LIFETIME DOG GUARDIANSHIP AND HYPERTENSION PREVALENCE IN PLOVDIV

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ABSTRACT

BACKGROUND: Dog guardianship (DG) is a novel behavioral preventive intervention against arterial hypertension (AH) based on increased opportunities for physical activity, positive neuroendocrine response to stress and improved social capital. Current biomedical mindset in Bulgaria, however, is mostly focused on treatment rather than prevention through such unconventional approaches.

AIM: This study aimed to determine whether DG was associated with lower odds of prevalent AH.

MATERIAL AND METHODS: A secondary analysis of a cross-sectional study among 513 residents of Plovdiv, Bulgaria was conducted. Data on self-reported doctor-diagnosis with AH, duration of lifetime dog guardianship (LDG) and confounding individual and environmental factors were available. A multivariate logistic regression model was set up to explore the odds of AH in relation to LDG; it was followed by sensitivity analyses to detect possible effect modification by individual differences.

RESULTS: We found 28.8% (95% CI: 2.6%, 47.9%) lower odds of AH per 8 years of LDG. This beneficial effect was more pronounced in males, people without family history of AH, who had never smoked, with lower socio-economic status, not obese and aged < 55 years.

CONCLUSION: Longer DG during one's lifetime was associated with significantly lower odds of prevalent AH. Bulgarian public health exerts should explore it as an alternative preventive intervention for AH and contribute to fostering social acceptance of companion animals as means to enhance people's health.

Keywords: *dog ownership, animal therapy, blood pressure, cardiovascular disease, non-communicable diseases, preventive medicine*

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INTRODUCTION

Cardiovascular diseases (CVD) are the number one mortality cause globally with hypertension accounting for 9.4 million deaths every year (1). According to the results from CINDI programme in 2007, 37% of Bulgarian men and 25.1% of women aged 25-64 years were hypertensive (blood pressure ≥ 140/90 mm Hg) (2). In 2013 alone 7 403 (7.1%) of all deaths were attributed to hypertension (ICD-10: I10

– I15) (3), which puts high demands on the society and healthcare system. Some of the reasons for this pandemic can be sought in the wide spread of low physical activity, unhealthy nutritional habits, alcohol consumption and smoking among other risk factors (2,4). In order to approach the high prevalence of arterial hypertension (AH) public health has to design various behavioral interventions such as promotion of active lifestyle and healthy nutrition (1).

However, despite all efforts, morbidity and mortality rates are still increasing which calls for adopting novel preventive strategies. In 2013 the American Heart Association issued a statement proposing dog guardianship (DG) as "reasonable for reducing CVD risk" when coupled with "other primary and secondary cardiovascular preventive measures" (5). A thorough literature review found evidence that it is associated with beneficial cardiovascular outcomes such as lower blood pressure and increased survival in patients with CVD (5). These effects are probably mediated through increased psychical activity, favorable lipid profile and lower obesity rate. Interaction with friendly animals reduces self-rated anxiety and depressive symptoms; it affects positively human neuroendocrine response to stress via boosting oxytocin and abating catecholamine and cortisol levels. (6). Another alleged pathway is improving social capital by increasing social attention and encouraging social behavior of the guardian, facilitating communication with others, improving empathic skills and reducing loneliness (6). The non-evaluative social support offered by dogs is essential for lowering physiological stress response (7). A randomized controlled trial showed that borderline hypertension management could be assisted successfully by behavioral interventions involving companion dogs (8). Furthermore, an experimental study found that administration of angiotensin-converting-enzyme inhibitors to hypertensive individuals lowered only their resting blood pressure but failed to attenuate its raise during mental stress, whereas the social support provided by dogs was effective in that regard (9).

Despite this growing body of evidence, there is a distinct lack of scientific research regarding the cardiovascular benefits of DG in Bulgaria. Companion dogs are often viewed as a health threat by the community due to fear of dog attacks and zoonoses, while health policy and research are limited to traditional preventive strategies. This study provokes the conventional biomedical mindset in Bulgaria and explores a novel approach for managing AH. Thus, we aimed to determine whether DG was associated with lower odds of prevalent AH.

