

Factors affecting the annual number of pet dogs and the changes in the pet dog population in Britain over the last decade

Abstract

Pet dogs are the world's most famous mammal species kept as companion animals. Therefore, understanding the local pet dog population size and influencing factors is crucial for rabies control strategies. This report aims to identify the factors that affect the annual pet dog population size and to find out how the pet dog population size has changed in the UK over the past decade. After performing a multiple regression model and plotting a time series graph, the result shows that the average annual cost of raising a dog, the number of child-rearing households, and GDP per capita affect Britain's total number of pet dogs. In addition, some special events also have a specific impact. Finally, this report describes the possible reasons for these results, limitations, and future directions.

Introduction

Pet dogs are the world's most widespread mammal species kept as companion animals, with a total global population of 175 million (Hughes & Macdonald, 2013). They provide companionship and improve pet owners' physical and mental health (Headey, 2003). For example, it is evident that dog owners have fewer visits to the hospital and survive longer after a heart attack than people who do not own a dog (Headey et al., 2002; Friedmann et al., 1980). However, because pet dogs are an essential source of zoonotic infection, understanding the local pet dog population and influencing factors is crucial for rabies control strategies, the veterinary field and society (Robertson & Thompson, 2002).

Therefore, the aim of this report is to identify the factors that affect the UK annual pet dog population size and to find out how the pet dog population size has changed in the UK over the past decade. Because raising a dog requires several expenses and families without children need more companionship, the first hypothesis is that the average annual cost per dog and the annual number of households without children are the affected factors of the total pet dog number (Thomas et al., 2017). In addition, because pet dogs have gradually become indispensable companions for the elderly and even young people, the second hypothesis is that the population size in the UK will increase yearly.

Method

Data were downloaded from the Office for National Statistics (UK) and The Kennel Club reports published in Statista. Statista is a website that collects and aggregates data from multiple public and private sector sources. The data from 2011 to 2021 in relevant reports were extracted for analysis. The annual total pet dog number in the last decade is the sum of ten common pet dogs' annual registration numbers in the UK from 2011 to 2021 (Staffordshire Bull Terrier, Cocker Spaniel, Labrador, German Shepherd, Golden Retriever, Miniature Schnauzer, Dachshund, Pug, French Bulldog, and Boxer). To investigate factors affecting UK annual pet dog population size, a multiple regression model was performed. Eight explanatory variables are selected from the country, family, and individual aspects. Before modelling, the final explanatory variables were chosen using the Variance Inflation Factor (VIF) with threshold = 3, which removes variables with strong multicollinearity. The response variable is the annual total pet dog number (million), and the final explanatory variables are annual GDP per capita (million GBP), the average annual cost per dog (million GBP), and the annual households with children (million) and without children (million). Since multiple continuous explanatory variables are on different scales, all explanatory variables are z-standardised using the scale function. Furthermore, visreg function in the visreg package visualises the multiple regression model (Breheny & Burchett, 2017). Finally, to investigate the changes in the pet dog population in the UK over the last decade, a time series graph of each pet dog and the total number of pet dogs was drawn using ggplot2 in RStudio.

Results

The average annual cost per dog, the number of child-rearing households and GDP per capita significantly affect Britain's annual pet dog population size. The multiple regression model explains a statistically significant and substantial proportion of variance (F-value= 108.4, df = (3, 7), p-value

<0.01) with an adjusted R^2 of 0.97, which means that this model can explain 97% of the variation. Moreover, the results show that for every 1SD increase in the average annual cost of raising a dog, the annual number of child-rearing households and per capita GDP, the total number of pet dogs raised in the year will decrease by 18.25 million, increase by 32.86 million and 5.43 million, respectively. In addition, the predictive power of the number of households with children coefficient is relatively reliable (t-value = 15.47), while the reliability of the GDP coefficient is low (t-value = 2.47). The model equations and further information are as follows (Table 1, Fig 2).

