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Dog Ownership and Cardiovascular Health: Results From the Kardiovize 2030 Project

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Abstract

Objective: To investigate the association of pet ownership, and specifically dog ownership, with cardiovascular diseases (CVD) risk factors and cardiovascular health (CVH) in the Kardiovize Brno 2030 study, a randomly selected prospective cohort in Central Europe.

Patients and Methods: We included 1769 subjects (aged from 25 to 64 years; 44.3% males) with no history of CVD who were recruited from January 1, 2013, to December 19, 2014. We compared sociodemographic characteristics, CVD risk factors, CVH metrics (ie, body mass index, healthy diet, physical activity level, smoking status, blood pressure, fasting glucose, and total cholesterol), and score between pet owners and non-pet owners or dog owners and several other subgroups.

Results: Approximately 42% of subjects owned any type of pet: 24.3% owned a dog and 17.9% owned another animal. Pet owners, and specifically dog owners, were more likely to report physical activity, diet, and blood glucose at ideal level, and smoking at poor level, which resulted in higher CVH score than non-pet owners (median, 10; interquartile range = 3 vs median, 9; interquartile range = 3; P=0.006). Compared with owners of other pets, dog owners were more likely to report physical activity and diet at ideal level. The comparison of dog owners with non-dog owners yielded similar results. After adjustment for covariates, dog owners exhibited higher CVH scores than non-pet owners (β=0.342; SE=0.122; P=0.005), other pet-owners (β=0.309; SE=0.151; P=0.041), and non-dog owners (β=0.341; SE=0.117; P=0.004).

Conclusion: Except for smoking, dog owners were more likely to achieve recommended level of behavioral CVH metrics (physical activity and diet) than non-dog owners, which translated into better CVH.

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For editorial comment, see page 249

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Every year, an estimated 17 million people globally die of cardiovascular disease (CVD), accounting for 4 million — nearly 45% of all deaths — across the European region in 2016.[1] Primary prevention of CVD is achievable through early identification and modification of behavioral risk factors such as tobacco use, unhealthy diet, physical inactivity, and adherence to medications to treat hypertension, diabetes, and hypercholesterolemia. To face this issue, the American Heart Association (AHA) proposed a definition of seven ideal health behaviors and health factors to estimate, promote, and monitor cardiovascular health (CVH) at the population level.[2] Those components — specifically body mass index (BMI), healthy diet, physical activity, smoking status, blood pressure, blood glucose, and total cholesterol — can be computed to create the CVH score, which helps identify individuals with poor CVH at higher risk of CVD.[3]

More recently, it has been proposed that owning a pet might prevent obesity,[4–6] improve lipid profiles,[4,7] and reduce systemic blood pressure,[4,6,8–10] thereby reducing risk of mortality and CVD events.[11–14] Among all pets, dogs appear to positively influence physical activity and to provide social support, which in turn is a predictor of adoption and maintenance of behavior changes.[15] Previous studies have shown that people who own a dog engage in more physical activity than non-owners.[16–21] Although several studies

have suggested health benefits of owning a pet, other studies have produced inconclusive findings.[22] In 2013, a scientific statement from the AHA concluded that pet ownership — particularly dog ownership — is probably associated with decreased CVD risk, with convincing evidence for a relationship with increased physical activity.[23] However, further research is encouraged to address this topic, including analysis of population-based studies that account for socioeconomic factors, behaviors, and well-defined medical conditions, and using robust statistical methodologies. Since the relationship between dog ownership and CVH has not been reported previously, we used data from the Kardiovize Brno cohort, a random urban sample population in Central Europe,[24] to investigate the association of dog ownership with CVH and its individual components.