MATERIAL AND METHODS

Design

We re-analyzed a dataset from a cross-sectional study designed to explore the risk of cardiometabolic diseases (type 2 diabetes, AH, ischemic heart disease and stroke) associated with several environmental risk factors (road traffic, noise and air pollution). More detailed methodology has been reported elsewhere (10). Briefly, we surveyed adult residents of Plovdiv, Bulgaria (July – November, 2014) using non-probability snowball and field sampling. Participants were assured of anonymity and answering the questionnaire was taken to constitute informed consent.

In the original design the maximum necessary sample size was estimated to be 558. For the present study, however, we used *post-hoc* power calculations to ascertain its adequacy.

Questionnaire and variables

Self-reported AH was the outcome variable: "Have you been diagnosed with any of the following diseases/conditions?" with one of the response option being "Hypertension (blood pressure≥140/90 mmHg)".

DG was defined as currently having a companion dog ("Do you currently have a pet dog?") and lifetime dog guardianship (LDG) ("Overall, for how many years during your lifetime have you had a pet dog?").

Data on the following confounding factors were collected:

- Demographics: age, sex, ethnicity, perceived socio-economic status (SES), highest educational attainment, occupation and marital status
- Residential noise and air pollution exposures were estimated after geocoding participants' addresses (10). Noise exposure was dichotomized (L_{den}<65 dB vs. L_{den}>65 dB) according to the threshold relevant to CVD (11). Based on satellite imagery we measured the Euclidean distance to the nearest major road (>10 000 vehicles/day) and dichotomized it (<50 m vs >

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50 m) as a proxy for traffic related air pollution (12). Road traffic data were extracted from official source (13).

- Lifetime occupational noise exposure was measured with the question: "For how long during your lifetime have you worked at a place where noise was loud enough to disturb normal conversations?". This need to speak in a raised voice was considered a proxy for exposure to over 66 dB (14).
- Duration of residence at the current address (in years)
- Other risk factors for AH: obesity (body mass index (BMI) ≥ 30), family history of AH, diagnosis with type 2 diabetes, pack-years of smoking and sleep disturbance (Liker scale, "0" to "10")
- Some factors relevant to DG: having a garden, time spent in green spaces/week (in hours) and perceived neighborhood greenness (scale, "1" to "10")

Attitudinal questions and those measuring temporally unstable states referred to the past year.

Statistical analyses

Initially data were examined for missing rates, univariate normality (D'Agostino-Pearson K^2 test) (15) and outliers (modified outlier labelling rule) (16). Missing values were subjected to listwise deletion except for the main regression analysis where they were replaced with multiple imputation (17). Outliers were retained if they were considered "unusual but honest answers" and the cause for these aberrances could not be determined (18).

Associations between LDG and other interval or ordinal variables were determined with Spearman correlations. In case of categorical variables, Welch's t-test and ANOVA were used due to their robustness to violations of normality and homogeneity of variance (19, 20, 21).

In order to determine whether there were lower odds of AH per one interquartile range (IQR) increase in LDG we specified a logistic regression model which was run of 50 imputed dataset to improve its statistical power. It was adjusted for relevant confounders selected according to a modification of the procedure for purposeful selection of variables in regression models (22). Briefly, all variables with significant (at the $p < 0.25$ level) univariate effects on AH were considered candidates for confounding factors in the multivariate model. In case of multicategorical covariates we included all "dummy variables" if at least one was significant at the $p < 0.25$ level. LDG was forced into the multivariate model along with the other potential covariates. The latter were retained if the effect of LDG changed with more than 15% upon their exclusion one at a time and/or if they were significant at the $p < 0.1$ level. After this iterative process was completed, the remaining variables having initially non-significant univariate effects at the $p < 0.25$ level were re-introduced into the model one at a time and retained if they confounded the relationship between LDG and AH with more than 15 % and/or if they were significant at the $p < 0.1$ level. Model was tested for multicollinearity. *Post-hoc* power was computed for the final model. Sensitivity analyses examined possible effect modification by some individual characteristics.

