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Using the incidence and impact of health conditions in guide dogs to investigate healthy ageing in working dogs

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ABSTRACT

This study aimed to use retirement data from working guide dogs to investigate healthy ageing in dogs and the demographic factors that influence ageing. Using a dataset of 7686 dogs spanning 20 years, dogs withdrawn for health reasons before they reached retirement were identified. Cases of retirement for old age, rather than for health reasons, were also recorded, as was the length of working life for all dogs. Specific health reasons were grouped into 14 different health categories. The influence of purebred or crossbreed, breed, and sex on the incidence of these health categories and the length of working life within each health category was considered.

The majority ($n = 6465/7686$; 84%) of working guide dogs were able to function as guide dogs until they had worked for 8.5 years, when they retired. This working life might constitute a reference for the different breeds considered, with the exception of the German shepherd dog, which had a shorter working life. The most common reason for health withdrawals was musculoskeletal conditions ($n = 387/1362$; 28%), mostly arthritis. Skin conditions (mostly comprised of cases of atopic dermatitis) reduced working life most commonly (mean, approximately 5 years). Nervous sensory conditions (35% of which were cases of epilepsy) reduced working life by 3 years.

Introduction

Ageing, in the latter stages of life, results in physical decline and in an increased vulnerability to disease. Distinguishing normal ageing from the results of disease could inform strategies to maximise health during the latter stages of life (Myint and Welch, 2012). There are likely to be at least 2.25 million ageing dogs in the UK, based on an estimated dog population of 9 million (Murray et al., 2010; Asher et al., 2011), with 25% aged ≥8 years (Thrushfield, 1989). While many researchers have considered the influence of disease on longevity in dogs (Bronson, 1982; Michell, 1999; Bonnett et al., 2005), few have considered the effects on longevity of healthy ageing. Rates of ageing and disease might be differently influenced by whether a dog is a purebred or crossbreed, and the dog's breed and sex.

Heterosis (or hybrid vigour) can confer health benefits on crossbreeds compared to purebreds, since the assumption is that animals of mixed breeds will function better than their parent breeds (Rettenmaier et al., 2002 and references therein). This view is supported by published studies that report lower incidences for certain medical conditions (O'Neill et al., 2014a) or mortality (Bonnett et al., 1997; Egenvall et al., 2000) in crossbreeds than in many purebred breeds. Working dog organisations, such as Guide Dogs (UK), breed first generation crosses because they believe these dogs combine the best traits of both parent breeds. However, not all studies have found differences between purebred and crossbreed dogs (Rettenmaier et al., 2002). Studies that consider crossbreed dogs rarely separate different generations of crosses, which could limit the sensitivity of the analysis to the effects of heterosis (O'Neill et al., 2014a).

There are marked breed differences in longevity (Egenvall et al., 2000; Bonnett et al., 2005) and the incidence or reported predisposition to disease (Asher et al., 2009; Summers et al., 2010). Such differences could result from closed gene pools, inbreeding or conformational aspects of pedigree breeding (Bateson, 2010). O'Neill et al. (2014b) argue that information on canine health is difficult to obtain, and is often unreliable. Yet understanding breed differences in the incidence of disease and predisposing factors is important for welfare, diagnosis, and treatment.

In general, female dogs live longer than males (Michell, 1999; Bonnett et al., 2005). There are disease-specific exceptions; for example, females are more likely to die from tumours than males, presumably (and as the authors report) due to a higher incidence of mammary tumours (Bonnett et al., 2005). To our knowledge there have not been any previous studies investigating sex effects on healthy ageing in dogs.

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Healthy ageing is difficult to define in animals, but it could be summarised by the ability to function unhindered by ill health, based on the definition for healthy ageing in humans by Myint and Welch (2012). This outcome could have particular relevance for working dogs, defined as those that are required, trained, or assessed to fulfil a particular purpose for human benefit beyond a hobby or sport (Serpell, 1995). Working dogs could be retired from their role if they can no longer perform their required purpose, or because continuing to do so would compromise their welfare. Like humans, dogs can be retired when they reach old age, or earlier if a health condition results in retirement. Thus retirement for health reasons prior to retirement for old age could be considered a proxy outcome measure of unhealthy ageing.

