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A retrospective study of age-specific disease incidence in major popular breed dogs in Republic of Korea

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Abstract

Dogs exhibit patterns of health issues that vary by life stage. An understanding of disease incidence with respect to breed and age/life stage could be an important component of canine health management and welfare. This study aimed to describe the age-specific disease incidence of 3 small dog breeds that attended veterinary clinics in the Republic of Korea, based on data from electronic veterinary medical records (EVMRs). A total of 40,785 EVMRs from Maltese (n = 21,355), Miniature Poodle (n = 11,658) and Shih Tzu dogs (n = 7,772) were analyzed. Common health problems in 3 small dog breeds were 'diseases of the skin' and 'diseases of the ear,' respectively. Among dogs aged ≤ 3 years, 'preventive medicine' was the most common cause cited for veterinary clinic visits. Among dogs aged 4 to 8 years, the most frequent health problems were 'diseases of the skin.' Among dogs aged 9 to 13 years, 'heart diseases,' 'kidney diseases,' 'mammary gland tumor,' and 'neoplasia (unspecified)' were considerably more frequent, compared to the rates in dogs ≤ 3 years. Among dogs aged ≥ 14 years, 'heart diseases' and 'sneezing/cough' were the main health problems. In all breeds, the frequencies of 'diseases of circulatory system,' 'diseases of respiratory system,' 'diseases of the nervous system,' 'endocrine' and 'neoplasia' increased rapidly with aging. This surveillance could inform strategies for disease screening tests and management based on life stage in these dog breeds and enable more effective health management.

Keywords: dog; disease; veterinary clinics; medical records; epidemiology

Introduction

In veterinary practice, aging is an important factor in the incidence of disease among dogs, as well as in the associated diagnosis, treatment and mortality [1-9]. Therefore, an understanding of the occurrence of diseases with respect to the specific dog breed and age may be important to veterinary health management and welfare. Many reports have described breed-specific diseases associated with morphologic or genetic characteristics in purebred and small-breed dogs [10-13]. For example, in-breeds of brachycephalic dogs frequently experience ocular disorders throughout their lifespans due to morphological abnormalities [14]. In addition to breed-specific issues, differing trends in canine medical problems and mortality by life stage suggest that the prevalence of disease is also affected by age [3,5,6]. For example, younger dogs are more likely than older dogs to be exposed to infectious diseases, trauma (e.g., falls), accidents and fractures [1-4]. In contrast, the

incidence of progressive diseases such as mammary tumor, heart diseases, arthritis and traumatic injuries is relatively higher in older dogs [1,3,5,7,9].

Different types of data can be surveyed to determine the incidence of disease. Recently, quantitative data from a variety of medical records have been made available for health surveys of specific types of dogs treated in small animal veterinary practices [15,16]. Other evidence-based studies have collected data mainly from insurance records [3,5,6,8,17], veterinary referral clinical records [18,19], primary-care veterinary practice records [1,4,9,20,21] and questionnaire surveys [22–24]. Accordingly, these studies can serve as a resource for population-based medical studies of disease prevalence, incidence and epidemiology in small animals.

The most common varieties of dog in the Republic of Korea (ROK) are small breeds, of which Maltese, Miniature Poodle and Shih Tzu dogs are most popular, accounting for nearly 50% of all dogs in a previous survey [1]. As companion dogs have a long average lifespan, appropriate approaches are needed when preparing for health issues associated with age. However, to what extent the age-related dynamics of morbidity, comorbidity, and mortality affect these breeds remains unclear. This study aimed to describe the age-specific disease incidence of the Maltese, Miniature Poodle and Shih Tzu dogs that attended veterinary clinics in the ROK, based on data from electronic veterinary medical records (EVMRs).

Materials and Methods

Data collection

This article study approved by the Institutional Animal Care and Use Committee of the National Institute of Animal Science, Korea (approval number: NIAS-2017-257).

A total of 192,717 medical records of canine patients were collected from 16 veterinary clinics in 4 provinces of the ROK from 1 January 2015 to 31 December 2017. The practices were selected randomly according to geographic region (Seoul, Daegu, Gwangju and Jeollabuk-do). A proprietary EVMR system (Into Vet.; Into CNS, ROK) was used to collect the medical data. The collected animal information included the dates of visits, identification numbers, species, name of the animal, breed, date of birth and clinical notes, including the reason for visiting the veterinary clinic, symptoms/signs, major health problems and diagnosis. The personal information of the dog owners was removed.

