their health conditions and that owners often underestimate the exercise they need (Packer *et al*., 2019), but this was not the case. However, the bond between brachycephalic dogs and their owners is said to be high due to their baby scheme features so this may have encouraged owners to interact with and play with their dogs, counteracting the effect of health conditions on play (Bognár *et al*., 2021).

Size

As with CI, it was not found that the dogs' size was a predictor of the amount that dogs were played/trained with. This contradicts with our predictions based on previous findings that larger dogs are more likely to be played with and trained than small dogs and that owners of small dogs are more inconsistent in interactions with their dog (Kobelt *et al*., 2003; Masters and Greevey, 2008; Arhant *et al*., 2010). Arhant *et al*., (2010) also suggested that larger dogs may be more likely to be trained as similar behavioural issues may be considered as more serious than in small dogs.

Sex and Neuter Status

Lastly, I did not find that play/training amount was predicted by the dogs' neuter status or sex. This latter finding makes sense as Takeuchi and Mori (2006) found no sex difference in playfulness.

3.3.1 Dog Behaviour

The finding that play/training amount was not predicted by any behavioural categories does not coincide with previous findings. Dog-owner play and training activities have been related to the reduction and absence of aggression to familiar people and it has been suggested that play may contribute to non-aggressive social behaviour of dogs (Bennett and Rohlf, 2007; Gobbo and Zupan, 2020; Ayrosa *et al*., 2022). However, it has also been found that whether owners and their dogs engage in play commands or training activities was not a significant predictor of aggression towards people, only level of obedience was a predictor (dogs that knew three or more obedience tasks had lower aggression towards people than dogs that knew a maximum of one task) (Wallis, Szabó and Kubinyi, 2020).

In terms of fearful behaviour, Tóth *et al*., (2008) revealed that the majority of dogs who were fearful when playing in an unfamiliar situation had less than 1 hour a day of active interaction (walking, playing, training), suggesting that active interaction reduces fear levels. Moreover, untrained dogs of young owners have been found to show more fear towards humans than trained dogs (Temesi, Turcsán and Miklósi, 2014).

Since undesirable behaviour may be associated with disobedience, it was unexpected that dogs that showed PUB were not played played/ trained with less, as it has been previously found that obedience is positively associated with owner involvement in play and training activities (Rooney and Bradshaw, 2002; Arhant *et al*., 2010; Rooney and Cowan, 2011).

One reason that play amount was not associated with potentially unwanted behaviour may be that owners might view play primarily as a way to bond or have fun with their dog, not as a tool for modifying behaviour. Play amount may be shaped more by owner lifestyle (time, routines, demographics) than by the dog's behaviour. For example, an owner who enjoys being active may play a lot with their dog regardless of whether the dog shows behaviours such as aggression and reactivity.

When Dogs Would Be Played With and Trained

It was found that owners most often play/train their dog in repones to the dog initiating play or on an *ad hoc* abasis, and least often in response to problem behaviours (barking/whining, misbehaving). This suggests that play/training is typically dog-driven rather than pre-planned. For dogs showing PUB, the same pattern was seen and was more prominent (over half were played with when they initiated play). This suggests that dogs which display PUB may be more demanding/energetic and their owners may be responding to this by playing with their dog. Similarly, owners of dogs with PUB may be more reactive to their dog's behaviour, rather than proactive.

3.3.2 Limitations

See Chapter 2 for limitations regarding the data collection, analysis and findings.

Additionally, whilst associations were found between play amount and dog demographics, a causal relationship is not certain. To determine the effect of demographics on play and training it would be beneficial to ask owners why they play with and train their dog the way that they do and if their dog's demographics and perceived behaviour influences their decisions.

Moreover, it would be useful to explore the relationship between play/training and the dogs' life experience, environmental factors and owner demographics, as evidence shows that these factors may relate to dog demographics and can influence dog-human interactions (Ayrosa *et al*., 2022). For example, it has been found that men own male and large dogs more frequently than women, owners of smaller dogs are an average of 1.5 years older than owners of larger dogs, and in a park setting young adults are more likely to play with their dogs (Arhant *et al*., 2010; Řezáč *et al*., 2011; Volsche *et al*., 2020). Including these factors may have improved the low value for McFadden's pseudo R^2. Whilst the model has provided insight into potential associations, it's current low pseudo R^2 means that, while some predictors may have statistically significant effects, their overall contribution to predicting the outcome is minimal. This makes sense as the decision to play or train with the dog is the owner's and this decision is likely influenced by the owner's demographics as well

as the dog's environment and history. Therefore, including these factors would likely improve the model's predictive ability.

3.3.3 Conclusion

In conclusion, a dog's demographics predict how often dogs are played with and trained by their owners but further research is required to determine causality. Additionally, future research should explore additional factors such as the dog's life experience and environment in relation to owner-dog play/training.

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3.5 Appendix 1. Results of chi-square test of independent analyses of associations between dog demographics and play-related variables. Standardised residuals are given for significant associations.

Table 1. Amount that dogs are played with per week and dog demographics

Demographic	**Amount of play per week**					
Age	$\chi2$ (30) =148.16, p<0.001					
		<Once a week	**Once or twice**	**3-4 times**	**5-6 times**	**Once a day**	**>Once a day**
	Puppy		-2.47				4.17
	Juveniles		-2.76				2.70
	Young adults	-3.31	-2.17				3.09
	Adults	-3.25	-2.47				
	Early seniors	2.62	3.27				-2.49
	Late seniors	4.80	3.10				-2.39
	Geriatrics	3.73	3.17				-4.29
Size	$\chi2$ (10) = 7.91, p=1.00						
Sex	$\chi2$ (5) =1.27, p=1.00						
Sex & neuter status	$\chi2$ (15) =18.77, p=1.00						
Kennel Club group	$\chi2$ (30) =43.93, p=0.58						
Cephalic index	$\chi2$ (10) =3.72, p=1.00						

Table 2. Number of game types played and dog demographics

Demographic	**No. of game types**				
Age	**0**	**1**	**2**	**3**	**4**
	χ2 (24) =945.4, p<0.001				
	Puppy	18.29	-4.73	-4.88	-6.53	-3.53
	Juveniles	-2.77	-5.52	-3.15	4.47	5.15
	Young adults	-2.97	-6.45	-4.19	3.06	8.64
	Adults	-9.06	-3.61		4.49	6.40
	Early seniors		2.99	2.37		-5.06
	Late seniors	2.16	7.85	4.20	-3.86	-7.95
	Geriatrics	8.48	9.41		-7.62	-8.87
Sex & neuter status	χ2 (12) =47.50, p<0.001				
	Male neutered				
	Female neutered		3.21			-2.71
	Male intact		-3.49	-2.10		4.00
	Female intact		-2.48			

Kennel Club group	$\chi2$ (24) =163.55, p<0.001					
	Gundog	-3.30	-2.40		2.53	4.44
	Hound	6.36			-3.94	-5.17
	Pastoral			-3.22	2.96	2.68
	Terrier		2.20			
	Toy	3.78	2.23		-3.00	-4.00
	Utility			3.49	-2.64	
	Working					
Cephalic index	$\chi2$ (8) =61.39, p<0.001					
	1	2.42				-3.65
	2	-4.61	-2.77	-2.44	3.74	5.23
	3	3.51			-2.82	-3.26
Size	$\chi2$ (8) =15.26, p=0.58619					
Sex	$\chi2$ (4) =9.83, p =0.56					

Table 3. Game types played and dog demographics

Demographic	Plays with toys	Plays owner-dog games	Plays finding games	Does training sessions
Age	$\chi2$ (6) =454.48, p<0.001	$\chi2$ (6) = 222.52, p<0.001	$\chi2$ (6) =181.25, p<0.001	$\chi2$ (6) =652.59, p<0.001
	Puppy -14.16	Puppy -8.45	Puppy -9.48	Puppy -8.44
	Juvenile 4.64	Juvenile 2.84	Juvenile 3.28	Juvenile 9.84
	Young Adult 6.76	Young Adult 5.45	Young Adult 3.76	Young Adult 10.06
	Adult 8.76	Adult 7.28	Adult 6.01	Adult 10.34
	Early Senior -2.00	Early Senior -2.62	Early Senior	Early Senior -3.89
	Late Senior -3.96	Late Senior -4.64	Late Senior -3.86	Late Senior -12.43
	Geriatrics -12.37	Geriatrics -8.49	Geriatrics -6.44	Geriatrics -14.62
Size	$\chi2$ (2) =1.84, p=1.00	$\chi2$ (2) =24.88, p<0.001	$\chi2$ (2) =14.87, p=0.01	$\chi2$ (2) =21.41, p<0.001
		Small 4.87	Small -3.74	Small -4.14
		Medium -3.54	Medium 2.80	Medium 3.97
		Large	Large	Large

Kennel Club group	$\chi2$ (6) =137.44, p<0.001 Gundog 6.34 Hound -9.70 Pastoral 2.74 Terrier Toy -4.52 Utility Working	$\chi2$ (6) =47.54, p<0.001 Gundog -2.12 Hound Pastoral -3.60 Terrier 4.75 Toy Utility 3.65 Working	$\chi2$ (6) =159.63, p<0.001; Gundog 9.13 Hound -6.41 Pastoral 4.16 Terrier Toy -5.70 Utility -4.53 Working	$\chi2$ (6) =123.47, p<0.001 Gundog 3.34 Hound -6.51 Pastoral 7.01 Terrier -2.42 Toy -5.67 Utility Working
Cephalic index	$\chi2$ (2) =43.50, p<0.001 1 -2.96 2 6.55 3 -5.38	$\chi2$ (2) =5.17, p =0.60	$\chi2$ (2) =88.33, p<0.001 1 -7.13 2 9.04 3 -4.96	$\chi2$ (2) =32.72, p<0.001 1 -4.46 2 5.45 3 -2.86
Sex	$\chi2$ (1) =8.66, p =0.049 Male 2.97 Female -2.97	$\chi2$ (1) =3.73, p =0.59	$\chi2$ (1) =3.45, p=0.59	$\chi2$ (1) =1.44, p =1.00

Sex & neuter status	χ2 (3) =11.44, p =0.13	χ2 (3) = 5.75, p=0.87	χ2 (3) =16.19, p =0.02 Male neutered Female neutered -2.24 Male intact 3.80 Female intact	χ2 (3) =22.38, p <0.001 Male neutered Female neutered -2.34 Male intact 3.95 Female intact 2.19

3.6 Appendix 2. Results of chi-square test of independent analyses of associations between dog behaviour and play-related variables. Standardised residuals are given for significant associations.