Here we consider the incidence of, and reduction in working life due to, health conditions that resulted in (early) retirement in a population of working guide dogs. The impact of three main external factors is considered: (1) sex; (2) whether the dog is a purebred or a crossbreed; and (3) breed. Additionally, we considered whether dogs were bred by Guide Dogs (UK) or sourced from an external breeder, since this has been found to be an important explanatory health factor in other studies of guide dogs (Goddard and Beilharz, 1983).

We aimed to investigate the main conditions that caused dogs to not reach old age healthily, and how much of a reduction in working life these conditions caused. To do so we explored a large dataset of working guide dogs that were either retired (i.e. reached old age) or withdrawn for health reasons. We considered the incidences of different conditions that caused working guide dogs to be withdrawn before reaching a healthy retirement. We then considered what constitutes healthy ageing in this population by examining the ages at which otherwise (apparently) healthy dogs were retired from working life. The impact of these conditions with regard to the length of time they reduced working life was also considered. At each stage we considered the potential effects of dog characteristics, purebred or crossbreed, breed, and sex on healthy ageing.

Materials and methods

Guide dogs and data

Guide Dogs (UK) is the working name of the Guide Dogs Association for the Blind. The organisation started in 1931 and is now the '*world's largest breeder and trainer of working dogs*'.[1] Guide Dogs (UK) breeds approximately 1300 puppies each year. Most puppies undergo training and are paired with a visually impaired person at about 2 years of age.

Dogs were included in this study if they had been matched by Guide Dogs (UK) with a person who was blind or partially sighted but were withdrawn for health conditions, or were retired due to old age between 1 January 1994 and 31 December 2013 (a 20-year period). Most guide dogs in this sample set were bred by the Guide Dogs (UK) breeding program, but a minority were sourced from breeders of relevant breeds.

The data were collated and maintained by Guide Dogs (UK) staff. The diagnosis and the associated withdrawal decision were made by relevant staff; the diagnosis was made by the veterinary surgeon or the referral specialist. The decision to withdraw a dog for health reasons was made by the Dog Care and Welfare Manager, based on the diagnosis and the potential implication for the dog's future as a guide dog, as well as the implications for the person who would need to manage the condition.

Data input was controlled by a small number of veterinary-qualified operators who reviewed diagnostic information before coding against agreed criteria.

Classification

In this study we were interested in the health reasons for withdrawal after dogs had qualified and been paired with a blind or partially sighted owner. The study population consisted of 6465 dogs (72%) that reached retirement, 1310 (14.5%) dogs that were withdrawn for behaviour reasons, and 1221 (13.5%) dogs that were withdrawn for health reasons. Dogs were considered to be retired if the reason provided for withdrawal was 'old age', and there was no indication of health (or behavioural) deterioration that affected their ability to function as a working guide dog. For each dog, the (total) working life was recorded as the number of days between the commencement of work and retirement.

For dogs withdrawn for health conditions, a specific reason was recorded for each dog (e.g. arthritis) before they reached retirement (i.e. the end of work). Specific reasons (approximately 150 different reasons) were categorised into 14 health groups according to body functions (e.g. musculoskeletal). Details of the specific reasons and their associated groupings are provided in Supplementary data. Since dogs left the study once they were retired, no data were collected from geriatric dogs.

Dogs with parent stock from the same breed were labelled as purebred, to distinguish them from crossbreed dogs that had parent stock from more than one breed. We considered the eight most common breeds (95% of the population) for analysis and grouped the rest (5%) into an 'Other' category. The number of dogs in each breed, and their abbreviation, were as follows: Labrador (L; $n = 2852$), Golden retriever x Labrador (GRxL; $n = 2087$), Golden retriever (GR; $n = 873$), Labrador x Golden retriever (LxGR; $n = 706$), other breeds (Other; $n = 358$), German shepherd dogs (GSD; $n = 341$), F2 Labrador x Golden retriever (LxGR*; $n = 249$), F2 Labrador cross (LxL*; $n = 120$), F2 Golden retriever cross (GRxGR*; $n = 100$). The sex of a dog was either 'dog' or 'bitch'; spay/neuter status was not considered since all dogs were altered. Dogs were recorded as having being bred by the Guide Dogs (UK) breeding programme or being outside bred (obred) if they were bred outside the organisation's breeding programme.