Data processing

Among the 192,717 collected data sets from EVMRs between 1 January 2015 and 31 December 2017, data corresponding to Maltese (26.2%, $n = 50,477$), Miniature Poodle (12.4%, $n = 23,860$) and Shih Tzu dogs (11.6%, $n = 22,374$) were extracted. Data related to non-medical services such as grooming and boarding were excluded, and repeated ongoing events within individual cases were excluded to avoid duplication. However, visits for a single patient due to 2 or more different diseases were counted as 2 diseases. As a result, a total of 40,785 medical data records from Maltese ($n = 21,355$), Miniature Poodle ($n = 11,658$) and Shih Tzu dogs ($n = 7,772$) were analyzed.

Definition and classification

Within each breed, the dogs were classified into the following age groups: ≤ 3 years, 4 to 8 years, 9 to 13 years and ≥ 14 years. The most definitive diagnostic terms and/or 'symptoms and signs' were classified manually according to the International Classification of Diseases (ICD), 10th Edition categories as designated by the World Health Organization. For example, otitis externa was classified as 'diseases of the ear,' while heartworm disease was classified as 'certain infectious or parasitic diseases.'

The reasons for veterinary clinic visits were classified according to the 'symptoms and signs' category. For example, heart murmur, valve diseases and cardiomegaly were classified as 'heart diseases,' while chronic renal diseases, acute renal diseases, renal failure and nephritis were included in 'kidney diseases.' Tartar in the ear, pruritus in the ear (not specified) and bacterial infection in the ear were classified as 'otitis externa,' whereas Malassezia and Mite infection of the ear were marked separately. Regarding skin problems, certain non-specific lesions such as pruritus, redness, oedema and alopecia were included in 'dermatitis or eczema (unspecified).' Additionally, we made new distinct categories specific for the small animal practice setting such as 'dental care,' 'preventive medicine' and 'neutralisation surgery.' The demographic variables of the overall study population were analyzed. The proportions and 95% confidence interval (CI) were calculated for each ICD and symptoms/signs category according to age group.

Results

Demography

Table 1 presents the demography of the 3 small dog breeds based on EVMRs provided by veterinary clinics in the ROK from 1 January 2015 to 31 December 2017. Among Maltese dogs ($n = 21,355$), 36.3% (female, 37.1%; male, 62.6%) were

Table 1. Demography of the 3 small dog breeds based on electronic veterinary medical records provided by veterinary clinics in the Republic of Korea from 1 January 2015 to 31 December 2017

Breed	Age group (y)	Analyzed records (n, %)	Sex (%)		All records (n, %)	Average clinic visits (n)
			Female	Male		
Maltese	≤ 3	7,760 (36.3)	37.1	62.6	13,798 (27.3)	1.78
	4–8	6,868 (32.2)	32.1	67.1	15,190 (30.1)	2.21
	9–13	4,692 (22.0)	30.9	68.9	13,504 (26.8)	2.88
	≥ 14	1,929 (9.0)	39.6	44.3	7,791 (15.4)	4.04
	Total	21,355 (100)	33.0	66.4	50,477 (100)	2.36
Poodle	≤ 3	6,642 (57.0)	33.9	65.6	11,916 (49.8)	1.79
	4–8	3,029 (26.0)	32.2	67.4	5,954 (24.9)	1.97
	9–13	1,321 (11.3)	28.1	71.8	3,951 (16.5)	2.99
	≥ 14	605 (5.2)	30.1	68.8	1,993 (8.3)	3.29
	Total	11,658 (100)	32.6	66.9	23,909 (100)	2.05
Shih Tzu	≤ 3	1,382 (17.8)	35.3	60.8	2,270 (10.1)	1.64
	4–8	1,830 (23.5)	32.6	66.7	4,091 (18.3)	2.24
	9–13	2,486 (32.0)	31.5	67.7	6,904 (30.9)	2.78
	≥ 14	2,028 (26.1)	23.6	75.3	9,011 (40.3)	4.44
	Total	7,772 (100)	30.4	68.0	22,374 (100)	2.88

Unknown data were not included in this table (average 0.5% of the total data).

