

Prevalence of feline hyperthyroidism in mature cats in urban population in Warsaw

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Abstract

The purpose of this study was to assess the prevalence of feline hyperthyroidism in a cat population in Warsaw, considering risk factors. The study was conducted between June 2007 and July 2011. Seven-year-old and older cats were examined. Diagnosis of feline hyperthyroidism was based on the results of clinical examination, data from clinical history, and serum concentrations of thyroid hormones. Hyperthyroidism was diagnosed in 20.14% of 417 cats (95% confidence interval (CI): 16.28%–24.01%). Statistically significant risk factors were age (odds ratio (OR) = 1.17; 95% CI: 1.08–1.27), feeding with a commercial wet feed (OR = 6.74, 95% CI: 2.03–22.37), and an indoor lifestyle (OR = 2.25, 95% CI: 1.04–4.84). There were no effects of breed, gender, castration, or the frequency of deworming on the occurrence of hyperthyroidism. Feline hyperthyroidism in Warsaw is a prevalent disease. This probably results from chronic exposure to dietary and environmental factors.

Key words: cat, feline hyperthyroidism, prevalence, risk factors.

Introduction

Feline hyperthyroidism is an endocrine disease of middle-aged and elderly cats, caused by excessive production and secretion of thyroid hormones by the thyroid gland. Iodine deficiency or excess in the diet, or changing levels of dietary iodine probably contribute to the development of the disease (1, 4, 11, 14). Moreover, dietary goitrogens such as soy isoflavones present in commercial cat feed may also have an impact the occurrence of feline hyperthyroidism (14). Other authors also suggested that long-term exposure to polybrominated diphenyl ethers (PBDEs), used as fire retardants, or genetic mutations may cause the development of feline hyperthyroidism (3, 15). Increasing age, canned wet feed, fish in the diet, female gender, indoor housing, domestic shorthair breed (or non-pure breed), sleeping on the floor, and lack of deworming have all been described as risk factors of feline hyperthyroidism (2, 5, 8, 13, 18, 19).

Although feline hyperthyroidism is one of the most common diseases of geriatric cats, there are only

a few studies on the prevalence and risk factors of the disease in the world. Research on the prevalence of feline hyperthyroidism has been conducted in the United States, United Kingdom, Spain, Germany, Hong Kong, and Japan (2, 5, 10, 12, 17).

The purpose of this study was to examine the occurrence of feline hyperthyroidism and identification of risk factors of the disease in cats in Warsaw.

Material and Methods

The prospective study was conducted between June 2007 and July 2011. One thousand three hundred and eighty-six seven-year-old and older cats presented to the veterinary clinic due to various reasons were examined. Cats treated with glucocorticoids and/or sulphonamides, animals after surgery, and cats with shock were excluded from the study (955 cats). Four hundred and thirty-one cats were included in this study.

Cats' age, breed, gender, castration, indoor housing, regular use of commercial wet feed in the diet,

and frequency of deworming were examined, as these factors are associated with a possible risk of hyperthyroidism development. Cats that spent at least half of their time outside (as declared by the owners) were considered as outdoor cats. Cats that spent less than half of their time outside or were outside only occasionally (e.g. in summer) were considered as indoor cats. Cats were also divided into groups based on health status: group A included cats with no clinical and laboratory signs of any disease, group B comprised cats diagnosed with diseases other than hyperthyroidism, while group C consisted of cats diagnosed with hyperthyroidism.

Serum was obtained by centrifugation of blood samples without an anticoagulant. The blood samples were collected from cats in the morning. Diagnosis of hyperthyroidism was based on the results of clinical examination, data from medical history, and concentration of total T4 (TT4). Lack of clinical signs of hyperthyroidism and a concentration of TT4 within reference intervals allowed exclusion of hyperthyroidism. In cats with clinical signs of hyperthyroidism but with a TT4 concentration within reference (10–30 ng/mL) or non-diagnostic intervals (30–50 ng/mL), or cats without clinical signs of hyperthyroidism but with an increased TT4 concentration, clinical examination was repeated after 14 to 28 d and concentrations of TT4 and free T4 (FT4; reference interval 1–4 ng/dL) allowed to confirm or exclude hyperthyroidism. In one cat, diagnosis of hyperthyroidism was confirmed by histopathology of the thyroid gland after euthanasia due to other severe systemic disease.