Table 1. Amount that dogs are played with per week and whether they display certain behaviours

Behaviour	**Amount of play per week**					
		<Once a week	**Once or twice**	**3-4 times**	**5-6 times**	**Once a day**	**>Once a day**
PUB	$\chi2$ (5) =36.65, p < 0.001					
	Yes	-4.73	-2.80	-0.56	0.15	2.71	1.79
	No	4.73	2.80	0.56	-0.15	-2.71	-1.79
Attachment/ attention-seeking	$\chi2$ (5) = 19.12, p=0.01					
	Yes	-3.58	-2.01	0.29	-0.12	1.69	1.14
	No	3.58	2.01	-0.29	0.12	-1.69	-1.14
Aggression	$\chi2$ (5) =2.33, p=0.86						
Fear	$\chi2$ (5) =4.91, p=0.86						
Reactivity	$\chi2$ (5) =6.70, p=0.73						

Table 2. Number of game types played and whether dogs display certain behaviours

Behaviour	**No. of game and training types**				
	0	**1**	**2**	**3**	**4**
PUB	$\chi 2$ (4) =3250.60, p<0.001)				
Yes	-55.74	3.82	14.67	24.53	27.27
No	55.74	-3.82	-14.67	-24.53	-27.27
Aggression	$\chi 2$ (4) =113.30, p < 0.001				
Yes	-10.21	-0.28	2.72	5.26	4.82
No	10.21	0.28	-2.72	-5.26	-4.82
Attachment/ attention-seeking	$\chi 2$ (4) =1722.30, p<0.001				
Yes	-40.09	2.03	8.85	18.00	21.41
No	40.09	-2.03	-8.85	-18.00	-21.41
Fear	$\chi 2$ (4) =52.83, p<0.001				
Yes	-6.84	0.99	4.46	2.51	0.91
No	6.84	-0.99	-4.46	-2.51	-0.91
Reactivity	$\chi 2$ (4) =4966.70, p<0.001				
Yes	-70.43	13.67	23.67	29.37	24.72
No	70.43	-13.67	-23.67	-29.37	-24.72

Table 3. Game types played and whether dogs display certain behaviours

Behaviour	Plays with toys	Plays owner-dog games	Plays finding games	Does training sessions
PUB	χ2 (1) =2572.70, p<0.001	χ2 (1) =1668.50, p< 0.001	χ2 (1) =1253.50, p<0.001	χ2 (1) =1824.10, p<0.001
	Yes 50.74	Yes 40.87	Yes 35.43	Yes 42.73
	No -50.74	No -40.87	No -35.43	No -42.73
Aggression	χ2 (1) =80.42, p<0.001	χ2 (1) =66.93, p<0.001	χ2 (1) =39.70, p<0.001	χ2 (1) =69.57, p<0.001
	Yes 9.03	Yes 8.25	Yes 6.37	Yes 8.41
	No -9.03	No -8.25	No -6.37	No -8.41
Attachment/ attention-seeking	χ2 (1) =1340.70, p<0.001	χ2 (1) =1017.30, p<0.001	χ2 (1) =665.03, p<0.001	χ2 (1) =973.42, p<0.001
	Yes 36.64	Yes 31.92	Yes 25.81	Yes 31.22
	No -36.64	No -31.92	No -25.81	No -31.22
Fear	χ2 (1) =20.82, p<0.001	χ2 (1) =25.73, p<0.001	χ2 (1) =2.59, p=0.43	χ2 (1) =23.23, p<0.001
	Yes 4.64	Yes 5.16		Yes 4.90
	No -4.64	No -5.16		No -4.90
Reactivity	χ2 (1) =3835.2, p<0.001	χ2 (1) =1907.70, p<0.001	χ2 (1) =1677.20, p<0.001	χ2 (1) =2179.4, p<0.001
	Yes 61.95	Yes 43.70	Yes 40.98	Yes 46.70
	No -61.95	No -43.70	No -40.98	No -46.70

Table 4. Chi-square test statistics and p-values for chi-square tests of independence between behavioural factors and response options to a question asking when the dogs would be played with/trained. For every test df=1.

Behaviour	**When the dogs would be played with/trained**									
	Distract from misbehaving (Y/N)	**Dog full of energy (Y/N)**	**Dog initiates play (Y/N)**	**Dog seems bored (Y/N)**	**When owner has break (Y/N)**	**Owner bored (Y/N)**	**Nudging or pawing (Y/N)**	**Time specific (Y/N)**	***Ad hoc* (Y/N)**	**Dog seems restless (Y/N)**
Potentially unwanted behaviour (Y/N)	$\chi2=592.49$ $p <0.001$	$\chi2=1418.7$ $p<0.001$	$\chi2=1345.8$ $p<0.001$	$\chi2=906.46$ $p<0.001$	$\chi2=825.51$ $p<0.001$	$\chi2=534.16$ $p<0.001$	$\chi2=742.54$ $p<0.001$	$\chi2=275.92$ $p<0.001$	$\chi2=760.52$ $p<0.001$	$\chi2=554.00$ $p<0.001$
Aggression (Y/N)	$\chi2=200.57$ $p<0.001$	$\chi2=90.14$ $p<0.001$	$\chi2=104.37$ $p<0.001$	$\chi2=85.193$ $p<0.001$	$\chi2=31.792$ $p<0.001$	$\chi2=48.81$ $p<0.001$	$\chi2=90.436$ $p<0.001$	$\chi2=8.267$ $p=0.01$	$\chi2=17.05$ $p<0.001$	$\chi2=86.38$ $p<0.001$
Attachment/ attention-seeking (Y/N)	$\chi2=435.16$ $p<0.001$	$\chi2=886.60$ $p<0.001$	$\chi2=1017.6$ $p<0.001$	$\chi2=693.8$ $p<0.001$	$\chi2=538.88$ $p<0.001$	$\chi2=403.38$ $p<0.001$	$\chi2=650.60$ $p<0.001$	$\chi2=135.67$ $p<0.001$	$\chi2=406.95$ $p<0.001$	$\chi2=468.66$ $p<0.001$
Reactive (Y/N)	$\chi2=353.35$ $p<0.001$	$\chi2=1398.9$ $p<0.001$	$\chi2=1602.4$ $p<0.001$	$\chi2=946.98$ $p<0.001$	$\chi2=828.41$ $p<0.001$	$\chi2=388.29$ $p<0.001$	$\chi2=721.93$ $p<0.001$	$\chi2=361.26$ $p<0.001$	$\chi2=1233.8$ $p<0.001$	$\chi2=409.94$ $p<0.001$
Fearful (Y/N)	$\chi2= 25.39$ $p<0.001$	$\chi2=21.69$ $p<0.001$	$\chi2=27.42$ $p<0.001$	$\chi2=39.35$ $p<0.001$	$\chi2=19.48$ $p<0.001$	$\chi2=45.85$ $p<0.001$	$\chi2=30.22$ $p<0.001$	$\chi2=18.35$ $p<0.001$	$\chi2=8.48$ $p=0.01$	$\chi2=56.80$ $p<0.001$

Chapter 4- Comparison of the Variables Included in Journal Articles and Newspaper Articles Regarding Dog Bites to Humans Within the UK

4.0 Introduction

With 1 in 4 people in the UK being bitten by a dog during their lifetime and the number of cases and severity on the rise, dog bites are an ever-growing public health concern (Westgarth, Brooke and Christley, 2018; Tulloch *et al*., 2021, O'Hara, 2024). Physical injuries resulting from dog bites range from superficial wounds to being fatal. There are roughly 4 recorded deaths per year in England according to hospital episode statistics for NHS England (Tulloch *et al*., 2021). A cross-sectional study of a UK community revealed that around a third of dog bite victims required further medical treatment and 0.6% required hospital admission (Westgarth, Brooke and Christley, 2018). Dog bites can also cause long- lasting psychological impacts on victims and their families, such as PTSD (Westgarth *et al*., 2024). As well as physical and emotional effects, dog bites place a burden on health care systems; in the financial year 2017/2018, hospital attendance and admissions for dog bites in England may have cost the NHS over £70,000,000 (Tulloch *et al*., 2021).