Results were considered statistically significant at $p<0.05$ (two-tailed). Data were processed with Statistical Package for the Social Sciences (SPSS Inc. Released 2008. SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc.). Power calculations were made with G*Power v. 3.1.9.2 (23).

RESULTS

Participants' characteristics

Two hundred and forty nine questionnaires were distributed and 213 were returned (85.5%) using snowball method, and 368 out of 1906 eligible participants (19.3%) answered the field interview. After excluding participants who did not meet inclusion criteria or had unacceptably high percentage of missing values on all key variables, 513 cases were left for further analysis.

Mean age was 36.45 years (SD = 15.39). Of those 36.06% were male. Most participants were Bulgarian (84.99%), with upper secondary (50.10%) or bachelor/master (46.00%) educational level, married/in a relationship (61.99%), employed (55.75%), and with middle SES (68.62%). About 20% (n = 102) had been diagnosed with hypertension.

Currently 25.93% cared for a dog and 46.20% reported ever having cared for a dog at some point in their life. Distribution of duration of LDG is given in Figure 1; one IQR of LDG was 8 years. LDG

was significantly and inversely associated with age (r_s = -0.109, 95% CI: -0.195, -0.022), educational level (r_s = -0.119, 95% CI: -0.204, -0.032) and duration of residence at the current address (r_s=-0.137, 95% CI: -0.224, -0.048), and positively with time spent in green spaces (r_s = 0.198, 95% CI: 0.111, 0.282). On average widowers and pensioners had cared for a dog longer than the others (Data not shown).

Lifetime dog guardianship and arterial hypertension

A logistic regression model examined the effect of LDG on prevalent AH. Due to the cross-sectional design of the study, LDG was preferred to current DG in this main analysis. Univariate OR associated with LDG was 0.695 (95% CI: 0.529, 0.914). The final multivariate model was constructed through an iterative process of re-fitting and specification according to the modified procedure of purposeful selection of variables in regression models. (See Table 1) There were 28.8% (95% CI: 2.6%, 47.9%) lower odds of AH per 8 years of LDG. This effect was adjusted for important environmental and individual confounders. Age, smoking, air pollution, occupational noise exposure, obesity, family history of AH, sleep

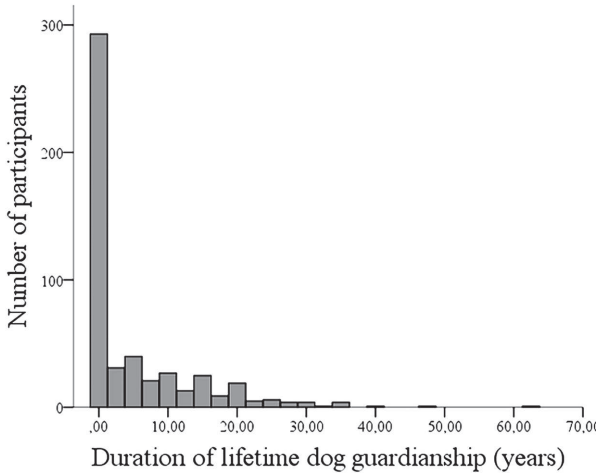

Fig. 1. Distribution of lifetime duration of dog guardianship in the sample

Table 1. Multivariate adjusted odds of arterial hypertension associated with one interquartile range increase in lifetime dog guardianship

Independent variables	p-value	OR	95% CI	
Lifetime dog guardianship (per 8 years)	0.033	0.712	0.521	0.974
Distance to major road (≥ 50 m)	0.090	0.523	0.247	1.106
Age (per 1 year)	0.018	1.038	1.006	1.070
Pack years of smoking (per 1 year)	0.005	1.035	1.010	1.061
Lifetime occupational noise > 66 dB (per 1 year)	0.072	1.033	0.997	1.071
Sleep disturbance	0.004	1.166	1.049	1.296
Time spent in green spaces/week (per 1 hour)	0.094	0.841	0.687	1.030
Perceived neighborhood greenness	0.037	0.832	0.700	0.989
BMI ≥ 30	< 0.001	7.603	3.065	18.861
Family history of AH	0.109	1.671	0.892	3.128
Basic education	Ref.	1.00	.	.
Upper secondary education	0.256	4.497	0.336	60.178
Bachelor/master/	0.225	5.092	0.367	70.574
PhD/DSc	0.416	3.636	0.162	81.640
Employed	Ref.	1.00	.	.
Studying	0.227	0.506	0.167	1.528
Unemployed	0.640	1.366	0.369	5.052
Retired	0.833	1.139	0.340	3.818
Constant	0.002	0.003	< 0.001	0.114