Concentrations of TT4 and FT4 were determined in a commercial veterinary laboratory in Warsaw (Veterinary Diagnostic Laboratory–Lab-Wet) using a clinical immunoassay analyser DPC IMMULITE ONE (Siemens Medical Solutions Diagnostics) and diagnostic kits IMMULITE Total T4 and IMMULITE Free T4 (Siemens Healthcare Diagnostics).

The results were analysed using the Statistica 8.0 programme. Shapiro–Wilk's *W* test was used to estimate normality of cats' age distribution in groups A, B, and C. Kruskal–Wallis test was used to compare the age of cats between groups A, B, and C. The χ^2 test was used to compare the prevalence of hyperthyroidism between groups. Using a multivariable logistic regression model, odds ratios (OR) along with 95% confidence intervals (95% CI) were calculated for variables in order to estimate the risk factors. A value of $P < 0.05$ was considered as significant.

Results

In 417 out of 431 cats hyperthyroidism was diagnosed or excluded. Fourteen cats were eliminated from the study because they were not brought to the

clinic for re-examination for confirmation or exclusion of hyperthyroidism.

The age of the cats was between 7 and 19 years ($\bar{x} = 11.9$ years $\pm$ SD = 3.21 years). The number of cats in the different age groups is shown in Table 1. The cats examined belonged to 15 breeds. Fifteen cats belonged to the group of longhair cats (3.6% of cats), 24 cats belonged to the group of semi-longhair cats (5.75% of cats), 360 belonged to the group of shorthair cats (86.33% of cats), and 18 cats belonged to the group of Siamese and Oriental shorthair cats (4.32% of cats).

Among 417 cats, 212 were males (50.84%; 95% CI: 46.02%–55.66%) and 205 were females (49.16%; 95% CI: 44.34%–53.98%). Three hundred and ninety-two cats were castrated (94.01%; 95% CI: 91.72%–96.29%), while 25 individuals were not castrated (5.99%; 95% CI: 3.71%–8.28%). Data on the number of castrated and intact males and females is shown in Table 1. Three hundred and thirty-seven cats were indoor cats (80.82%; 95% CI: 77.02%–84.61%), while 80 cats were outdoor cats (19.18%; 95% CI: 15.39%–22.98%). Three hundred and fifty-two cats were fed commercial wet feed (84.41%; 95% CI: 80.92%–87.91%) and 65 cats were not fed commercial wet feed (15.59%; 95% CI: 12.09%–19.08%). The 417 examined cats were dewormed during the last 5 years from 0 to 4 times a year (median = 1, 25th–75th: 1–1, $\bar{x} = 1.057 \pm$ SD = 0.524 deworming per year). In the last 5 years, 16 cats were not dewormed, 66 cats were dewormed every second year, 266 cats were dewormed once a year, 66 cats were dewormed twice a year, two cats were dewormed three times per year, and one cat was dewormed four times per year.

Out of 417 examined cats, 124 (29.74%; 95% CI: 25.33%–34.14%) were considered as healthy cats (no clinical and laboratory signs of any disease; group A); in 209 cats (50.12%; 95% CI: 45.30%–54.94%) diseases other than hyperthyroidism were diagnosed (group B); in 84 cats (20.14%; 95% CI: 16.28%–24.01%) hyperthyroidism was diagnosed (group C). Moreover, in 29 out of the 84 hyperthyroid cats (34.52%; 95% CI: 24.14%–44.90%) one or two other concurrent diseases were diagnosed. Hepatitis, hypertrophic cardiomyopathy, chronic renal insufficiency, and tumours of the small intestine were the most prevalent diseases in the 29 hyperthyroid cats. In one cat, previously suspected of hyperthyroidism (mildly increased level of TT4 above reference interval, and enlargement of the right lobe of the thyroid gland in palpable and ultrasound examination), adenomatous hyperplasia was diagnosed histopathologically. This case was described in detail in previous work (6).