Table 1. Summary of the multiple regression model with total pet dog number as response variable

Coefficient	Estimate \pm SE	t-value	95%CI	p-value
(Intercept)	130.82 \pm 1.67	78.58	[126.74, 134.89]	<0.05 ***
Scale(Cost per dog)	-18.25 \pm 2.22	-8.23	[-23.68, -12.82]	<0.05 ***
Scale(households without children)	2.03 \pm 2.11	0.96	[-3.13, 7.19]	0.37
Scale(households with children)	32.86 \pm 2.13	15.47	[27.66, 38.05]	<0.05 ***
scale(GDP per capita)	5.43 \pm 2.20	2.47	[0.05, 10.82]	<0.05 *
Model equation: Total number (million) = 130.82 - 18.25* scale (Cost)+ 32.86 * scale (households with children) + 5.43 *scale (GDP)				

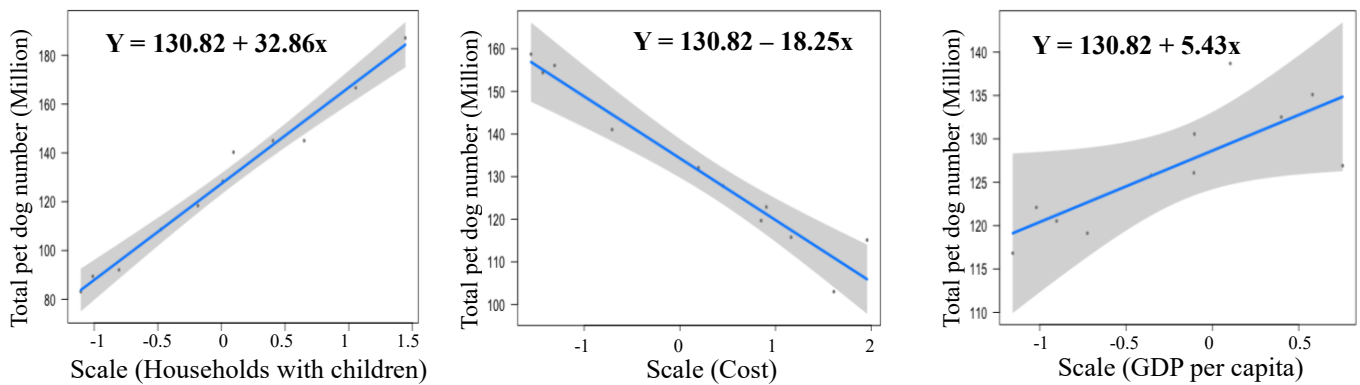


Figure 2. The significant relationships and equations between total pet dog number in million and three z-standardised explanatory variables. The shaded area represents the 95% Confidence Interval.

Moreover, the total number of pet dogs levelled off from 2011 to 2015, increased slowly from 2015, but showed a downward trend from 2018 to 2019, and then began to increase sharply from 2019 (Fig 1). From 2017, Labrador Retrievers and French bulldogs are the most popular pet dogs in the UK. The number of bulldogs has increased dramatically since 2014, and the registration number was similar to that of Labradors in 2017.