≤ 3 years of age, while 31.0% (female, 29.2%; male, 70.6%) were ≥ 9 years of age. Among Miniature Poodle dogs (n = 11,658), 57.0% (female, 33.9%; male, 65.7%) were ≤ 3 years of age, while 16.5% (female, 28.7%; male, 70.9%) were ≥ 9 years of age. Among Shih Tzu dogs (n = 7,772), 17.8% (female, 35.3%; male, 60.8%) were ≤ 3 years of age, while 58.1% (female, 27.96%; male, 28.0%) were ≥ 9 years of age, respectively.

Average number of clinic visits

A comparative analysis of the original records revealed that on average, Maltese dogs visited veterinary clinics 2.3 times during their lifespan (Table 1). An analysis stratified by age group indicated that dogs aged ≤ 3 years had visited veterinary clinics at least 1.7 times, whereas those aged ≥ 14 years had made 4.0 visits. Miniature Poodles visited veterinary clinics 2.0 times during their lifespan, and an analysis stratified by age group indicated that dogs aged ≤ 3 years had visited veterinary clinics at least 1.7 times, whereas dogs aged ≥ 14 years had visited clinics 3.2 times. Shih Tzu dogs had visited veterinary clinics at least 2.8 times during their lifespan. In an analysis stratified by age group, dogs aged ≤ 3 years had made an average of 1.6 visits to veterinary clinics, while dogs aged ≥ 14 years had visited 4.4 times.

Common disorders and reasons for visiting veterinary clinics among all dog breeds

To determine the differences in the disease incidence of 3 small-breed dogs depending on their age, we analyzed the

EVMRs results of each age group (Figs. 1, 2). As shown in Fig. 1, the most common disorders affecting Maltese dogs included diseases of the skin (14.0%; 95% CI, 13.57%–14.50%) and diseases of the ear (12.2%; 95% CI, 11.73%–12.60%). The most common reason for visiting the veterinary clinic was otitis externa (9.9%; 95% CI, 9.47%–10.27%), followed by dermatitis or eczema (unspecified) (7.7%; 95% CI, 7.35%–8.06%). In Miniature Poodles, the most common disorders were diseases of the digestive system (15.4%; 95% CI, 14.54%–16.15%), followed by preventive medicine (12.4%; 95% CI, 11.62%–13.08%). Otitis externa (9.2%; 95% CI, 8.51%–9.79%) was the most common reason for visiting a veterinary clinic, followed by vaccination (9.0%; 95% CI, 8.40%–9.67%). In Shih Tzu dogs, the most common disorder was diseases of the skin (18.1%; 95% CI, 17.22%–18.93%), followed by diseases of the visual system (14.0%; 95% CI, 13.20%–14.74%). Dermatitis or eczema (unspecified) (9.7%; 95% CI, 9.07%–10.39%) was the most common reason for visiting a veterinary clinic, followed by otitis externa (6.9%; 95% CI, 6.25%–7.37%). These data, as well as the frequencies of other reasons cited for veterinary clinic visits, are presented in Supplementary Tables 1–3.

Maltese

In Maltese dogs, among those aged ≤ 3 years, otitis externa was cited as the most common reason for visiting the clinic (10.7%; 95% CI, 10.27%–11.10%), followed by vaccination (10.6%; 95% CI, 10.18%–11.01%). In aged 4 to 8 years, the most common reason for a veterinary clinic visit was otitis externa