Multiple factors are considered to influence the likelihood of a dog bite, including victim and dog demographics and the context of the incident. In Cheshire, UK, it was found that men were more likely to have ever been bitten by a dog than women, and that most commonly people were bitten by a dog that they had never met before (Westgarth, Brooke and Christley, 2018). A convenience sample questionnaire within the UK provided further insight into factors associated with dog bites; it revealed that the most frequent location was within a house (Oxley, Christley and Westgarth, 2018). Moreover, the most common context in which dog bites occurred was related to the victim attempting to interact with the dog, leading to bites on the upper and lower extremities (Oxley, Christley and Westgarth, 2018), although children are more likely to be bitten on the head compared to older age groups (Cameron, Al-Himdani and Oliver, 2017). Where dog-related factors were known to the victims, dogs were most commonly male, adults, medium or large, neutered, and were German Shepherds, Border Collies, and Jack Russells (Oxley, Christley and Westgarth, 2018). The complexity of both human and dog related factors associated with

dog bites highlights the need for multifaceted interventions to reduce the likelihood of dog bites.

In response to a series of high profile, including some fatal, dog bites, the Dangerous Dogs Act (DDA) was introduced in 1991. The current legislation prohibits certain types of dogs as well as allowing a dog to being dangerously out of control (see Figure 1. for details on key developments) and was likely implemented as a result of media attention on severe dog bites. The way incidents are reported varies with different articles highlighting varying aspects of the bites. In general, different media types adopt varying tones in their reporting; whilst newspapers often adopt a more narrative-driven, story-like approach, scientific literature tends to avoid these structures and are drier, focussing more on more neutrally phrased data interpretation (Katz, 2013; Dahlstrom, 2014). In Chile and Spain, press literature regarding dog bites were more likely to discuss variables such as potentially dangerous dogs (PDD), death reports, and multiple bites, than scientific articles (Barrios *et al*., 2021). It was concluded that the differences in the inclusion and weight of relevant variables likely stems from the editorial objectives of the different sources and can affect how readers view such variables. Ultimately, misleading information can distort public opinion and contribute to the creation of legislation that is reactive rather than evidence based (Sheshadri and Singh, 2019; Walker, Godley and Nuno, 2019; Hammond, Dickman and Biggs, 2022).

Since articles on dog bites can influence dog-related legislation, it is important to examine the information that is being presented. This research will compare how variables related to dog bites have been reported in press and scientific literature within the UK. Variables include those related to the victim, the biting dog, the context, the injury/treatment, and the prevention and prevalence of dog bites. It is predicted that newspapers will be more likely to discuss variables related to the injury, particularly whether the bite resulted in death, whether a PDD type was involved, and context-related variables as this information may be more attention-grabbing and aids in storytelling (Vučinić and Vučićević, 2019; Barrios *et al*., 2021). In contrast, it is expected that journal articles will focus more on informative variables such as those related to injury treatment and bite prevention (Owczarczak-Garstecka *et al*., 2019; Katz, 2013; Barrios *et al*., 2021). Moreover, it is predicted that both article types will frequently discuss victim and dog demographics as this

information helps create the scene for newspaper articles and are potential risk factors in bite prevention that journal articles may be more likely to focus on.

1991 – The legislation came into force prohibiting owning, breeding, selling, gifting or abandoning a dangerous dog. The dangerous dogs types are the pit bull terrier, dogo Argentino, fila Braziliero and Japanese tosa. It is also an offence for any dog to be dangerously out of control in a public place.

1997 – An amendment removed the mandatory destruction order for banned dog types. If owners can prove that the dogs are not a danger to the public they can be placed on the Index of Exempted Dogs. The order may also be suspended if certain conditions are met e.g. muzzling.

2014 – An amendment made it an offense to own or be in charge of a dog that attacks an assistance dog, and the original act now includes private property. Maximum penalties for allowing a dog to be dangerously out of control were increased and authorities are now allowed to impose Dog Control Orders to prevent incidents before they occur.

2018 – PETA petitioned for the UK government to add Staffordshire bull terriers to the Dangerous Dogs Act as they are the most abused and abandoned dogs, and the House of Commons debated this issue and supported the opposition.

2023 – An amendment added the XL Bully to the list of dangerous dog types. It became illegal to breed, sell, advertise, gift, exchange, abandon, or let XL Bully dogs stray.

2024 – It became a Criminal offense to own an XL Bully dog unless it has certificate of exemption.

Penalties range from a fine to a prison sentence.

Figure 1. Summary and timeline of the main amendments to the Dangerous Dogs Act 1991. (Dangerous Dogs Act 1991; House of Commons, 2018)

4.1 Methods

4.1.0 Search Strategy

To explore how different media types report dog bites to humans that take place within the UK, a scoping review of journal and newspaper articles on this topic was conducted. During November 2024, online newspapers were sourced from ProQuest and journal articles were sourced from Web of Science Core Collection. This is one of the most popularly used databases, has a broad coverage of fields, and preliminary investigations revealed that this database not only contained most of the papers found in other databases, but also a number of additional ones.

On ProQuest, the filters for 'Newspaper' and 'UK' only were applied to produce UK-based publishers as newspapers from these local publishers are most representative of what British audiences are likely to read. The search term used on ProQuest was '(Dog OR dogs OR canine OR Canis) AND (bite OR bites OR bitten)'. Additional terms such as 'injury' and 'attack' were avoided as preliminary exploration suggested that they might retrieve articles about other types of dog-related incidents, such as scratches or being pushed over, which fall outside the scope of this study.

Using Web of Science Core Collection, the 'review article' and 'article' filters were selected to only contain these data types. Additionally, the 'open access' filter was selected to include articles accessible to a non-academic audience. The search term: '(Dog OR dogs OR canine OR Canis) AND (bite OR bites OR bitten) AND UK' was used as the addition of 'UK' helped narrow down the results to articles focusing on dog bites occurring within the UK. The journal location/author was not filtered as British readers can access journals published globally.

All resulting articles from the Web of Science search (n=114) were checked for eligibility against inclusion and exclusion criterion. Due to the large sample of ProQuest newspaper articles (n=6318) and limited time, the articles were ordered by relevance and the first 100 articles were selected to be checked for eligibility using the PRISMA process (See Figure 2.).

4.1.1 Exclusion Criteria

Samples for both article types were checked for duplicates which were subsequently excluded, and in cases of multiple versions of almost identical articles (such as Western Mail, 2024 and Hill, 2024) one was kept, and the rest were excluded. Articles were then excluded based on their title if it was clearly unrelated to dogs biting humans (for example, snakes biting dogs), or referenced other countries (for example, 'Dog-bite injuries in Korea and risk factors for significant dog-bite injuries: A 6-year cross-sectional study'). Additionally, during the ProQuest search, despite applying the 'UK' filter, some newspapers that were not published in the UK still appeared in the sample and were excluded. Moreover, any newspaper or journal articles focusing on rabies were excluded as they typically did not focus on dog bites within the UK, only initially stating that 'people usually get infected from dog bites'.