Data analysis

All statistical and numerical analyses were conducted in R 3.1.x (R Core Team, 2014). There were two outcome variables considered: (1) the number of cases in each of the 14 different health groups; and (2) the length of working life. We considered the effects on these outcome variables of four predictors of interest: purebred, breed, sex, and obred. We defined the incidence as the number of cases (i.e. dogs) in this population during the study period (Last, 2001).

The Pearson's χ^2 test for count data was used to test for independence between each of the different factors of interest (purebred, breed, sex, and obred) and to consider differences in incidence of the 14 health groups (Table 1).

A logistic regression, generalised linear model, was used to test for the likelihood of dogs being withdrawn for each of the 14 health groups, in turn. We used the glm() function with a binomial family. We checked for the influence of each of the predictors (breed, purebred, and sex) on each likelihood. We also tested for the interactions between purebred and sex and between breed and sex. We did not check for the influence of obred, as the test for independence was not statistically significant. The logistic regressions were run as follows: the health group retired (Old) was tested against all the other groups combined (i.e. not retired) thereby testing the likelihood of dogs reaching retirement, and how breed, purebred, or sex, might influence this. However, each other health group (e.g. musculoskeletal) was tested against retired, thereby testing the likelihood of dogs being withdrawn for health problems specific to that particular health group, and how breed, purebred, or sex could influence this.

We used a standard linear model to check for the difference in total working life between the health groups and how the three different predictors (purebred, breed, and sex) might influence these differences in the length of working life. Working life was defined as the time (days) between qualification and withdrawal/retirement (or time spent in service). The retired group was used as the reference group. Throughout this paper, we limit the results presentation to statistically significant results. When factor levels presented no, or few, significant results, they were omitted from the tables or figures. However, all factor levels were kept in the analysis unless stated otherwise. As noted previously, the obred factor was not significant in any analyses and will not be mentioned further.

Table 1
P values for independence test (χ^2, degrees of freedom) between each health group and predictors.[a]

Health group (n)	Purebred (χ^2, d.f.)	Breed (χ^2, d.f.)	Sex (χ^2, d.f.)
Old (6465)	<0.001 (25.88, 1)	<0.001 (192.87, 8)	0.007 (7.33, 1)
Can (141)	NS (0.91, 1)	<0.001 (53.47, 8)	0.01 (6.6, 1)
Car (31)	NS (0.21, 1)	0.003 (23.11, 8)	NS (0, 1)
Eye (71)	0.014 (5.99, 1)	NS (10.98, 8)	NS (2.56, 1)
Gas (38)	NS (1.37, 1)	<0.001 (71.16, 8)	NS (0, 1)
Gen (174)	0.044 (4.07, 1)	NS (7.33, 8)	NS (2.71, 1)
Mus (387)	<0.001 (15.67, 1)	<0.001 (169.85, 8)	0.022 (5.22, 1)
Ner (180)	NS (2.31, 1)	0.002 (24.97, 8)	NS (0.09, 1)
Non (36)	NS (0.01, 1)	0.005 (22, 8)	NS (1.44, 1)
Ski (74)	NS (0.42, 1)	<0.001 (36.11, 8)	NS (0.74, 1)

NS, non-significant; Old, retired; Can, cancer; Car, cardiovascular; Gas, gastrointestinal; Gen, general health deterioration; Mus, musculoskeletal; Ner, nervous/sensory; Non, nonspecific; Ski, skin.

[a] Only health groups with statistically significant results are shown.

[1] See: Guide Dogs, 2015. http://www.guidedogs.org.uk/ (accessed 3 October 2015).