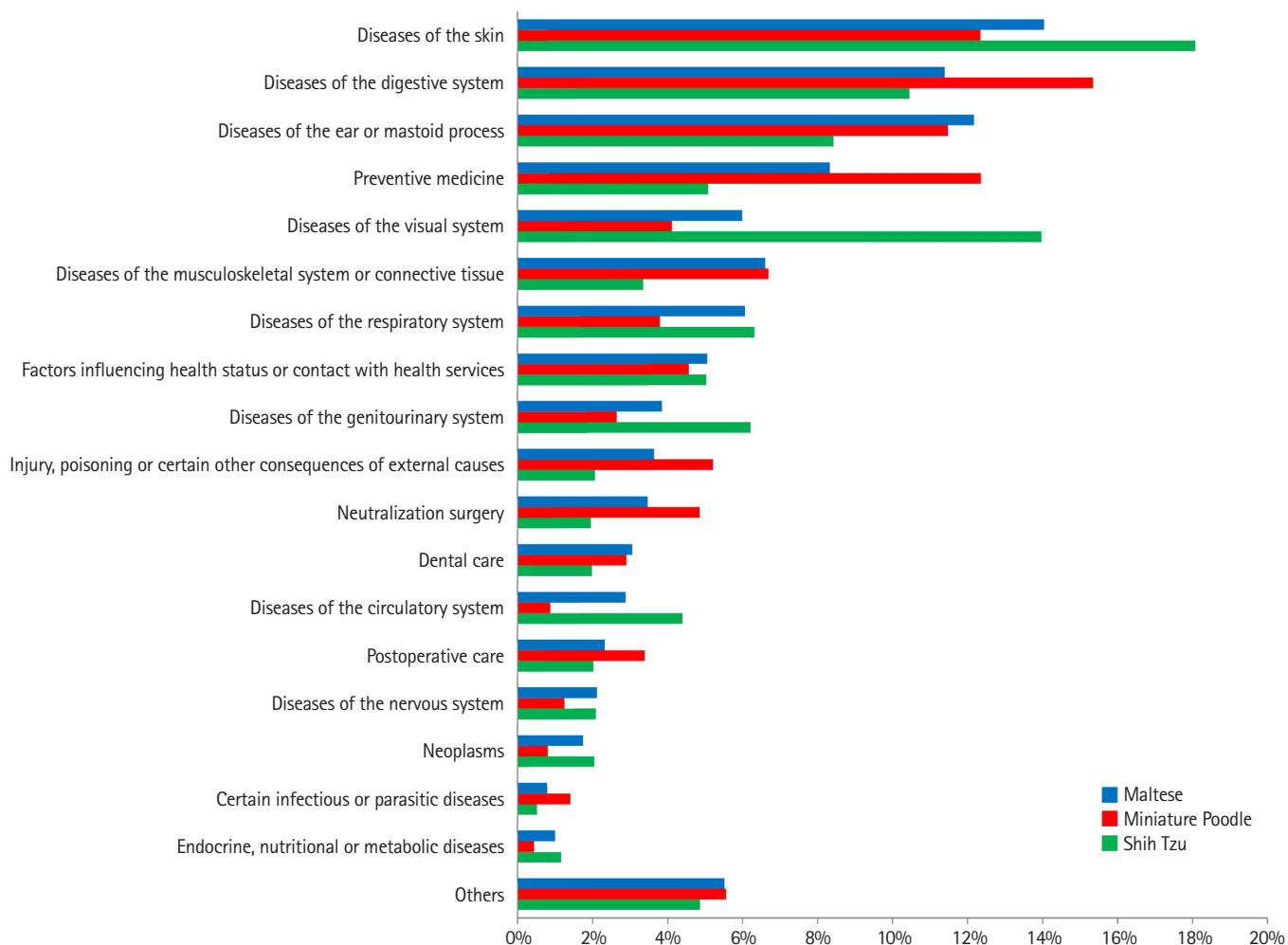


Fig. 1. Proportion of the most frequent disorders analyzed from electronic veterinary medical records in each breed of Maltese, Miniature Poodle, and Shih Tzu.

(12.2%; 95% CI, 11.73%–12.61%), dermatitis or eczema (unspecified) (9.7%; 95% CI, 9.34%–10.14%). In aged 9 to 13 years, diseases of the skin was the most common veterinary issue, followed by diseases of the digestive system (10.3%; 95% CI, 9.87%–10.68%). Heart diseases (5.8%; 95% CI, 5.53%–6.15%), kidney diseases (1.2%; 95% CI, 1.01%–1.29%), sneezing/cough (3.7%; 95% CI, 3.50%–4.01%), respiratory disorders (unspecified) (3.1%; 95% CI, 2.86%–3.32%), mammary gland tumor (2.1%; 95% CI, 1.94%–2.32%), and neoplasia (unspecified) (2.0%; 95% CI, 1.77%–2.15%) were reported more frequently in this group, compared with dogs aged ≤ 3 years. For dogs aged ≥ 14 years, sneezing/cough (4.3%; 95% CI, 4.03%–4.57%), respiratory disorders (unspecified) (3.6%; 95% CI, 3.33%–3.83%), lameness (3.2%; 95% CI, 2.93%–3.40%) and kidney diseases (2.3%; 95% CI, 2.13%–2.54%) were also important health problems affecting very old Maltese dogs. Detailed disease incidence

rates for Maltese are shown in [Supplementary Table 1](#).