Note. n = 493. OR– odds ratio, CI – confidence interval, Ref. – referent category, BMI – body mass index, AH – arterial hypertension, PhD/DSc – philosophy doctor/doctor of sciences

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disturbance, perceived neighborhood greenness and time spent in green spaces were all significant determinants of AH. Educational attainment and occupation were not significant covariates but confounded the effect of LDG with more than 15%. This model explained about 43% – 47% of the variance in AH. Specifications for the *post-hoc* power analysis were exponential distribution of LDG, prevalence of AH = 0.20, $\alpha = 0.05$, $n = 493$, R^2 and with other covariates = 0.40; the observed power was modest, i.e., 35%.

When the model was run on the original dataset (prior to data imputation), the multivariate effect of LDG was OR = 0.639 (95% CI: 0.400, 1.021). In sensitivity analyses we examined effect modification by several individual characteristics and found that the beneficial effect of LDG was more pronounced in males, people without family history of hypertension, who had never smoked, with lower SES, not obese and aged < 55 years. (see Figure 2) Finally, if current DG was used instead of LDG, a non-significant OR = 0.705 (95% CI: 0.331, 1.503) was yielded.

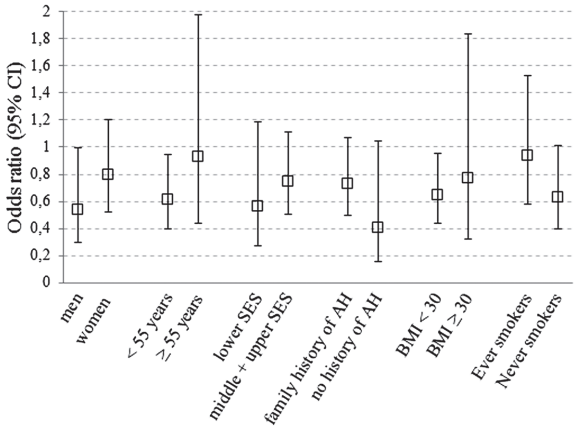

Fig. 2. Odds of prevalent arterial hypertension associated with lifetime dog guardianship stratified by individual characteristics

Note. AH – arterial hypertension, SES – socio-economic status, BMI – body mass index

DISCUSSION

Overall findings

This was the first Bulgarian study investigating the preventive benefits of DG with respect to AH. We found lower odds (OR = 0.712, 95% CI: 0.521, 0.974) of prevalent AH per 8 years of LDG. Despite the adjustments for multiple important confounders and the modest power of the test, this beneficial effect of LDG was statistically significant with relatively narrow 95% CIs. Sensitivity analyses revealed some important effect modifiers. Males seemed to benefit more from owning a dog than females. This might be explained by sex differences in psycho-physiological stress response (24) or by the fact that males might be more involved in dog walking and other recreational activities with their companion animals. Significantly lower odds of AH among men but not women were previously reported by Wrigth et al. (25). We also suggest that DG might be more beneficial for preventing stress-related AH rather than AH due to heredity, aging or unhealthy lifestyle (obesity and smoking). As for people with lower SES, they might be spending more time at home interacting with their companion animals or being active in the neighborhood.

Because we conducted secondary analysis of previously collected data, we were able to adjust for environmental risks such as noise and air pollution, sleep disturbance and opportunities to interact with local green spaces, which are relevant to AH but were not considered in previous studies (5). For example, Wright et al. controlled only for age, sex, BMI, exercise and antihypertensive medication (25). Another, strength was that, as far as we are aware, we studied the effect of duration of LDG for the first time. Other authors have focused on current DG or ever owning a dog (5,25). Coupled with the use of dichotomized measure for AH, contrary to most previous studies using a continuous measure of blood pressure (5), this makes our results highly relevant from epidemiological standpoint.