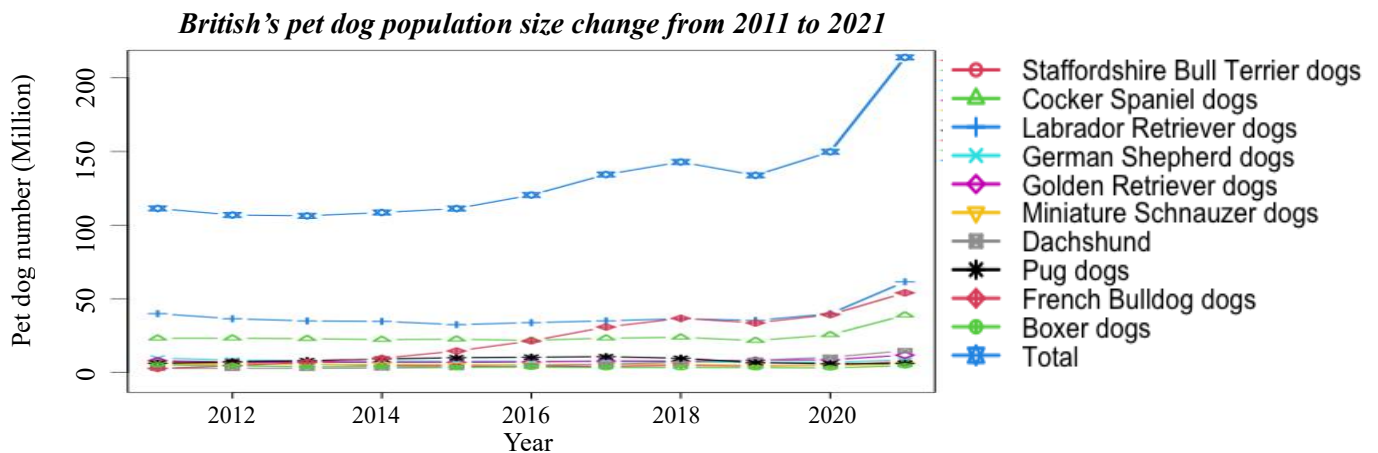


Figure1. A time series graph of each pet dog and total pet dog number in the UK. The x-axis shows time (2011 to 2021), and the y-axis presents the annual pet dog number in a million. Different line features represent different pet dogs. The blue five-star line represents the total number of pet dogs.

Discussion

The results partly support the first hypothesis. It shows a negative relation between the average annual cost per dog and the annual pet dog population size. However, other factors that significantly affect the pet dogs' population size are GDP per capita and the annual number of households with children rather than those without children. It illustrates that child-rearing households prefer having dogs to households without children. Relevant studies in the United States and Australia have found that this is because pet dogs can bring children necessary companionship and play an essential role in children's emotional development, such as self-esteem, autonomy, and compassion (Franti & Kraus, 1974; Poresky, 1996). Furthermore, the results do not support the second hypothesis. In addition to these explanatory variables, the change in the number of pet dogs may also be caused by specific events that occurred in the year. For example, the potential reason for the increase from 2016 is that England legislated that all pet dogs must have microchips in 2016. Besides, Covid-19 may contribute to the significant increase in pet dog numbers from 2019. Evidence suggests that the presence of pet dogs can effectively prevent the negative psychological and physical effects of lockdowns (Holland et al., 2021). However, the small amount of data and sample size (only eleven data for each independent variable) is the limitation that must be considered, leading to poor reliability and validity (Faber & Fonseca, 2014). Another limitation is that the number of registered dogs in just ten kinds does not represent the total number of the pet dog, and there are even many unregistered dogs.

Overall, the number of child-rearing households, cost per dog, and GDP per capita affect Britain's annual pet dog population size. Besides, some special events also have a specific impact. With the increasing popularity of pet dogs, their population change and impact on human health have become a social and medical focus. Unfortunately, the field is currently inconclusive since the affected factors and their causal relationships are complicated. In the future, more research can be conducted on the other countries and other affected factors (human psychological state, annual earnings etc.), and the prediction of future pet dog population, which will provide valuable information for the formulation of public health policies, animal disease control and stray dog population management.