Miniature Poodle

In Miniature Poodles aged ≤ 3 years, the most common reason for a veterinary clinic visit was vaccination (12.7%; 95% CI, 11.88%–13.48%), followed by otitis externa (9.1%; 95% CI, 8.37%–9.77%). In aged 4 to 8 years, the most common reasons for a clinic visit were otitis externa (11.0%; 95% CI, 9.91%–12.14%), dermatitis or eczema (unspecified) (7.9%; 95% CI, 6.93%–8.85%). In aged 9 to 13 years, the frequencies of visits for heart diseases (4.2%; 95% CI, 3.09%–5.24%) and mammary gland tumor (1.9%, 95% CI, 1.16%–2.63%) were greatly increased relative to those in younger age groups. In aged ≥ 14 years, health services (6.1%; 95% CI, 4.21%–8.03%) was cited most frequently as the reason for a veterinary clinic visit, although otitis externa (4.1%; 95% CI, 2.55%–5.72%), sneezing/

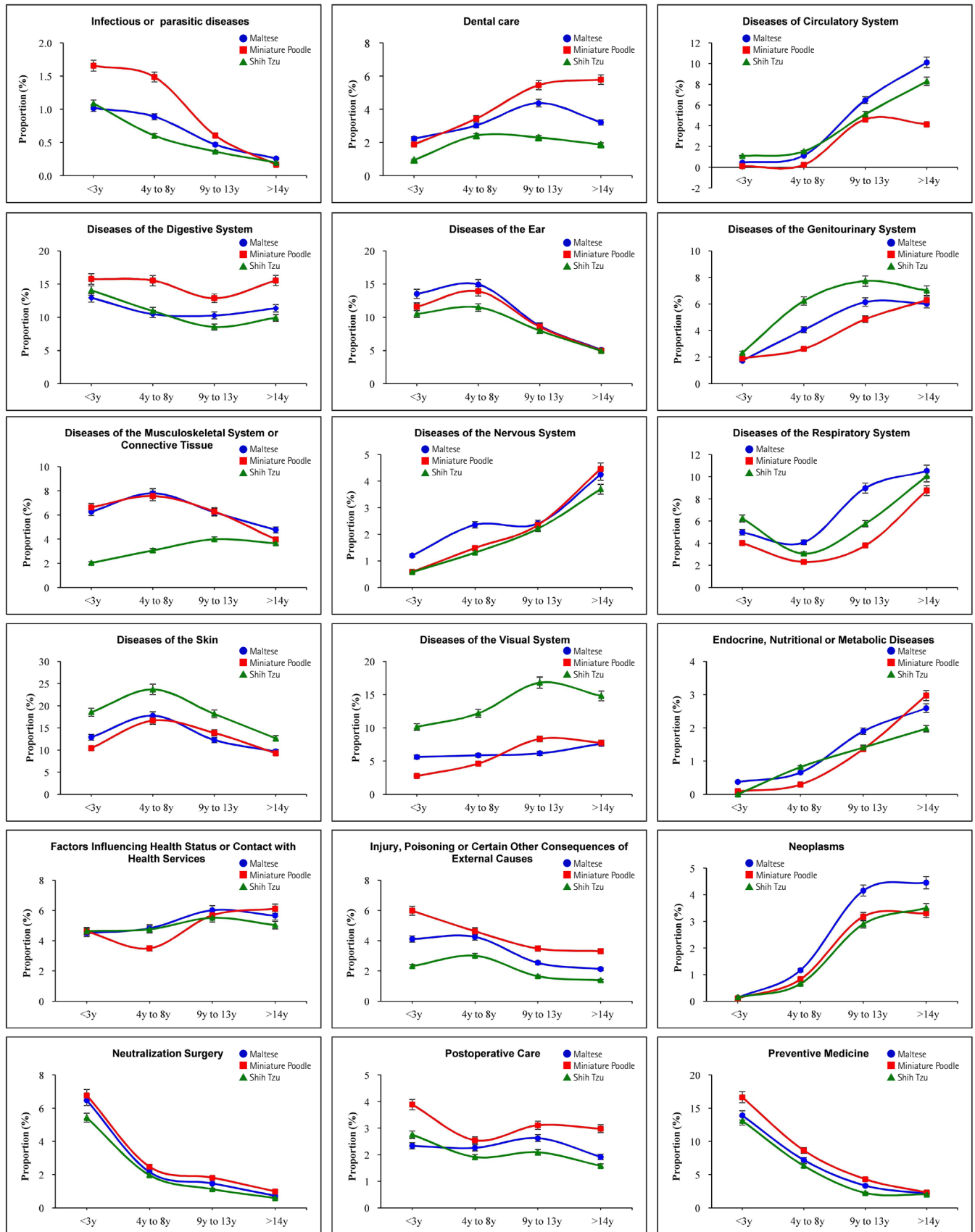


Fig. 2. Proportion of the most frequent disorders analyzed from in each age group of Maltese, Miniature Poodle, and Shih Tzu.