PATIENTS AND METHODS

Study Design and Participants

The Kardiovize Brno 2030 cohort prospectively recruited a random sample of residents (aged 25 to 64 years) of the city of Brno, Czech Republic; protocol and baseline findings have been previously described.[24] Briefly, baseline examinations started on January 1, 2013, and lasted until December 19, 2014, with planned follow-up at 5-year intervals until 2030. The baseline study protocol was approved by the ethics committee of St Anne's University Hospital, Brno, Czech Republic (reference 2 G/2012), in accordance with the Declaration of Helsinki, and all participants signed an informed consent to participate in the study. Face-to-face health comprehensive interviews were performed on (1) demographic and socioeconomic status (age, sex, educational level, employment, and marital status), (2) behaviors (smoking status, diet, and physical activity), and (3) personal history (diseases and medications).[24] Physical activity was assessed using the long version of the International Physical Activity Questionnaire translated into Czech.[25,26] Dietary data were collected using 24-hour recall and food and nutrient intakes were assessed by NutriDan software.[27–29] Physical examinations and anthropometric measurements were performed by trained nurses according to standardized techniques and protocols.[24,30,31] In this cross-sectional analysis, we used data from Kardiovize members with complete assessment of pet ownership and CVH, and no previous or current history of CVD.

Pet Ownership Assessment

During the face-to-face interview, Kardiovize members were asked to indicate whether they have any pets, followed by items about specific pets (dog, cat, horse, or other). The last three groups were collapsed owing to a low prevalence of ownership. For the purpose of our analysis, we compared pet owners with non-pet owners and dog owners with non-dog owners, other pet owners, or non-pet owners.

Ideal Cardiovascular Health Score

CVH score, as defined by the AHA,[2,3] was computed first as the sum of seven metrics: BMI, healthy diet, physical activity level, smoking status, blood pressure, blood glucose, and total cholesterol. Each metric was scored from 0 to 2 (0 = poor, 1 = intermediate, and 2 = ideal); thus, the overall CVH score ranged from 0 to 14 (Supplemental Table 1, available online at http://www.mayoclinicproceedings.org). Ideal CVH status was categorized as having all seven metrics being at ideal levels; intermediate CVH as having at least one metric at intermediate level, but no poor metrics; and poor CVH as having at least one of seven metrics at poor level.[32]

Statistical Analyses

All statistical analyses were performed using the SPSS software (version 22.0, SPSS, Chicago, IL). The Kolmogorov-Smirnov test was used to assess the normal distribution of variables. Continuous variables were reported as median and interquartile range (IQR), and compared using the Mann-Whitney U test. Categorical variables were reported as frequency and percentage, and compared using the χ^2 test. To assess the independent effect of dog ownership on CVH score, multiple linear regression analyses were used to estimate β coefficients with accompanying 95% CIs. Regression models were adjusted for those variables significantly associated with dog ownership and not included in the CVH score (ie, age, sex, and educational level). To test the robustness of our results, we

TABLE 1. Characteristics of Study Population (N=1769) According to Pet Ownership[a]

Characteristics Median (Interquartile Range) or %	Pet Owners (n=746)	Non-pet Owners (n=1023)	*P* Value
Age, y	44.0 (16.0)	50.0 (17.0)	<0.001
Sex (% male)	41.0	46.6	0.019
Educational level (% low[b])	21.7	16.7	<0.001
Marital status (% living alone)	38.1	38.2	0.950
Employment (% unemployed)	18.2	18.2	0.641
Income (% less than 30,000 CZK)	39.3	42.0	0.401
Smoking (% current smokers)	29.9	24.6	0.044
Physical activity, MET-min/wk	4265 (5685)	2805 (4176)	<0.001
Weight, kg	76.0 (24.0)	77.0 (24.0)	0.115
Body mass index, kg/m^2	25.0 (6.4)	25.4 (6.0)	0.115
Waist circumference, cm	87.0 (21.0)	89.0 (20.0)	0.042
Central obesity[c] (%)	28.4	32.2	0.088
Systolic blood pressure, mm Hg	117.5 (18.5)	118.5 (19.8)	0.206
Diastolic blood pressure, mm Hg	79.0 (12.5)	79.5 (13.0)	0.584
History of hypertension (%)	27.5	32.9	0.016
Fasting glucose, nmol/L	4.9 (0.8)	4.9 (0.7)	0.357
History of diabetes mellitus (%)	7.3	10.0	0.046
Triglycerides, nmol/L	1.04 (0.80)	1.05 (0.80)	0.876
Total cholesterol, nmol/L	5.1 (1.3)	5.1 (1.3)	0.889
HDL cholesterol, nmol/L	1.5 (0.5)	1.4 (0.5)	0.021
LDL cholesterol, nmol/L	3.0 (1.2)	3.1 (1.2)	0.334
Total cholesterol/HDL-cholesterol ratio	3.3 (1.5)	3.4 (1.4)	0.054
History of hypercholesterolemia (%)	26.3	29.5	0.139
CVH score[d]	10 (3)	9 (3)	0.007
Number of ideal CVH metrics	4 (2)	4 (1)	0.105