Shapiro–Wilk's *W*-test for normality in the values of cats' age showed a lack of normal distribution in all three groups: A ($N = 124$, $W = 0.9373$, $P = 0.000021$), B ($N = 209$, $W = 0.9505$, $P = 0.000001$), and C ($N = 84$, $W = 0.9571$, $P = 0.006903$). The comparison of the cats' age in groups A, B, and C showed statistically

significant differences between medians of all three groups (Table 2). Median of age of cats in group A was $M_A = 11$ (25th% = 8, 75th% = 13, Min. = 7, Max. = 18). Median of age of cats in group B was $M_B = 12$ (25th% = 9, 75th% = 15, Min. = 7, Max. = 19). Median of age of cats in group C was $M_C = 13$ (25th% = 11, 75th% = 15, Min. = 7, Max. = 19). The prevalence of hyperthyroidism in different age groups of cats is shown in Table 3. The results of the χ^2 tests showed that the main differences in the prevalence of hyperthyroidism were between 15-year-old cats and cats younger than 13 years of age (single results of all comparisons not shown).

The prevalence of hyperthyroidism in different breed groups of cats is shown in Table 4. Comparison of the prevalence of hyperthyroidism in breed groups did not show any differences (data not shown).

Hyperthyroidism was diagnosed in 42 out of 205 female cats (20.49%; 95% CI: 14.92%–26.06%) and in 42 out of 212 male cats (19.81%; 95% CI: 14.40%–25.22%). The χ^2 test used for comparison of the prevalence of hyperthyroidism in females and males showed no statistically significant differences ($\chi^2 = 0.03$, $P = 0.8633$).

Hyperthyroidism was diagnosed in 82 out of 392 castrated cats (20.92%; 95% CI: 16.87%–24.96%), and in two out of 25 intact cats (8.00%; 95% CI: -3.43%–19.43%). The χ^2 test used for comparison of the

prevalence of hyperthyroidism in castrated and intact cats showed no statistically significant differences ($\chi^2 = 2.44$, $P = 0.1184$).

Hyperthyroidism was diagnosed in 75 out of 337 indoor cats (22.25%; 95% CI: 17.79%–26.72%) and in nine of 80 outdoor cats (11.25%; 95% CI: 4.17%–18.33%). The χ^2 test used for comparison of the prevalence of hyperthyroidism in indoor and outdoor cats showed a statistically significant difference ($\chi^2 = 4.87$, $P = 0.0274$).

Hyperthyroidism was diagnosed in 81 out of 352 cats fed commercial wet feed (23.01%; 95% CI: 18.59%–27.43%) and in three out of 65 cats not fed commercial wet feed (4.61%; 95% CI: -0.62%–9.85%). The χ^2 test used for comparison of the prevalence of hyperthyroidism in cats fed commercial wet feed and cats not fed commercial wet feed showed statistically significant difference ($\chi^2 = 11.54$, $P = 0.0007$).

Model of multivariable logistic regression showed that there were no effects of gender ($P = 0.914213$), castration ($P = 0.112842$), or the frequency of deworming ($P = 0.430044$) on the occurrence of hyperthyroidism. The age of cats, indoor lifestyle, and the use of commercial wet feed in feeding were retained in the final model of logistic regression for feline hyperthyroidism risk factors (Table 5).