Reference

1. Breheny P and Burchett W (2017). Visualization of Regression Models Using visreg. *The R Journal*, 9: 56–71.
2. Faber, J., & Fonseca, L. M. (2014). How sample size influences research outcomes. *Dental press journal of orthodontics*, 19(4), 27–29.
3. Franti, C. E., & Kraus, J. F. (1974). Aspects of pet ownership in Yolo County, California. *Journal of the American Veterinary Medical Association*, 164(2), 166–171.
4. Friedmann, E., Katcher, A. H., Lynch, J. J., & Thomas, S. A. (1980). Animal companions and one-year survival of patients after discharge from a coronary care unit. *Public health reports (Washington, D.C. : 1974)*, 95(4), 307–312.
5. Headey, B., Grabka, M.M., Kelley, J., Reddy, P., & Tseng, Y. (2002). Pet Ownership is Good for Your Health and Saves Public Expenditure Too: Australian and German Longitudinal Evidence. *Australian Social Monitor*, 5, 93.
6. Headey B. (2003). Pet ownership: good for health?. *The Medical journal of Australia*, 179(9), 460–461.
7. Hughes, J.; Macdonald, D.W. (2013). A review of the interactions between free-roaming domestic dogs and wildlife. *Biol. Conserv.* 157, 341–351.
8. Holland, K. E., Owczarczak-Garstecka, S. C., Anderson, K. L., Casey, R. A., Christley, R. M., Harris, L., McMillan, K. M., Mead, R., Murray, J., Samet, L., & Upjohn, M. M. (2021). "More Attention than Usual": A Thematic Analysis of Dog Ownership Experiences in the UK during the First COVID-19 Lockdown. *Animals: an open access journal from MDPI*, 11(1), 240.
9. Poresky, R.H. (1996). Companion Animals and other Factors Affecting Young Children's Development. *Anthrozoos*, 9, 159–168.
10. Robertson, I. D., & Thompson, R. C. (2002). Enteric parasitic zoonoses of domesticated dogs and cats. *Microbes and infection*, 4(8), 867–873.
11. Thomas, P. A., Liu, H., & Umberson, D. (2017). Family Relationships and Well-Being. *Innovation in aging*, 1(3), igx025.

Reflection

Throughout the mini-project, I acquired relevant project management skills and learned how to deal with problems during the project. First, I used to always finish my work on the deadline day despite having enough working hours. I found an efficient and easy way to solve this problem during this mini-project: create a detailed task schedule. I divided this mini-project into five parts and set deadlines for each part. The first is to consider and confirm the mini-project direction and research question by February 13th. The second part is statistical analysis, including graphing and modelling, and the deadline is February 17th. The next part is writing the mini-project report (the deadline is February 21st). Subsequently, the report figure and format adjustments were completed on February 22nd. The last part is preparing the presentation slides and making final revisions to the report by February 24th. This method can make every day more fulfilling and greatly reduce my stress and anxiety, allowing me to relax and complete this mini-project more effectively. I believe this method will also allow me to complete my final project better.

And I also found from this mini project that I am more suitable for studying in the library, which is more effective and easier to concentrate on than studying at home. Eventually, I found that allowing time for revisions and adjustments was necessary after the report was written. During this mini-project, I found the logical problems in the report and made timely revisions in the revision stage.

Moreover, there are two major problems that I encountered during this period. The first is the data source. Honestly, my first idea for the mini-project was to discover the difference between the aquatic invasion between temperate and tropical zones. However, relevant data such as biodiversity and invasive species numbers in these regions are difficult to obtain. It means that the data provided by the global database is limited. If I want to do extended research with additional data in my final project, I need to ensure I have access to this data or seek help from the final project supervisor.

The second problem is how to simplify my report. I would have a couple of creative and extended ideas, which might be my strength. It also led me to do a lot of extended statistical analysis, including Principal component analysis (PCA), Non-linear least squares (NLLS), and model selection. For example, during the mini project, after using the multiple regression model and checking the plot, I still want to figure out the relationship between each specific explanatory variable and the total pet dog number (linear or nonlinear - I need to use the NLS function). If I include all of these, it will exceed the page limit. So, the way to solve this problem is to find out what my project's specific research questions and hypotheses are. Then I must focus on my research question and choose more relevant and beneficial analyses. For example, I did not choose to use the model after model selection, although it made a multiple regression model have a smaller AIC. There are two reasons, (1) After selection, I lost a vital coefficient (household without children). Though it is not statistically significant, it will affect my final discussion. (2) While this procedure doesn't make the model worse (comparing two models by using ANOVA), it doesn't make it much better either (the AIC difference between the two models is very small, only 0.2).

Furthermore, Correct grammar, formatting of the project report, and outside reading were my weaknesses. I would spend a lot of time and seek professional help on this before the final project. For example, write a simple essay and read two related papers daily.

Overall, start early, do not procrastinate, and create a detailed schedule. The mini-project was quite beneficial and valuable. I will take the project management skills, the problem-solving methods, and the working style into my final project to complete it efficiently and flawlessly.