[a]CVH = cardiovascular health; CZK = Czech koruna; HDL = high-density lipoprotein; LDL = low-density lipoprotein; MET = metabolic equivalent for task.
[b]Primary education or apprenticeship.
[c]Defined as waist circumference ≥102 cm in men and ≥88 cm in women.
[d]Computed as the sum of seven metrics defined by the American Heart Association.

performed a sensitivity analysis by excluding people who owned dogs and other pets. We also investigated the interactions of dog ownership with age, sex, and educational level on CVH score using a general linear model. All statistical tests were two-sided, and *P* values less than 0.05 were considered statistically significant.

RESULTS

A total of 1769 Kardiovize members (aged 25-64 years; 44.3% males) who satisfied the selection criteria were included in the current analysis. Approximately 42% of subjects owned any type of pet: 429 (24.3%) owned a dog (ie, 328 owned exclusively dogs and 101 owned dogs and other pets), whereas 317 (17.9%) owned another animal. In general, pet owners were younger, less likely to be men, less educated, and more likely to smoke tobacco and perform more physical activity than non-owners (Table 1). Pet owners also exhibited higher high-density lipoprotein (HDL) cholesterol and lower prevalence of diabetes. With respect to CVH metrics, people who owned a pet were more likely to report physical activity, diet, and blood glucose at higher level, and smoking at a poorer level (Figure 1). We also observed higher CVH scores among pet owners compared with participants who did not own a pet (median, 10; IQR=3 vs. median, 9; IQR=3; *P*=0.007).

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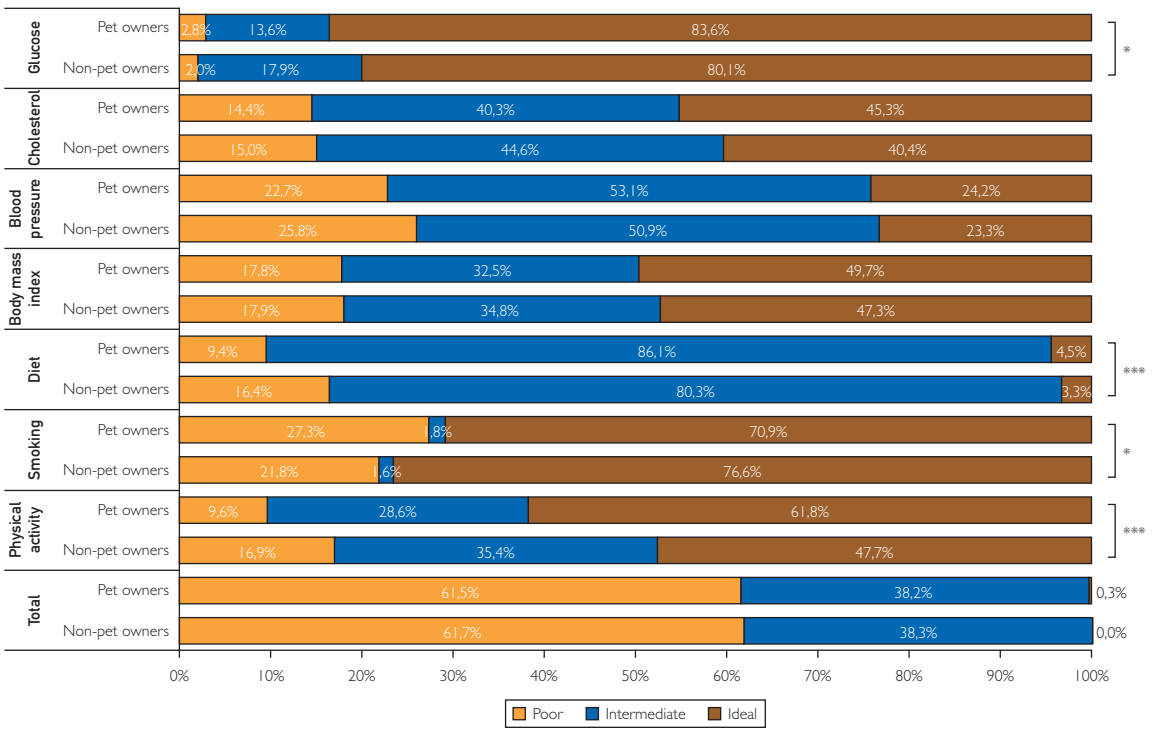