Table 1. The number of cats in different age groups

Age group		7	8	9	10	11	12	13	14	15	16	17+	Sum
Males	Castr.	20	16	22	16	22	21	29	17	16	14	14	207
	Intact	2	1	1	1	0	0	0	0	0	0	0	5
Females	Castr.	14	26	12	19	12	15	16	18	19	17	17	185
	Intact	3	1	2	1	0	3	3	1	4	1	1	20
Sum		39	44	37	37	34	39	48	36	39	32	32	417

Castr. – castrated cats. The ‘17+’ group included cats aged from 17 to 19 years (16 cats, 17-year-old; 10 cats, 18-year-old; 6 cats, 19-year-old)

Table 2. Statistical significance between age of cats from groups A, B, and C calculated with Kruskal-Wallis test ($H = 30.33555$, $P < 0.001$). The Table shows the P values

Differences between groups	Group B	Group A	Group C
Group B	-	0.000384	0.041771
Group A	0.000384	-	0.000000
Group C	0.041771	0.000000	-

Table 3. The prevalence of hyperthyroidism in different age groups of cats

Age group (years)	Number of hyperthyroid cats/number of cats in age group	Prevalence in particular age group	95% CI
7	1/39	2.56%	-2.63% – 7.75%
8	7/44	15.91%	4.66% – 27.16%
9	3/37	8.11%	-1.12% – 17.33%
10	6/37	16.22%	3.76% – 28.67%
11	6/34	17.65%	4.15% – 31.15%
12	6/39	15.38%	3.54% – 27.23%
13	15/48	31.25%	17.65% – 44.85%
14	9/36	25.00%	10.14% – 39.86%
15	17/39	43.59%	27.30% – 59.87%
16	8/32	25.00%	9.14% – 40.86%
≥17	6/32	18.75%	4.45% – 33.05%

95% CI, 95% confidence interval

Table 4. The number of hyperthyroid cats belonging to different breed groups (95% CI, 95% confidence interval)

Breed group	Number of hyperthyroid cats/number of cats in breed group	Prevalence in particular breed group	95% CI
Longhair cats	4/15	26.67%	1.32% – 52.02%
Semi-longhair cats	4/24	16.67%	0.59% – 32.74%
Shorthair cats	74/360	20.55%	16.36% – 24.75%
Siamese and Oriental Shorthair cats	2/18	11.11%	-4.97% – 27.19%

95% CI, 95% confidence interval

Table 5. Model of multivariable logistic regression for hyperthyroidism risk factors in cats between 7 and 19 years old from Warsaw using Rosenbrock and quasi-Newton estimation method ($\chi^2 = 35.795$, $P < 0.001$). A value of $P < 0.05$ is considered as statistically significant

Independent variable	OR	95% CI	P
Age of cats	1.17	1.08 – 1.27	0.000096
Indore lifestyle	2.25	1.04 – 4.84	0.037655
Use of commercial wet food	6.74	2.03 – 22.37	0.001775

OR – odds ratio, 95% CI – 95% confidence interval, P – a value of P

Discussion

The prevalence of hyperthyroidism in middle-aged and elderly cats from Warsaw amounted to over 20%. However, 955 cats were excluded from this study owing to the exclusion criteria, and cats younger than 7-years-old were not examined. Thus, the real prevalence of hyperthyroidism in cats from Warsaw is likely to be rather lower, especially in younger cats, but in comparison with the results of previous research in other regions seems to be very high (2, 5, 10, 17).

In the United States, in a 20-year study (1978-1997) hyperthyroidism was diagnosed in 3570 cats out of 169 576, representing 2.1% of cats (5). However, in that work all animals at the age of four years and older were examined. Moreover, the occurrence of hyperthyroidism in cats has increased since 1979 (14). Edinboro *et al.* (5) showed that age-adjusted prevalence increased from 0.1% to 2% in 1978-1997 in the United States. Mooney (11) pays attention to increased longevity in cats; with an increased risk of the occurrence of the disease in older cats. This may lead to an increased number of cases of hyperthyroidism in the cat population.

Similarly, the relatively low percentage of cases of hyperthyroidism observed in the United States has also been reported in Spain and Hong Kong (2, 12). Higher prevalence of hyperthyroidism in cats was found in Japan, the United Kingdom, and Germany (10, 12, 17).