Some authors, however, did not find evidence that DG was significantly associated with lower prevalence of AH. For example, in a survey of 1 179 elderly participants (50 – 95 years) Wright et al. reported non-significantly lower OR in their fully-adjusted model (OR = 0.91, 0.61, 1.34) when AH was defined as blood pressure ≥ 140/90 mmHg. When they applied less stringent criteria for AH (≥ 130/85 mmHg) the multivariate OR was still non-significant (OR = 0.81, 95% CI: 0.57, 1.14) (25). Our study offers possible explanations for these non-significant results: namely, when we stratified our results by age, we also failed to observe significantly lower OR in people

over 55 years; moreover, current DG was non-significant predictor of AH in our study as well.

Limitations

There are some methodological limitations. Due to the cross-sectional design we could not disentangle the temporal relationship between LDG and AH, that is, there was no way to ascertain whether DG preceded the onset of AH. The fact that we used a measure of DG during participants' lifetime and adjusted for age partially reduces this bias. The non-random sampling should not be viewed as a major limitation because it is a common misconception that random sampling is mandatory in risk assessment if certain criteria are met (26).

Using self-reported data makes this study prone to common method bias. However, DG questions were only 2 out of 59 therefore the possibility of reporting bias or manipulation of the results is unlikely. Self-reported doctor-diagnosis might be underestimating the true prevalence of AH since many people in Bulgaria are unaware of their status. Questions on some covariates that we controlled for (e.g., time spent in green spaces, sleep disturbance, BMI, etc.) referred to the past year and might not be adequately reflecting the long-term situation. For this reason we did not include personal attitudes towards nature and noise sensitivity which are arguably even more temporally unstable. Finally, we did not collect information regarding dog characteristics, dog walking habits or number and type of other pet animals in the household. Nevertheless, these limitations are pertinent to previous studies as well.

Future research and implementation

Unfortunately, disease prevention in Bulgaria has not reached sufficient priority in terms of resource allocation among the national public health priorities (27). Furthermore, traditional medical research has a strong positivistic heritage and "inbuilt reluctance towards innovative ideas and creativity" (28). Medical scientists have different understanding of causation than social scientists and seek for clear pathophysiological mechanisms explaining how interventions "work" (29). This conventional mindset should be provoked in order to find new ways to generate ideas for prevention of non-communicable diseases (28).

Further studies on CVD prevention by DG are needed. Epidemiological surveys should be designed specifically for this purpose collecting relevant data for physical activity related to dogs, interaction with them and neighborhood characteristics. Whether people walk their dog is determined by a combination of demographic factors related to both the guardian and his/her companion animal, and their surrounding psychical and social environment. Thus it is recommended to target guardian – dog relationship, convincing people in their obligation to walk their dog for its own benefit, stressing the fun and enjoyment that one gets from this activity rather than presenting it as a health intervention (30). Providing dog-supporting psychical environments such as dog parks and off-leash areas is also recommended (31, 32) and can be achieved through collaboration in urban planning and green space management between public health experts and local authorities. Moreover, we must foster social support of DG, which might be particularly challenging given the community reaction to reports of dog attacks. Involvement of public health experts might facilitate disseminating evidence of the positive effects of DG; primary health care providers and clinicians might consider DG as additional non-pharmacological approach to reduce the burden of stress-related AH.

CONCLUSION

Longer dog guardianship during one's lifetime was associated with significantly lower odds of prevalent arterial hypertension even after adjusting for multiple important individual and environmental confounders. Some individual differences (sex, age, socio-economic status, smoking, obesity and heredity) were important effect modifiers that need to be explored in future research. Bulgarian public health exerts should explore dog guardianship as an alternative preventive intervention for AH and contribute to fostering social acceptance of companion animals as means to enhance people's health.

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CONFLICT OF INTEREST STATEMENT

This study received no external funding and the authors declare that they do not have any financial relationships which could be construed as potential conflict of interest. All authors are dog guardians.

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