FIGURE 1. Distribution of cardiovascular health metrics according to pet ownership. *$P<0.05$, and ***$P<0.001$ based on the χ^2 test.

However, multivariable linear regression analysis did not confirm the association of pet ownership with CVH scores after adjusting for age, sex, and educational level.

We next compared dog owners with people who did not own any pet or who owned other pets (Table 2). Specifically, dog owners were less likely to be men, less educated, more likely to smoke tobacco and to perform more physical activity than people who did not own any pet (Table 2). With respect to CVH metrics, they reported physical activity, diet, and blood glucose CVH metrics at higher level and smoking CVH metric at poorer level (Figure 2). They also exhibited higher CVH scores than people who did not own any pet (median, 10; IQR=3 vs. median, 9; IQR=3; P=0.006) in bivariate analysis, and after adjusting for age, sex, and educational level (β=0.342; SE=0.122; P=0.005). Compared with other pet owners, dog owners were younger, less educated, and more likely to smoke tobacco and to perform more physical activity. With respect to CVH metrics, they reported physical activity and diet at higher level (Figure 2). After adjusting for age, sex, and educational level, they also exhibited 0.3 points higher on CVH scores than owners of other pets (β=0.309; SE=0.151; P=0.041). The comparison of dog owners with people who did not own dogs yielded similar results (Supplemental Table 2 and Supplemental Figure 1, available online at http://www.mayoclinicproceedings.org), with 0.3 points higher on CVH scores among dog owners after adjusting for covariates (β=0.341; SE=0.117; P=0.004).

For each comparison, sensitivity analysis confirmed the robustness of previous findings by excluding people who owned dogs and other pets (data not shown). Finally, no interactions of dog ownership with age, sex, or educational level were evident (P=0.323, P=0.287, and P=0.563, respectively).

DISCUSSION

To the best of our knowledge, our analysis on the Kardiovize cohort is the first showing the association between pet ownership and CVH, as defined by the AHA.[2,3] People who owned a pet, and specifically a dog, were more likely to report physical activity, diet, and blood

TABLE 2. Comparison of Characteristics Between Dog Owners, Non-Pet Owners, and Owners of Other Pets[a]