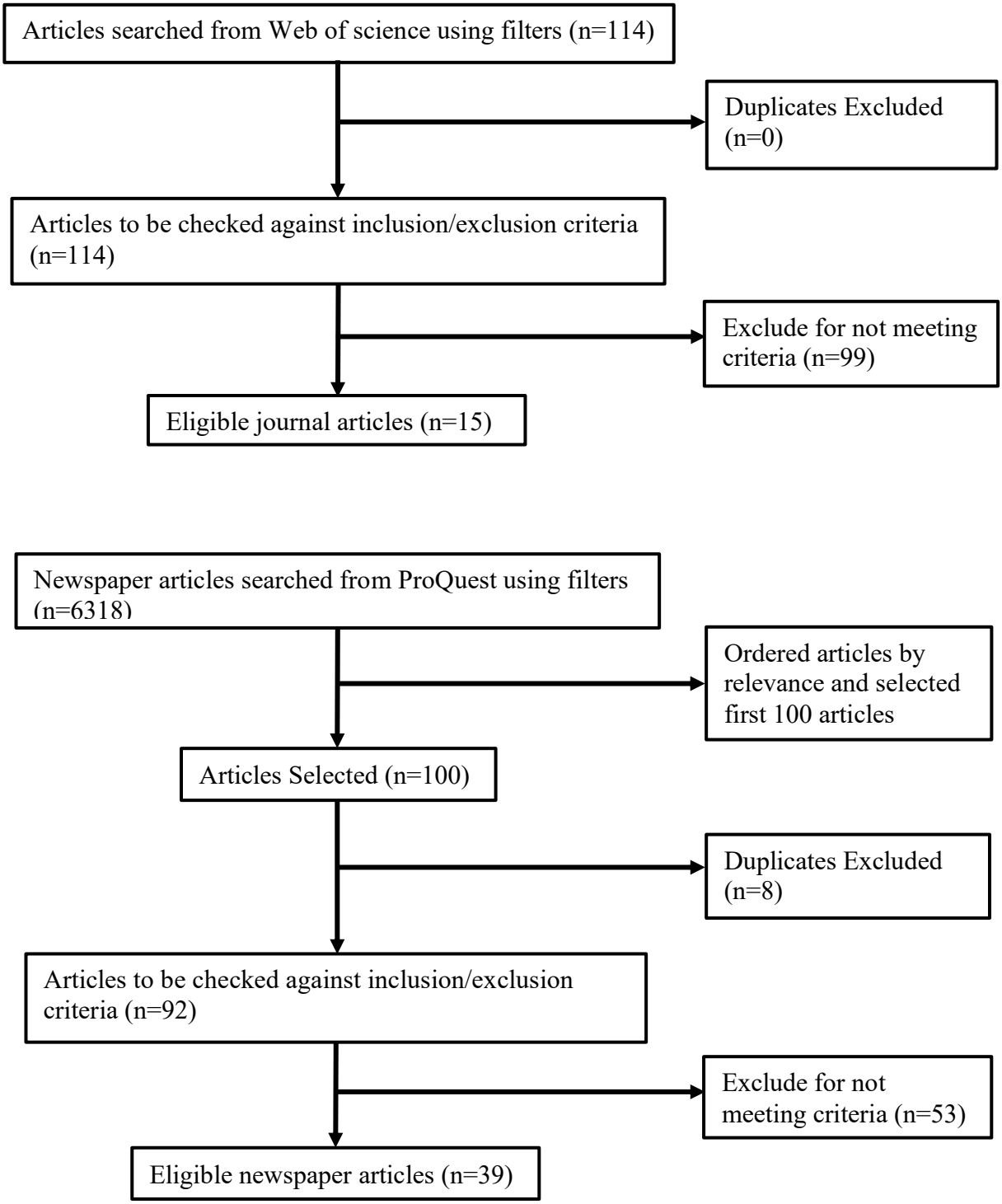

Figure 2. Flow charts of the processes used to select articles for sampling after completing the database searches.

4.1.2 Inclusion Criteria

The articles were included if they discussed anything in relation to a dog bite(s) to a human(s) that took/takes place within the UK. As well as specific incidents, this included statistics, opinion, reviews, and treatment types. For example, 'The bigger the dog, the more powerful the bite. A bite from a husky or Akita can be worse than a bite from a Highland Terrier for example' would be included as it discusses size and breed in relation to dog bites to humans.

4.1.3 Variables Analysed

Each peer-reviewed article (total n=54) was read to identify whether its content included certain variables related to dog bites to humans, including bite victim information, biting dog information, the context of the bite, characteristics of the injury and treatment, and additional information regarding the prevention and prevalence of such bites (see Table 1.). The variable was only considered mentioned if it was clearly related to bites specifically. If the variable was discussed in relation to dog 'attacks' or 'mauling', it was not counted, as these terms can refer to incidents involving scratching. Whilst the NHS uses a combined category of strikes and bites, it is likely that the media may dramatize incidents that involve chasing/scratching by referring to them as attacks. Excluding "attack" therefore ensured that this study remained specific to bite-related incidents. For example, in the sentence, 'In September, Prime Minster Rishi Sunak announced the ban following a spate of attacks, including the death of Ian Price, 52, in Walsall, Staffordshire', the variables (death, victim age) would not be counted as they relate to 'attacks', not necessarily bites.

4.1.4 Statistical Analysis

To compare the variables mentioned in newspaper articles and journal articles, the total number of articles that either included or omitted each variable was calculated separately for both types of articles. For each variable, the proportion of articles that mentioned the variable was compared between newspaper and journal articles using a chi-square test of independence, or a Fisher's exact test if one of more of the expected counts was less than 5. A result was considered significant if $p<0.05$. The Holm-Bonferroni correction was then carried out on all p-values due to the large number of statistical tests being performed. This

was carried out using RStudio, version 1.3.1093 (R Core Team, 2022). Due to the small sample size and resulting limited statistical power, p-values of tests that showed significance before the correction are also reported to explore potential trends, although these are interpreted with caution.

Table 1. Variables of interest, based on those included by Barrios *et al*. (2021), with alterations.

Variable	**Description**
Bite Victim Information	
Sex	Sex of the victim
Age	Age of the victim, can be in years or category (e.g. child)
Education Level	Educational category reached by the victim (e.g. degree)
Profession	Profession of the victim – any paid occupation
Biting Dog Information	
Relationship Between Dog and Victim	Whether/ how the victim knows the dog (e.g., owner, neighbour's dog, previously unknown). Needs to be specified not assumed
Potentially dangerous dog (PDD) type under DDA	The dog is classed as a PDD under The Dangerous Dogs Act (e.g. XL Bully)
Size	Size of the dog. Can be weight, height, or a category (e.g. small)
Sex	Sex of the dog
Breed	Breed of the dog
Reproductive Status	Reproductive status of the dog
Bite Context	
Location	Local location of where the bite occurred (e.g. park, street, house, shop)
Situation	What led to the bite, the interaction between the dog and victim (e.g dog bit someone running past, owner and dog playing)

Date	Date that the bite occurred, has to be more specific than the year
Characteristics of Injury and Treatment	
No. of Bites per Victim	The specific number of bites per victim, or general amount such as 'multiple'
Severity of Injury	Level of damage caused by the bite (e.g scratch, serious injury, deep wound)
Treatment Type	Interventions applied to the victim (e.g stitches, tetanus jab)
Death	If a victim died resulting from a bite, can be in the form of statistics
Anatomical Area	Area of the body where the victim was bitten (e.g face, arm)
Psychological impact	The psychological impact on the victim (e.g post-traumatic stress disorder, anxiety)
Additional Information	
Prevention	How the bite/bites in general was/could have been/could be prevented (e.g banning breeds to prevent bites)
Prevalence/ Statistics	Any statistics regarding dog bites, such as their prevalence

4.2 Results

The sample of newspaper articles (n=39) contained articles from 22 different publishers, with the most common newspaper publishers within the sample being Express, Daily Mail, and Daily Record. The publishing date of the articles ranged from 2014-2024, with the majority being published in 2024 (n=20) and 2023 (n=11). All journal articles (n=15) included within the sample were research articles and their publishing date ranged from 2015 to 2023.

There was not a significant difference between journal versus newspaper articles in the amount that any variable was mentioned. This includes victim sex (p=1.00), age (p=1.00), education level (p=1.00), profession ($\chi2$ (1) =0.04 , p=1.00), relationship between biting dog and victim ($\chi2$ (1) =2.56 , p=1.00), PDD (p=1.00), dog size ($\chi2$ (1) =0.18, p=1.00), sex (p=1.00), breed ($\chi2$ (1) =1.10, p =1.00), reproductive status (p=1.00), location of bite ($\chi2$ (1) =1.68,

p=1.00), situation ($\chi 2$ (1) =1.50, p=1.00), date (p=1.00), no. of bites per victim ($\chi 2$ (1) =0.73, p=1.00), severity of bite ($\chi 2$ (1) =0.77, p=1.00), treatment type (p=1.00), death (p=1.00), anatomical area of bite ($\chi 2$ (1) =0.37, p=1.00) prevention ($\chi 2$ (1) = 1.92, p=1.00), psychological impact (p=0.06), and prevalence/statistics of dog bites (p=0.28) (See Table 2. and Figure 3a-3e.)

Prior to applying the Holm–Bonferroni correction, two associations were found; media type was significantly associated with whether psychological impact (p= 0.003) and prevalence/statistics of dog bites (p-value = 0.01) were mentioned within the articles. A higher proportion of journals articles mentioned these variables compared to newspaper articles.

Table 2. The number and proportion (%) of journal (n=15) and newspaper articles (n=39) that mention each variable related to dog bites to humans within the UK

Variable	**Number and (proportion (%)) of journal articles (total n= 15)**	**Number and (proportion (%)) of newspaper articles (total n =39)**	**Number and (proportion (%)) of all articles (total n =54)**
Bite Victim Information			
Sex	11 (73.33)	23 (58.97)	34 (62.96)
Age	11 (73.33)	17 (43.59)	28 (51.85)
Education Level	2 (13.33)	0 (0.00)	2 (3.70)
Profession	5 (33.33)	16 (41.03)	21 (38.89)
Biting Dog Information			
Relationship Between Dog and Victim	8 (53.33)	10 (25.64)	18 (33.33)
Potentially dangerous dog (PDD) type under DDA	3 (20.00)	7 (17.95)	10 (18.52)
Size	5 (33.33)	9 (23.08)	14 (25.93)

Sex	4 (26.67)	6 (15.38)	10 (18.52)
Breed	5 (33.33)	21 (53.85)	26 (48.15)
Reproductive Status	1 (6.67)	0 (0.00)	1 (1.85)
Bite Context			
Location	9 (60.00)	14 (35.90)	23 (42.59)
Situation	8 (53.33)	12 (30.77)	20 (37.04)
Date	4 (26.67)	14 (35.90)	18 (33.33)
Characteristics of Injury and Treatment			
No. of Bites per Victim	5 (33.33)	7 (17.95)	12 (22.22)
Severity of Injury	10 (66.67)	19 (48.72)	29 (53.70)
Treatment Type	4 (26.67)	8 (20.51)	12 (22.22)
Death	4 (26.67)	11 (28.21)	15 (27.78)
Anatomical Area	9 (60.00)	18 (46.15)	27 (50.00)
Psychological impact	7 (46.67)	3 (7.69)	10 (18.52)
Additional Information			
Prevention	10 (66.67)	16 (41.03)	26 (48.15)
Prevalence/ Statistics	12 (80.00)	16 (41.03)	28 (51.85)