cough (4.3%; 95% CI, 2.68%–5.91%), dermatitis or eczema (unspecified) (4.0%; 95% CI, 2.41%–5.52%), heart diseases (3.8%; 95% CI, 2.28%–5.33%) were also important health problems in this age group. Detailed disease incidence rates for Miniature Poodle are shown in [Supplementary Table 2](#).

Shih Tzu

In Shih Tzu dogs aged ≤ 3 years, vaccination (10.0%; 95% CI, 8.40%–11.57%) was the most common reason for visiting a clinic, followed by dermatitis or eczema (unspecified) (9.8%; 95% CI, 8.27%–11.41%), otitis externa (8.0%; 95% CI, 6.60%–9.46%) and neutralisation surgery (5.4%; 95% CI, 4.23%–6.62%). In aged 4 to 8 years, diseases of the skin (23.7%; 95% CI, 21.71%–25.61%) was the most common veterinary issue, followed by diseases of the visual system (12.2%; 95% CI, 10.69%–13.68%), and diseases of the ear (11.5%; 95% CI, 10.02%–12.94%). In aged 9 to 13 years, dermatitis or eczema (12.1%; 95% CI, 10.58%–13.57% and 10.9%, 95% CI: 9.64%–12.08%, respectively) and otitis externa (9.3%; 95% CI, 7.96%–10.62% and 6.7%; 95% CI, 5.73%–7.70%, respectively) were the most common health problems. However, disorder of orbit (unspecified) (4.1%; 95% CI, 3.32%–4.88%), keratitis (4.0%; 95% CI, 3.25%–4.79%) and conjunctivitis (3.5%; 95% CI, 2.81%–4.27%) within the category diseases of the visual system, as well as other specified benign proliferation in skin (2.7%; 95% CI, 2.02%–3.29%) within the category diseases of the skin, were greatly increased in dogs aged 9 to 13 years, compared to those aged ≤ 3 years. Among Shih Tzu dogs aged ≥ 14 years, heart diseases (7.3%; 95% CI, 6.12%–8.38%), disorder of orbit (unspecified) (5.3%; 95% CI, 4.39%–6.36%) and respiratory disorder (unspecified) (4.3%; 95% CI, 3.45%–5.23%) were the most frequent reasons for clinic visits. Detailed disease incidence rates for Shih Tzu are shown in [Supplementary Table 3](#).

Discussion

This study based on EVMRs from veterinary clinics in the ROK used recorded ICD categories and signs/symptoms to evaluate the prevalence of diseases associated with age in 3 small dog breeds, including Maltese, Miniature Poodle and Shih Tzu.

Age is the single greatest predictor of morbidity and mortality in humans. Like humans, companion dogs exhibit age-related increases in many chronic conditions and disease incidence rates differed with age [1,3,7]. In our analysis, age was directly related with the prevalence of specific diseases or reasons cited for veterinary clinic visits. Vaccination, otitis externa, neutrali-

sation surgery, vomiting, and diarrhoea were the most common causes cited for veterinary clinic visits among all dogs aged ≤ 3 years. Similar results were observed in other studies, suggesting that these conditions are influenced by age, rather than breed [1,3,17,25].

Specifically, this study revealed that the prevalence of ‘diseases of the circulatory system,’ ‘diseases of the genitourinary system,’ ‘diseases of the nervous system,’ ‘endocrine, nutritional or metabolic diseases’ and ‘neoplasms’ increased remarkably with age, particularly among dogs over 9 years old. Particularly, signs and symptoms such as ‘heart diseases,’ ‘Respiratory disorder (unspecified),’ ‘Mammary gland tumor,’ ‘neoplasia (unspecified),’ ‘other specific benign proliferation in skin,’ ‘inflammatory diseases of uterus,’ ‘gingival diseases’ and ‘kidney diseases’ increased considerably between 9 and 13 years of age, while ‘heart diseases’ was a major issue in all dogs of all 3 breeds aged ≥ 14 years.