Characteristics Median (IQR) or %	Dog owners (n=429)	Non-pet owners (n=1023)	*P* value	Owners of pets other than dogs (n=317)	*P* value
Age, y	47.0 (18.0)	50.0 (17.0)	0.183	44.0 (15.0)	0.001
Sex (% male)	39.4	46.6	0.011	43.2	0.294
Educational level (% low[b])	22.6	16.7	<0.001	20.5	0.003
Marital status (% living alone)	38.8	38.2	0.844	37.1	0.649
Employment (% unemployed)	19.6	18.2	0.596	16.4	0.562
Income (% less than 30,000 CZK)	38.1	42.0	0.254	40.8	0.808
Smoking (% current smokers)	31.9	24.6	0.007	27.1	0.035
Physical activity, MET-min/wk	4833 (5631)	2805 (4176)	<0.001	3217 (4331)	<0.001
Weight, kg	76.0 (24.0)	77.0 (24.0)	0.367	77.0 (23.0)	0.863
Body mass index, kg/m^2	25.0 (6.6)	25.4 (6.0)	0.441	25.1 (5.8)	0.882
Waist circumference, cm	87.0 (20.3)	89.0 (20.0)	0.063	88.0 (21.0)	0.857
Central obesity[c] (%)	29.2	32.2	0.263	37.3	0.570
Systolic blood pressure, mm Hg	118.0 (17.5)	118.5 (19.8)	0.550	117.0 (20.5)	0.396
Diastolic blood pressure, mm Hg	79.5 (11.0)	79.5 (13.0)	0.839	78.0 (14.0)	0.539
History of hypertension (%)	28.4	32.9	0.096	26.3	0.519
Fasting glucose, nmol/L	4.9 (0.8)	4.9 (0.7)	0.872	4.9 (0.8)	0.342
History of diabetes mellitus (%)	6.9	10.0	0.064	7.7	0.675
Triglycerides, nmol/L	1.04 (0.80)	1.05 (0.80)	0.952	1.05 (0.80)	0.838
Total Cholesterol, nmol/L	5.1 (1.3)	5.1 (1.3)	0.590	5.1 (1.3)	0.839
HDL Cholesterol, nmol/L	1.5 (0.5)	1.4 (0.5)	0.225	1.5 (0.6)	0.635
LDL Cholesterol, nmol/L	3.0 (1.2)	3.1 (1.2)	0.777	3.0 (1.2)	0.560
Total cholesterol/HDL-cholesterol ratio	3.4 (1.4)	3.4 (1.4)	0.556	3.3 (1.5)	0.342
History of hypercholesterolemia (%)	26.8	29.5	0.301	25.6	0.709
CVH score[d]	10 (3)	9 (3)	0.006	9 (3)	0.314
Number of ideal CVH metrics	4 (2)	4 (1)	0.324	4 (2)	0.809

[a]CVH = cardiovascular health; CZK = Czech koruna; HDL = high-density lipoprotein; IQR = interquartile range; LDL = low-density lipoprotein; MET = metabolic equivalent for task;
[b]Primary education or apprenticeship.
[c]Defined as waist circumference ≥102 cm in men and ≥88 cm in women.
[d]Computed as the sum of seven metrics defined by the American Heart Association.

glucose components at higher level, and smoking at poor level. This translated into higher CVH score among owners of dogs or other pets than non-owners. In fact, dog owners exhibited better CVH even than non-dog owners, including owners of other pets. This is in line with the scientific statement from the AHA that reported benefits of owning a dog in terms of physical activity engagement and CVD risk.[23]

We first assessed bivariate associations between pet ownership and several CVD risk factors. Particularly, pet owners exhibited higher HDL cholesterol and lower prevalence of diabetes than non-owners. Although data are limited on the association of pet ownership with lipid profile, a previous study showed that people who owned a pet had significantly lower levels of triglycerides than those who did not.[7] Similarly, an analysis by Anderson et al[8] of 5741 participants attending a free screening clinic showed that men who owned a dog had significantly lower levels of total cholesterol and triglycerides than non-owners. Benefits of