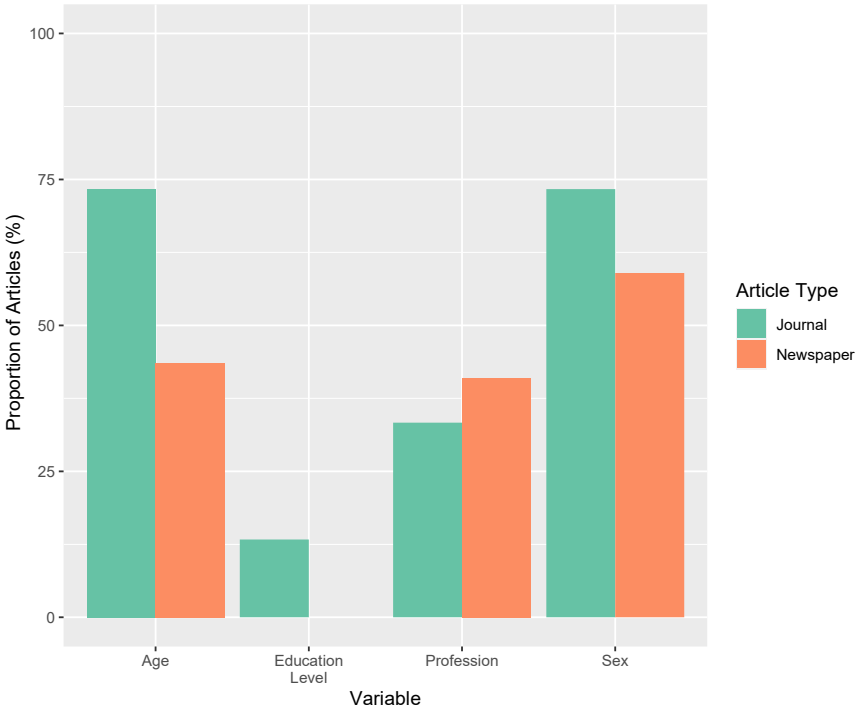

Figure 3a. The proportion (%) of journal (n=15) and newspaper articles (n=39) about dog bites to humans within the UK that included each victim-related variable.

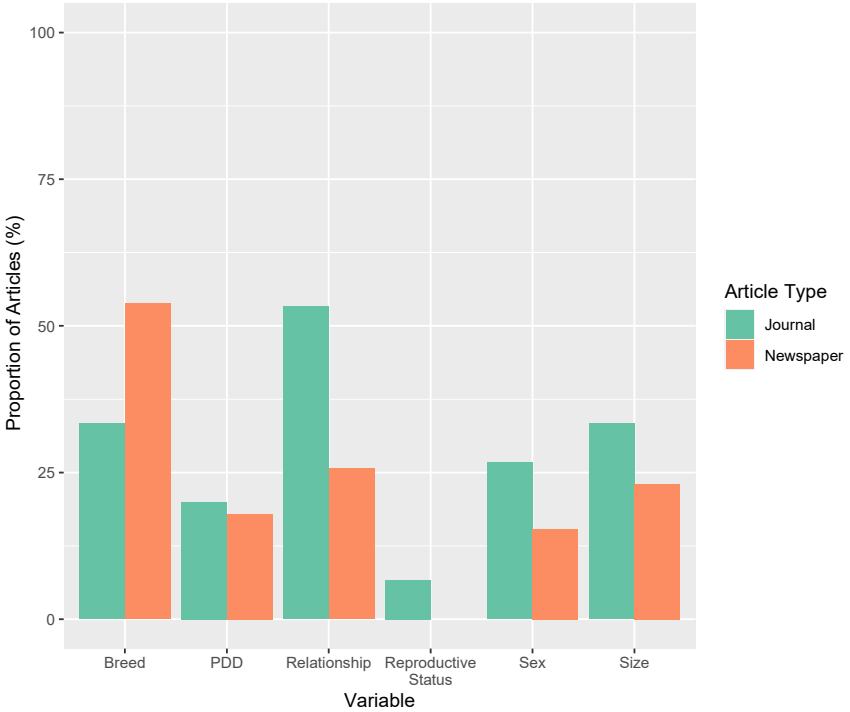

Figure 3b. The proportion (%) of journal (n=15) and newspaper articles (n=39) about dog bites to humans within the UK that included each biting-dog related variable. PDD = potentially dangerous dog. Relationship refers to the relationship between the dog and victim.

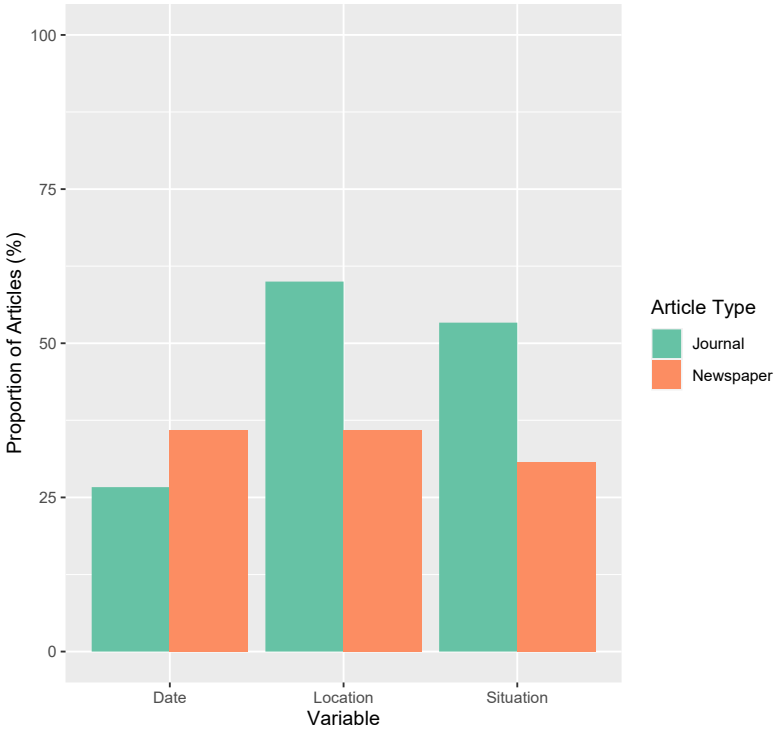

Figure 3c. The proportion (%) of journal (n=15) and newspaper articles (n=39) about dog bites to humans within the UK that included each context related variable.

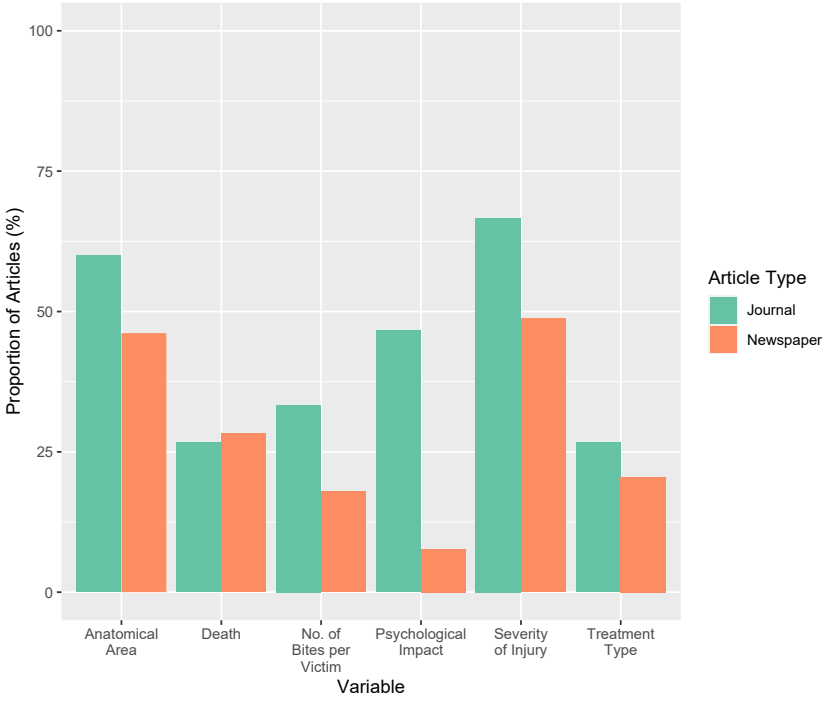

Figure 3d. The proportion (%) of journal (n=15) and newspaper articles (n=39) about dog bites to humans within the UK that included each victim injury-related variable.