In contrast, the incidence of certain diseases, such as circulatory diseases, Diseases of visual system occurred differently depending on breed. For example, in Shih Tzu dogs ‘diseases of the visual system’ was the second most frequent disease category overall and continued to increase in frequency with aging, along with signs and symptoms such as ‘keratitis,’ ‘conjunctivitis’ and ‘glaucoma.’ On the other hand, the proportions of cases involving trauma/injury and fracture of external causes were higher in Miniature Poodles than in their counterparts of other breeds. These differences suggest that not only age but breed-specific external and/or internal risk factors affect the observed disease incidences [5,10].

Previous studies identified that diseases gastrointestinal disorders, skin and/or ear problems, oral diseases and cardiovascular diseases were common medical disorders affecting companion dogs [1,3,9,17,22]. Our findings show that digestive diseases, skin and ear problems occur at a high rate throughout life in analyzed dogs. Digestive diseases are relatively common in veterinary practice and can affect dogs of all ages, breeds, and sizes. These conditions can vary in severity, ranging from mild gastrointestinal upset to more serious and life-threatening illnesses. It has been reported to have a direct effect on mortality, especially in young dogs [3,5,7]. Although skin and/or ear diseases do not account for all causes of mortality in the literature, these illnesses contribute to the risk of death in aging populations and affect the health-related quality of life of affected dogs and their owners [26,27].

Although it has been generally recognized that age and breed affect disease development patterns, this study shows evidence-based analysis of specific disease development patterns

through EVMRs in 3 different small breeds that make up the majority of the population's companion dogs in ROK. Therefore, the results of this study will provide specific and practical information to the field of veterinary medicine and may help dog owners to prepare health care plans suitable for the life stages of their dogs. The severity level, duration, and recurrence status of canine diseases may have significant effects on the lives of owners, including their emotional and financial condition. Therefore, it is necessary to establish regular canine health care plans specific for ages and breeds.

When interpreting the data from this study, it should be noted that the overall disease prevalence might have been inflated by the predominance of a certain breed or age group. Among younger dogs, the proportion of Miniature Poodles (57.0%) was higher than those of the other breeds (Maltese, 36.3%; Shih Tzu, 17.8%) in the same age group, whereas Shih Tzu dogs accounted for the highest proportion (26.1% vs. Maltese, 9.0% and Miniature Poodle, 5.2%) among very old dogs (≥ 14 years). Thus, the high incidence of a few diseases among the overall study population might be unrepresentative with respect to the breeds or age groups included in our study. The data should be interpreted cautiously with respect to the prevalence of diseases according to age within each breed. Additionally, the quality and reliability of the analysis depend on the completeness and accuracy of the collected data, and the proportion of each disease category may differ depending on the method of disease classification. In this study, the diseases and signs/symptoms were classified into limited categories and subcategories. Consequently, various signs and symptoms were simplified and included in certain disease categories. For example, a wide range of clinical signs, including itching, redness, scales and alopecia of non-specific cause, may have been classified as 'diseases of the skin' or 'dermatitis and eczema (unspecified)'. These classifications may have affected the interpretation of the results and could have increased or decreased the proportions of certain categories or subcategories relative to those of other categories. Although a previous study suggested that the use of EVMRs was limited by frequent inaccuracy, incompleteness and complexity [25,28–30], our study involved a large-scale analysis of population and medical data from these records. Therefore, the presence of a few errors or misclassifications derived from insufficient information might not have significantly affected the overall disease proportions in this study.

EVMRs based analysis of disease occurrence patterns in companion dogs is a data-driven approach that involves analyzing electronic medical records of companion dogs to identify patterns and trends related to disease occurrences. This type of

analysis can provide valuable insights for veterinarians, researchers, and pet owners, leading to better understanding and management of various diseases affecting dogs. The findings from this study could provide educational information, improve disease prevention strategies and enable dog owners to manage expected health problems earlier and more effectively. The study findings may also enable veterinary practitioners to develop prioritised age- and breed-specific diagnostic plans for these 3 dog breeds. Additionally, EVMRs based analysis can be a powerful tool in advancing veterinary medicine and improving the health and well-being of companion dogs.

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Supplementary Materials

Supplementary data are available at <https://doi.org/10.14405/kjvr.20230029>.

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