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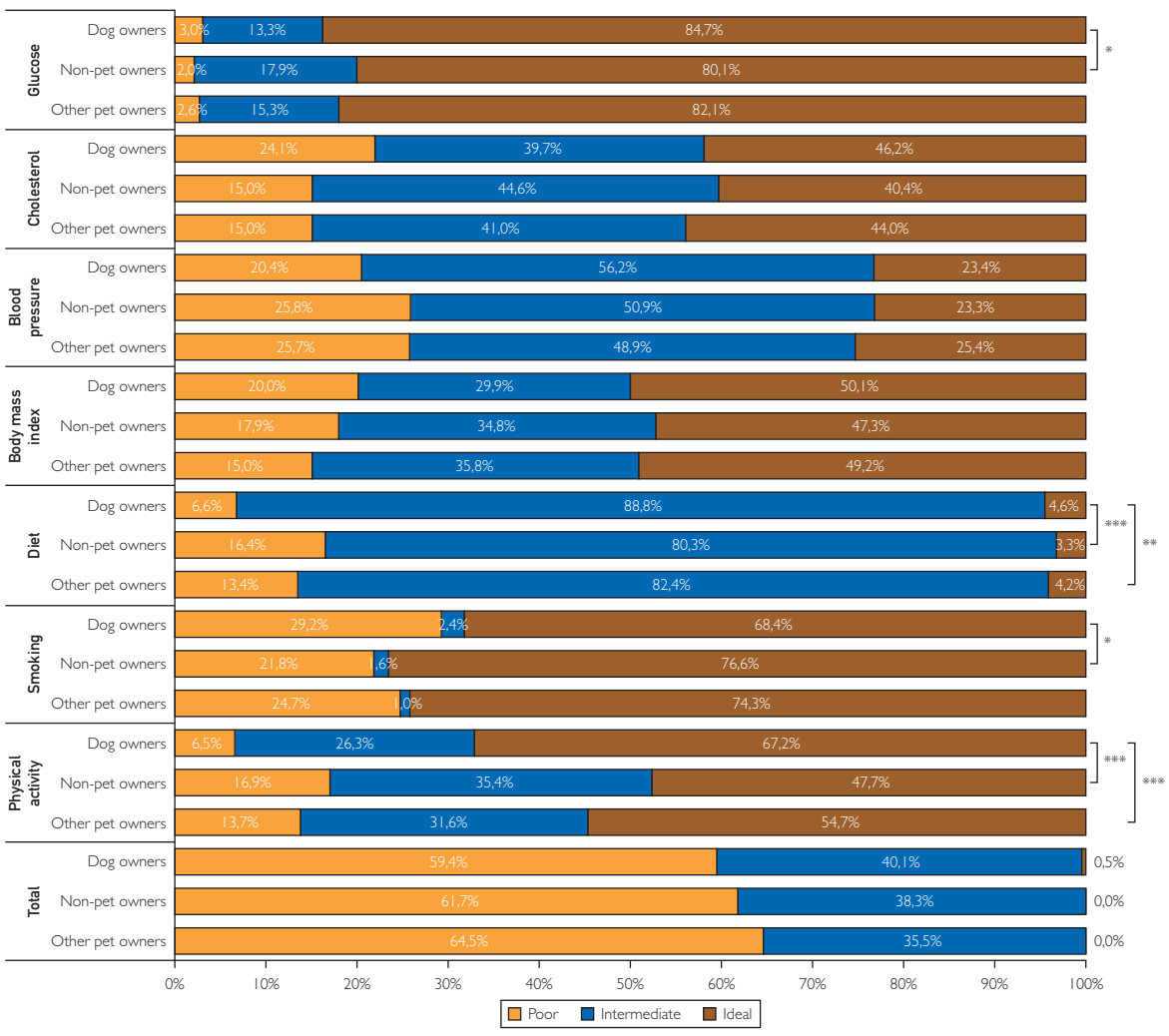

FIGURE 2. Distribution of cardiovascular health metrics and comparison between dog owners, non-pet owners, and owners of other pets. *$P<0.05$, **$P<0.01$, and ***$P<0.001$ based on the χ^2 test.