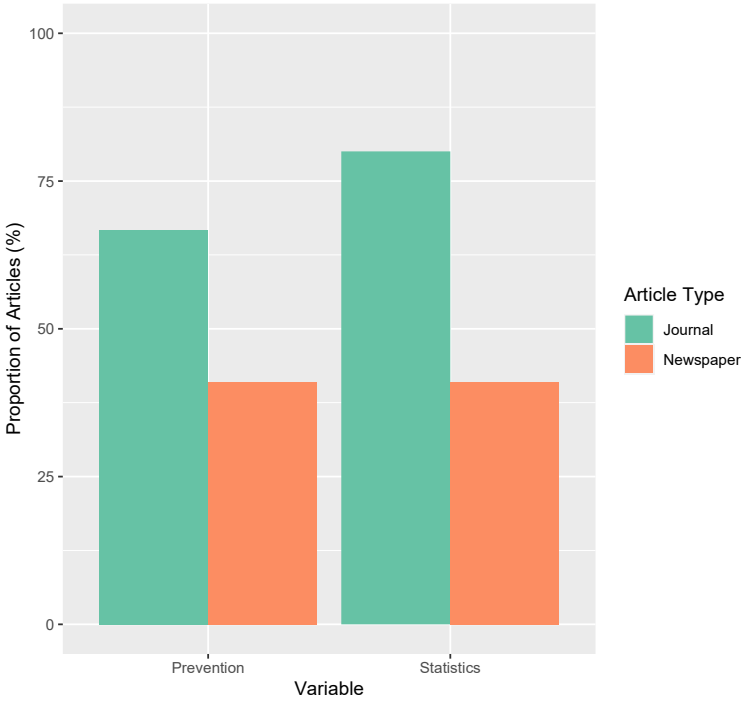

Figure 3e. The proportion (%) of journal (n=15) and newspaper articles (n=39) about dog bites to humans within the UK that included related statistics or mentioned prevention of such bites.

4.3 Discussion

The analyses presented here aimed to look at associations between media type and which dog bite related variables are reported. No significant associations were found (following the statistical corrections), but different variables were reported with varying frequencies amongst both article types. The absence of significant associations between media type and dog-bite related variables indicates that in the case of dog bites, both article types are equally as informative so both audiences can access the same type of information. One reason for the lack of associations may be that the variables are considered equally as important/unimportant to both audiences, though this may depend on the variable.

Whilst the prevalence/statistics and psychological impact variables were not significantly related to media type following corrections, they showed a potential association, being discussed proportionally more often in journal articles than newspaper articles. It is possible that a larger sample size would reveal significant associations.

The possible explanations and implications of the findings are explored below.

4.3.0 Bite Victim

Sex and age were talked about fairly frequently in both article types, presumably as the press and journal authors both have access to this information via access to family and witnesses in addition to medical databases and questionnaires/interviews with victims. In Serbia it was also found that newspapers provided information on the gender and age of dog bite victims (Vučinić and Vučićević, 2019). Profession and education level were discussed less frequently within my study. This is surprising given that profession is a known risk factor for dog bites and such information should be in journals to educate the public (Owczarczak-Garstecka *et al*., 2019). However, this may be down to the lack of information from sources such as medical records/databases and YouTube videos which the journal articles within this study utilised in addition to surveys/ interviews with victims and workers at rehoming centres. One potential reason that newspapers reported these variables infrequently may be that the publishers are likely to respond selectively to what they consider newsworthy, reporting primarily on major, attention-grabbing incidents rather than less emotive details, even if this information was available.

4.3.1 Biting-dog

The lack of information from such sources may explain why another known risk factor, the relationship between dog and victim, was only mentioned in a third of articles. Similarly, the dog's reproductive status was the least mentioned variable in both article types, with it not being mentioned at all in newspapers. Barrios *et al*. (2021) also found that reproductive status was not discussed in 91% of the press articles or 88% of the indexed literature. This is perhaps because this is not something the authors can easily find out and the public may not find interesting. Breed was the most mentioned biting-dog related variable with nearly half of all articles mentioning breed, likely because the newspaper readers are interested to know this, and because it's potentially an important risk factor in dog bites for journals to discuss. Many articles specifying the breed may explain why size was mentioned less frequently; the information on size may have become redundant as size can often be inferred from the breed.

PDD types (5 types of dogs banned by the DDA due to being considered a risk to the public) and sex were mentioned in under a fifth of articles. The lack of articles mentioning PPD is especially surprising with the recent legislative changes regarding the DDA. The reason may be that over half of the press articles were published in 2024, after a major addition to the legislation (XL Bully was added to the list of dangerous dog types) and PDDs may be more likely to be discussed in the lead up to the legislative changes. However, the pit bull made up two thirds of the PPD types mentioned in the journal articles and these papers were published in 2018, so was likely unrelated to legislation.

4.3.2 Context

It was also surprising that there was no difference in the number of context-related variables between article types as these are the more immediate, tangible aspects that the press usually has more access to compared to journals. Barrios *et al*. (2021) found that the press had the largest number of articles that included the season in which the bite occurred; it was suggested that this may be due to completing the scene for the readers but not being prioritized on healthcare databases for journals to access. Additionally, Vučinić and Vučićević (2019) found that season was reported frequently in newspapers on dog bites to

children. As well as season, my study included the month, specific dates, and included phrases such as 'last Saturday' within the 'Date' variable. This makes it additionally surprising that it was reported infrequently in both article types, especially as newspapers aim to deliver news immediately and use the time markers such as specific days to make the news timely and relevant to their audience.

The location was talked about relatively frequently in the articles, perhaps because it is relevant to local newspaper readers and helps them to relate to the article. Additionally, location is an important risk factor to include within journal articles that aim to understand the risk factors of dog bites. Location was also reported frequently in newspapers on dog bites to children in Serbia (Vučinić and Vučićević, 2019).

The situation in which the bite occurred was talked about in less than half of all articles. This is problematic as the context in which dog bites occur is key to understanding the causes of dog bites and therefore developing prevention measures (Oxley, Christley and Westgarth, 2018). One reason for the lack of situational information may be that the medical records/databases do not gather this information, although this information should be accessible via YouTube videos and surveys/interviews which were utilised for many of the journal articles within this study.

4.3.3 Injury

In terms of the injury related variables, the tentative finding that psychological impact was discussed in proportionally more journal articles than newspaper articles may be explained by newspaper articles being more likely to focus on the immediate aspects of dog bites, rather than the less tangible effects. Whereas, journal articles often explore incidents retrospectively, enabling a more comprehensive reflection of the incidents, especially in interviews with victims. This means that newspaper readers may be more likely to underestimate the psychological consequences of dog bites, which could in turn lead policymakers to underestimate the need for interventions addressing emotional trauma.

The anatomical area and severity of injury was mentioned fairly frequently in both article types. This is likely because the press will have access to this information and it is of medical importance as well as interest to the reader, particularly severe injuries. In Calgary,

Alberta it was found that within newspaper articles the severity of the victim's injury is often the focus of the injury-related information (Mouton *et al*., 2019), and in Serbia information regarding the anatomical area of dog bite injuries was able to be obtained from newspapers (Vučinić and Vučićević, 2019). As well as the severity of the injury, it was expected that death would be reported frequently within the press as they are more likely to discuss these more sensationalised topics to make it more attention-grabbing for the general public (Barrios *et al*., 2021). Therefore, it was surprising that death was mentioned in only 15 articles.

4.3.4 Additional Information

Just under a half of all articles reviewed addressed the prevention of dog bites. It was expected that newspapers may have few articles discussing prevention as they generally focus on consequences and sensationalised story telling over educational content. However, as highlighted by Vučinić and Vučićević (2019), the lack of injury prevention messages is a missed opportunity to educate the public. Including such messages within journal and newspaper articles could play a pivotal role in reducing the likelihood of incidents by informing the public how to prevent dog bite injuries.

Statistics related to bite prevalence and occurrence were mentioned in over half of all articles, and a tentative association suggested that they appeared proportionally more often in journal articles than in newspapers. Journals can often access medical record databases, allowing them to report detailed statistical information, whereas newspapers may not have direct access to such data and likely source statistics from journal articles. The tentative association may mean that newspaper readers may not be as able to accurately grasp how common dog bites are. To help important statistical findings on dog bites reach a wider audience, there needs to be more of a flow of information from journals to newspapers.

4.3.5 Limitations

One limitation of the study is the small sample size of 39 newspaper articles and 15 journal articles. The 15 journal articles, for example, may not represent the wider range of research on dog bites to humans within the UK. Similarly, the most common newspaper publishers within the sample were Express, Daily Mail, and Daily Record. These are tabloid style

papers, known more for emotive reporting than in-depth, balanced coverage. Consequently, the newspaper dataset may overrepresent severe or sensational cases, while underrepresenting less dramatic incidents or more balanced reporting that might appear in other outlets.

Moreover, in other studies, 69 articles were used to explore newspaper reports on dog bites to children over 10 years (Vučinić and Vučićević, 2019), and 385 articles on dog bites from three sources were analysed to compare publications between 2013 and 2017 (Barrios *et al*., 2021). This may be the reason that my findings did not correspond to what was expected based on previous research; a large sample size would enable greater statistical power, so using more articles may have revealed significant differences in more variables.

Moreover, the choice to only include incidents referred to as 'bite's means that, since the term 'attack' is commonly interchangeably with 'bite' in the media, bite incidents will have been excluded and therefore are missing from the dataset. The word attack may also be used in more severe cases, meaning that my dataset may be skewed toward less serious incidents.