It seems probable that the observed phenomenon of increasing prevalence of feline hyperthyroidism may be one of the reasons of the high prevalence of this disease observed in the presented study in comparison with the previous results (5, 14).

One of the major factors that increases the risk of feline hyperthyroidism is the increasing age (19). The current study showed that each additional year of age increased the risk of developing hyperthyroidism 1.17-fold in 7-year-old to 19-year-old cats. This result is

similar to the results from the United Kingdom and the United States (5, 19).

In this research, a higher incidence of hyperthyroidism was found in indoor cats, which is consistent with the literature (12, 18). However, Kass *et al.* (8) demonstrated that a clear link between the decreased risk of hyperthyroidism and outdoor lifestyle occurs only when the cats spend more than half the time away from home. Olczak *et al.* (13) also showed that sleeping on the floor increases the risk of developing hyperthyroidism over six-fold. These data suggests the contribution of an environmental factor (or group of factors) present at homes in the development of feline hyperthyroidism. Dye *et al.* (3) suggested that PBDEs may belong to such factors. PBDEs are fire retardants used in the production of many goods present in the household such as: plastic materials, furniture, or electronic stuff. Currently, these compounds are used in production of the majority (90%) of electrical and electronic equipment, but they also contribute to permanent environmental contamination (7). Dye *et al.* (3) detected a significantly higher concentration of PBDE congeners in the serum of cats compared to human serum. Moreover, this concentration was higher in older cats, and the highest mean concentration of these compounds was observed in cats with hyperthyroidism. In addition, a higher accumulation of some PBDEs in cats with hyperthyroidism in comparison with other cats was observed in that study. The authors also found that concentrations of PBDEs in the serum of indoor cats were 5-fold higher than in the serum of outdoor cats (3). Mensching *et al.* (9) have also detected higher concentration of total PBDE in the serum of client-owned cats than in feral cats; this resulted from the fact that house dust contains significant quantities of these compounds. Mensching *et al.* (9) also showed that the concentration of PBDEs in dust from homes of hyperthyroid cats was higher than in dust from homes

of euthyroid cats. Thus, it may be assumed that the increased risk of hyperthyroidism in indoor cats is mainly the result of higher exposure to PBDEs.

The presented study shows a significantly higher incidence of hyperthyroidism in cats fed commercial wet feed. This result is consistent with literature data, according to which wet feed is one of the major risk factors of hyperthyroidism (4). Other authors have also shown that the use of wet canned feed increases 2-4-fold the risk of hyperthyroidism in cats (5, 8, 13, 19). Dye *et al.* (3) investigated the presence of different proportions of PBDE congeners in the serum of cats fed with wet and dry commercial feeds; it was found that PBDE congeners BDE-47 and BDE-99 were dominant in the serum of cats fed wet feed, while in cats fed only dry feed BDE-209 and BDE-207 were the predominant PBDE congeners in the serum. Edinboro *et al.* (5) also suggested influence of bisphenol-A on the development of hyperthyroidism in cats. Bisphenols such as bisphenol-A, bisphenol A diglycidyl ether, or bisphenol F diglycidyl ether are used in the production of linings of metal cans, which allows to avoid corrosion of cans and contamination of food with metal ions (16). It seems possible that the effect of commercial wet feed on the development of feline hyperthyroidism may result from the use of such compounds in cat feed packaging, and is likely to facilitate their transition to wet feed. Furthermore, increased interior surface of cans in regard to weight of feed in smaller cans may increase transition of chemical compounds from the can lining to feed. Moreover, it is suggested that increased prevalence of feline hyperthyroidism may not only result from ageing but also from the lifetime consumption of canned feed (5).

To conclude, hyperthyroidism is one of the most prevalent diseases of older cats in Warsaw. Age, indoor lifestyle and feeding commercial wet feed are the factors that may increase the risk of hyperthyroidism in cats. There was no effect of breed, gender, castration, or frequency of deworming of cats on the occurrence of hyperthyroidism.

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