dog ownership on lipid profile, including those on HDL cholesterol, might be explained by an increased engagement in physical activity of people who own a dog. Indeed, dog walking appeared to be associated with lower total cholesterol levels and diabetes.[4] Regarding diabetes, however, evidence is currently controversial, as a previous study reported higher likelihood of diabetes in pet owners compared with non-owners, an inverse association probably due to confounding by indication.[10] Andersen et al[8] also showed that pet owners had significantly lower systolic blood pressure than non-owners, with slight differences between men and women. In line with this evidence, an online electronic survey reported higher risk of hypertension in dog non-owners compared to dog owners.[4] Nevertheless, conflicting data exist, as observed by Wright et al[10]: although blood pressure and incidence of hypertension appeared to be lower in pet owners than in non-owners, no associations were maintained after adjusting for potential confounders such as age, sex, BMI, antihypertensive treatment, physical activity, and diagnosis of diabetes. Other studies[33] including our analysis of the Kardiovize cohort, showed similar blood pressure levels between pet owners and non-owners.

These controversies might be attributed either to unmeasured factors or comorbid medical conditions; hence, future research should account for confounders using robust statistical analytical methodologies.[23] For instance, in the Kardiovize cohort, there were differences in social and behavioral factors between pet owners and non-owners that might partially explain our inconclusive findings on blood pressure. Particularly, people who owned pets, and specifically a dog, were less educated and more likely to smoke tobacco.

Overall, these findings suggested a positive effect of owning a dog on several behavioral and clinical CVD risk factors. However, CVDs are often multifactorial and previous studies did not evaluate the potential relationship between pet or dog ownership with CVH status, a composite measure that takes into account both clinical parameters (ie, BMI, blood pressure, blood glucose, and total cholesterol) and behaviors (ie, diet, physical activity, and smoking status).[3] To fill this gap, we first assessed the bivariate association between pet ownership and CVH, showing higher CVH scores among pet owners compared with people who did not own a pet. Particularly, pet owners were more likely to report CVH components at better levels, including physical activity, diet, and blood glucose, whereas smoking was more common. However, the association between pet ownership and higher CVH was not maintained after adjusting for age, sex, and educational level, suggesting that those confounding factors play a more important role in CVH than pet ownership. By contrast, owning a dog was associated with higher CVH score than people who did not own any pet even after adjusting for covariates. Indeed, except for smoking, dog owners were more likely to achieve the recommended intermediate/ideal level of behavioral (physical activity and diet) and clinical (blood glucose) CVH metrics than non-owners of pets, which translated into better CVH.

Dog owners exhibited better CVH even than non-owners of dogs, including owners of other pets, association mediated through more engagement in physical activity and healthier diet. Although the positive association between dog ownership and physical activity has been discussed previously, the association between pet ownership and dietary habits has not been extensively assessed. To our knowledge, only the study by Heuberger et al[34] reported differences in eating patterns among older adults owning or not owning a dog. How pet ownership may favor a healthier diet is yet to be determined.

Our study has several strengths. First, it was based on a randomly selected sample of the urban population of Brno, Czech Republic. Second, comprehensive health interviews and examinations were performed using standardized and validated protocols, which allowed use of a composite measure of CVH. Finally, the majority of the results are robust, as they were confirmed after adjusting for known confounders, and also by excluding people who owned dogs and other pets. Some limitations that warrant discussion include its cross-sectional design that precluded assessing causality of observed relationships. Moreover, we did not collect information about the duration of pet ownership. Thus, experimental studies will help to determine if pet ownership fosters better CVH and its components or if the owning a dog is only a marker of healthier lifestyle.

Moreover, the effect of unmeasured sociodemographic factors, behaviors, and comorbidities cannot be completely excluded. Additionally, pet ownership was self-reported and could not be validated in our survey.

CONCLUSION

In conclusion, pet ownership, especially dog ownership, is associated with CVH. Dog owners are more likely to achieve the recommended level of behavioral CVH metrics such as physical activity and diet than non-owners of dogs. The higher smoking rates among dog owners attenuate the association between dog ownership and CVH.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mayoclinicproceedings.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: **AHA** = American Heart Association; **BMI** = body mass index; **CVD** = cardiovascular disease; **CVH** = cardiovascular health; **IQR** = interquartile range

Potential Competing Interests: The authors report no conflicts of interest.

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