An additional limitation is the dates in which the articles were published. The majority of newspaper articles were published in 2023 and 2024, whereas the journal articles were most frequently published in 2018 and 2021, which are very different in terms of the legislation timeline (see Figure 1.). To allow a truer comparison of what each article type publishes, it would be useful to gather both sources of articles from similar time points. However, it would be important to consider the different publication timelines; newspapers typically publish articles shortly after the event whereas journal articles take time to collect, analyse and publish data.

In the future, it would be valuable to explore variable categories, such as whether the articles are more likely to discuss male/ female dog bite victims, rather than just whether the sex of victims was mentioned, as was done by Barrios *et al*., (2021) in Spain and Chile. This will allow us to gain further insight into what British readers are learning from different article types. For example, in Calgary, Alberta it was found that journalists may focus on dog bites by breeds with negative reputations rather than those with positive reputations

(Mouton *et al*., 2019). Moreover, it would be beneficial to explore how the frequency of dog bite- related articles and the variables they discuss, such as the breeds involved and severity of injuries, vary over time. In particular, how they vary in relation to the introduction of the Dangerous Dogs Act and subsequent amendments, including the ban on XL Bully dogs. This would enable us to understand the dynamic between public perceptions and related legislation.

4.3.6 Conclusion

There was not a significant difference (following corrections) in the amount that variables discussed between article types which does not align with previous findings that the press focuses on more sensationalised topics and demonstrates that journal articles do not always provide more comprehensive information than newspaper articles. However, potential trends may suggest that there needs to be more communication between journals and newspapers to enable scientific and retrospective information to reach a wider audience. Across both article types there was a lack of information on the situation surrounding the bite as well as preventative measures which is a missed opportunity to educate the public.

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Chapter 5- General Discussion

5.0 Main Findings

Throughout the last three chapters, I have explored how a dog's demographics is associated with whether they display potentially unwanted behaviour, and how both of these factors are related to when they are played/trained with. I also investigated how a particular behaviour, dog-bites, are reported in the media versus scientific literature, whether they discuss variables such as dog demographics and prevention. Whist the former study contained over 9,000 survey responses which provided ample power to detect statistical differences, the sample size for the final study was much smaller so findings should be considered more preliminary.

As summarised in Figure 1., my findings suggest a network of relationships between dog demographics and behaviour, and dog human-interactions including owner behaviour and media reporting on dog bites. Dog demographics, specifically age and Kennel Club group, were predictive of how much they are played and trained with per week (see Table 1.). For example, young pastorals and terriers were most likely to be played with / trained often. These demographics, along with size, neuter status, CI and sex were also associated with whether they displayed potentially unwanted behaviours such as fear, reactivity, and attachment/attention seeking, but not aggression (see Table 2.). Play and training amount was not related to any dog behaviours, but the preliminary chi-square tests revealed various relationships between play/ training variables with dog behaviour, though it is not certain which direction this relationship goes. Moreover, owners most commonly play/train their dogs in response to the dog initiating it, or on an *ad hoc* basis; for owners of dogs that displayed potentially unwanted behaviour, this pattern was strengthened.

Within the media (newspaper and journal articles), breed was the most common dog-related factor mentioned and was the second most frequently mentioned variable reported in newspapers. This may lead to breed stigmatisation which has likely been a driver of the implementation of the Dangerous Dogs Act 1991. In turn, this may affect how owners treat their dogs. For example, if they have a potentially dangerous breed, they may be more likely to avoid certain areas and activities such as local parks and training classes due to fear of their behaviour being scrutinised by the public. In terms of the reporting of dog bites, I did

not find that newspapers and journal articles varied in the variables that they discussed. However, this may be down to my small sample size, and there were tentative relationships with journal articles being mor likely to discuss psychological impact and include statistics than newspaper articles.

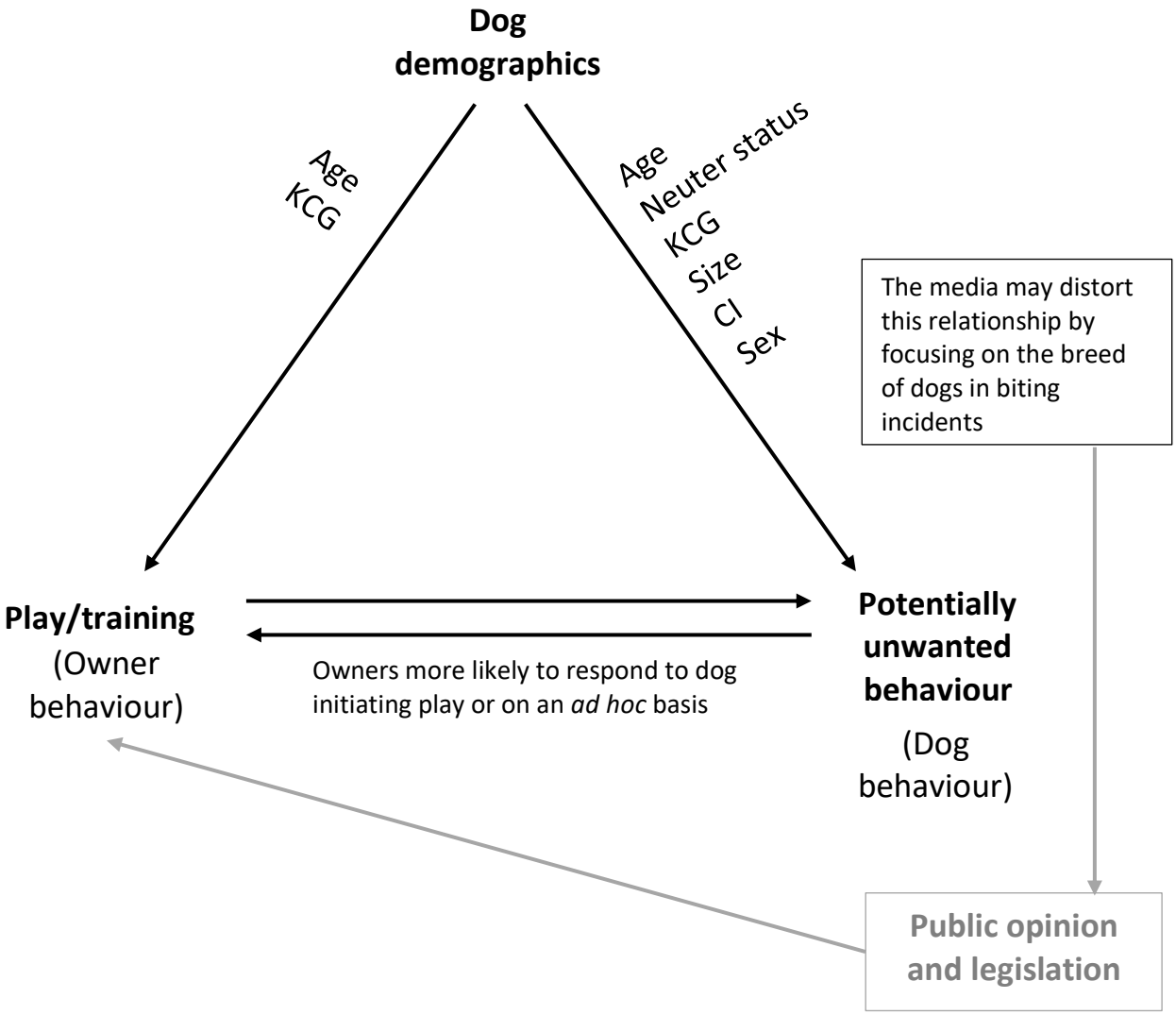

Figure 1. My findings on the relationship between dog demographics, owner behaviour, and dog behaviour. Arrow directions show which factor influences another factor. Grey colouring represents proposed relationships that were not investigated in this study.

Table 1. Demographics predicting how often dogs are played with/trained by owners each week according to an ordinal logistic regression model (Chapter 3). ✓= there was a significant relationship. X= there was not a significant relationship. +/- indicate which categories were more or less likely to play frequently.

Variable	**Associated with play amount**
Age	✓ +Puppy, Juvenile, Young adult -Early senior, Late senior, Geriatric
Sex	X
Neuter Status	X
KCG	✓ +Pastoral, Terrier
Size	X
CI	X
PUB	X
Aggression	X
AAS	X
Fear	X
Reactivity	X

Table 2. Demographic variables predicting whether dogs display certain behaviours according to binary logistic regression models (Chapter 2). ✓= there was a significant relationship. X= there was not a significant relationship. +/- indicate which categories were more or less likely to display the behaviour

Behaviour	**Age**	**Sex**	**Neuter Status**	**KCG**	**Size**	**CI**
PUB	✓ +Juvenile, Young adult -Puppy, Late senior, Early senior, Geriatric	X	X	✓ -Pastoral	✓ +Small, Medium	✓ +2, 3
Aggression (based on chi-square results)	X +Young adult -Late senior, Early senior	X	X	X	X	X
AAS	✓ +Young adult -Puppy, Late senior, Early senior	✓ +Male	X	✓ -Pastoral, Hound, Terrier	✓ +Small, Medium	✓ +3
Fear	X	X	X	✓ +Hound, Pastoral, Toy, Utility	X	X
Reactivity	✓ -Puppy, Geriatric	X	✓ +Neutered	✓ -Hound +Utility	✓ +Small	✓ +3

5.1 Aggression and Dog Bites

The finding that aggression towards adult living within the household was not associated with dog demographics has significant legislative impacts. Although my research focused specifically on aggression directed towards familiar people within the home, many dog bites, a form of aggression, also occur in similar domestic contexts and involve dogs known to the victim (Oxley, Christley and Westgarth, 2018; Cornelissen and Hopster, 2010; Meek *at al*., 2024). Therefore, both household aggression and many bite incidents are likely determined by other factors than a dog's physical characteristics, which challenges the premise of the Dangerous Dogs Act 1991.

It has been determined that a dog's early experience plays a substantial role in the likelihood of aggression in later life. Appleby, Bradshaw and Casey (2002) showed that dogs are more likely to be aggressive to unfamiliar people if they have lack typical early socialisation experiences through being reared in a non-domestic environment (such as a kennel or shed), or through a lack of experience in an urban environment between 3-6 months. Similarly, dogs obtained from pet stores are more likely to show aggression towards people than dogs obtained from non-commercial breeders (McMillan *et al*., 2013), and dogs homed at 9–12 weeks are less likely to show aggressive behaviour to unfamiliar people while those homed at 13–16 weeks are twice as likely to show aggressive behaviour to unfamiliar people inside the home (Jokinen *et al*., 2017). Moreover, if a puppy has been threatened by an unfamiliar dog, they are more likely to show stranger-directed aggression at 12 months of age (Serpell and Duffy, 2016).

A dog's environment and owner behaviour also influence the likelihood of dogs displaying aggression. A lack of conspecific company (Mikkola *et al*., 2021) and being kept outdoors are associated with an increase in aggression (Ayrosa *et al*., 2022). Dogs who are not walked and played with regularly by their owners are also more likely to show aggression (Ayrosa *et al*., 2022; Savalli *et al*., 2021).

A heritable component to aggression has also been demonstrated. In golden retrievers, human-directed aggression had high heritability estimates, indicating that offspring may inherit tendencies towards aggression from their parents (Liinamo *et al*., 2007). Ilska *et al.* (2017) also reported moderate heritability for stranger-directed aggression.

5.1.0 Puppy Farming and Legislation

It is clear that other measures need to be in place to prevent dog bites; since early experience, environment and heritability play a role in aggression, I suggest clamping down on intensive breeding/puppy farming. Such establishments breed in high volumes and prioritise profit over welfare.

It is evident that dogs bred in high-volume commercial breeding establishments have a higher risk of developing behavioural issues due to their early life experience and lack of socialization (McMillan, 2017; Wauthier and Williams, 2018). McMillan, (2017) suggested that the behavioural issues may be caused by puppies bring bred in barns/kennels, limiting their exposure people and other stimuli during their early life, being weaned early, and having early maternal separation, all of which are shown to increase unwanted behaviours such as aggression. Commercial breeding establishments may also select sires/dams to select based on their appearance or fecundity, rather than behaviour.

In England, legislation has made a start towards clamping down on puppy farming. The Animal Welfare (Licensing of Activities Involving Animals) Regulations 2018 requires that anyone breeding and selling three or more litters of puppies in a year must obtain a licence. Breeders must also meet a range of welfare standards, including not being able to sell puppies under 8 weeks of age and not being able to show puppies without their biological mother present. An amendment to this legislation, termed Lucy's Law, came into force in 2020 and made it illegal for third parties (such as pet shops or dealers) to sell puppies and kittens under six months old (The Animal Welfare (Licensing of Activities Involving Animals) (England) (Amendment) Regulation, 2019). Instead, prospective owners must buy directly from breeders or adopt from rescue centres. Lucy's Law aimed to increase transparency, make it harder for poor breeding practices to be hidden and allow the temperament and condition of the mother and puppies, and how they interact, to be assessed by potential owners.

Despite these regulations, it has been found that owning a licence does not guarantee high welfare standards or even legality (Maher and Wyatt, 2021; Four Paws UK, 2025). This is due to the limited and non-specialist enforcement resources meaning that legislation such as

Lucy's Law is inadequately enforced. As a result, most or all licensing applications are approved, inspections are insufficient, complaints are frequently overlooked, and licences are rarely revoked (Four Paws UK, 2025). Consequently, the dog breeding licensing system has been described as being largely "administered rather than enforced" (Four Paws UK, 2025). Furthermore, Packer *et al*. (2023) revealed that in 2021, prospective buyers were less likely to view puppies in person before purchase, instead relying on videos and photos, and were less likely to collect their puppy from inside their breeders' property, compared to 2019 (practices that Lucy's Law made illegal). Additionally, there is an unregulated sector of the breeding industry, as breeders producing fewer than three litters a year are exempt from licensing requirements This loophole allows unscrupulous breeders to bypass welfare standards and the lack of traceability also facilitates illegal trading including puppy trafficking (Maher and Wyatt, 2021).

Maher and Wyatt (2021) highlighted an illegal trade of puppies coming from central and eastern Europe that breaches import/export laws, often going undetected and unpunished, with evidence suggesting involvement by organised criminal networks. It is likely that puppies involved in this illegal import trade also originate from low-welfare breeding establishments, Unfortunately, there appears to be significant knowledge gaps among buyers, including the importation requirements such as the minimum age for importing puppies, and that the EU Pet Passport could no longer be issued in the UK (Belshaw and Packer, 2025).

To help overcome these issues, consistent and well-resourced enforcement of licensing conditions is essential. Public education is equally crucial to ensure that potential owners understand the importance of purchasing from ethical, small-scale breeders who raise puppies in home environments under high welfare condition to lessen the risk of health and behaviour issues. Additionally, I suggest that buyers view both parents of the puppy as it has been found that that puppies purchased without their prospective owners viewing both of the puppies parents were more likely to develop behavioural problems later in life (Westgarth, Reevell and Barclay, 2012).

To tackle the issue of illegal importation of puppies, the Animal Welfare (Import of Dogs, Cats and Ferrets) Bill is currently being debated in the House of Lords. Amongst other

measures, the bill will prohibit the import of puppies under 6 months of age (an increase from the current 15 weeks) which is an encouraging step forward. However, this will be most effective when combined with improved public awareness, ensuring that puppy buyers understand both the laws as well as the welfare and ethical implications of their choice, as research shows that the public underestimate the range of risks to their puppies (Belshaw *et al*., 2025).

5.1.1 Owner management

A key aspect of preventing dog aggression and bites is responsible dog ownership. Owner interactions such as walking and training their dog may even mitigate behavioural impacts of puppies bred in commercial breeding establishments (Wauthier and Williams, 2018). Whilst I did not find that the amount of play and training is associated with reduced aggression, this does not necessarily mean that play and training itself is unimportant. It is likely that the quality and methods of play and training are more influential. According to my chi-square tests performed during the preliminary analyses (see Chapter 3, Appendix 2), dogs that participate in training sessions were more likely to display aggression. This relationship may reflect that owners of aggressive dogs are more motivated to engage in training to manage or reduce problem behaviours, rather than training itself causing aggression. However, if the latter were true, this could indicate that ineffective training methods, such as the use of punishment, are contributing to increased aggression. Therefore, it would be advisable for owners to use qualified dog trainers who use positive reinforcement methods which are associated with better welfare and reduced undesirable behaviour compared to aversive methods (Blackwell *et al*., 2008; Ziv, 2017; de Castro *et al*., 2020). Moreover, since no associations were found between aggression and demographic factors, it is important for aggression-management/prevention strategies focus on the individual dog's behaviour and context, rather than stereotypes linked to particular breeds or types.

5.1.2 Media

Within the sample of newspaper articles I investigated, factors surrounding the injury and dog demographics were mentioned more than information on how to prevent bites, and since I did not find demographics to be a risk factor of aggression, I suggest that the media

needs to prioritise sharing evidence-based interventions. For example, teaching dog body language would be useful as many bites occur because people often misinterpret or miss the signals (Lakestani, Donaldson and Waran, 2014).

By continuing to emphasise factors such as dog breed, rather than behaviour or management, media coverage risks reinforcing breed stigmatisation where people believe that aggression is solely an inherent trait of certain breeds rather than being influenced by other factors such as early experience and the environment. This can lead to unjust restrictions, such as breed-specific legislation, and may divert attention away from interventions that are more effective at preventing bites, including where owners source their dogs, providing appropriate training and sufficient physical exercise, and the public learning to interpret dog body language.

5.2 Conclusion

Overall, this research shows that that there is an interplay between dog demographics, behaviour, owner interactions and public perceptions.

A key finding was that aggression (and every other potentially unwanted behavioural category) was not related to a dog's demographics, which challenges the assumptions that underpin legislation such as the Dangerous Dogs Act 1991. Nevertheless, media coverage continues to emphasise breed over preventative factors, risking further breed stigmatisation. Whilst dog-bite prevention is a large topic that cannot be fully covered here, it is clear that effective aggression/bite prevention should move beyond breed-focused solutions to more evidence-based measures such as public education, consistent enforcement of welfare legislation, particularly regarding breeding practices, and responsible ownership management. Whist play/training amount may not be associated with aggression, it likely that positive-reinforcement training undertaken by certified trainers remains an effective method for reducing undesirable behaviour.

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