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The psychological effects on pet owners after a diagnosis of cancer in their pets: a cross-sectional study

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1 **TITLE PAGE**

2 **Title**

3 **The psychological effects on pet owners after a diagnosis of cancer in their pets: a**

4 **cross-sectional study**

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30

31 **Word count**

32 3256

33

1 **ABSTRACT**

2 **Objective** To determine the presence and predictors of depression and anxiety in pet owners after a

3 diagnosis of cancer in their pets.

4 **Design** Cross-sectional study.

5 **Setting** A veterinary medical center specialized in oncology for dogs and cats and two primary

6 veterinary clinics in Japan.

7 **Participants** The participants were 99 owners of pets with a cancer diagnosis received in the past 1–3

8 weeks and 94 owners of healthy pets.

9 **Main outcome measures** Self-reported questionnaires were used to assess depression and anxiety.

10 Depression was assessed using the Center of Epidemiologic Studies Depression Scale, and anxiety was

11 measured by using the State-Trait Anxiety Inventory-Form JYZ.

12 **Results** Depression scores were significantly higher in owners of pets with cancer even after adjustment

13 for potential confounders in the multiple regression analysis ($p < 0.001$). Among the owners of pets with

14 cancer, those who were employed had a higher rate of depression than those who were unemployed ($p = $

15 0.048). State anxiety scores were significantly higher in owners of pets with cancer after adjustment for

16 potential confounders, including trait-anxiety scores ($p < 0.001$). Furthermore, in owners of pets with

17 cancer, state anxiety was higher in owners with high trait anxiety ($p < 0.001$) and in owners whose pets

18 had a poor prognosis ($p = 0.027$).

19 **Conclusion** The results indicate that some owners tended to become depressed and anxious after

20 receiving a diagnosis of cancer in their pets. Employment may be a predictor of depression. High trait

21 anxiety and a pet with a poor prognosis may increase owners' state anxiety. Including the pet in a family

22 genogram and attention to the pet's health condition may be important considerations for family practice.

23 **Keywords**

24 family practice, depression, anxiety, pet's cancer, family genogram

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Strengths and limitations of this study

- This is the first report investigating association between psychological effects on pet owners and a diagnosis of cancer in their pets.

- This study is the interdisciplinary research between medicine and veterinary medicine, which has not been studied to date.

- A limitation of this study is that it was conducted at a referral veterinary medical center specialized in oncology in an urban area.

3

Introduction

The majority of pet owners regard their companion animals as family members.[1] Companion animals often play an important role for individuals, couples, and families, and animals that become important family members can give patients being comfortable.[2] Conversely, mental and physical mourning after the loss of a domestic pet was first reported in 1977.[3] When the bond between humans and animals is strong, grief can be profound and the process of mourning can take a long time. It has been reported that more than 85 % of pet owners showed grief symptoms following the death of a companion animal, and over one third of pet owners continued to grieve after 6 months.[4] According to a cross-sectional survey in Canada, 27 % of pet owners experienced severe grief after the death of a companion animal.[5] Most reports on pet loss and bereavement have focused on individuals, but it is important to focus on family systems to determine how family members and social support affect owners' recovery from pet loss.[6]

The roles and responsibilities of family members of patients with cancer are significant because families are required to support and care for the patient and deal with social problems. Therefore, in many cases family members feel a great burden. A survey of families of patients with leukemia found that depression, measured by the Center for Epidemiologic Studies Depression Scale (CES-D), was higher than the healthy level.[7] Another study of families of cancer patients found that physical symptoms, anxiety and insomnia, social activity disorders, and depression tendency, measured by the General Health Questionnaire Mental Health Survey, were also above the healthy level.[8] In particular, it is clear that parents of childhood cancer patients experience high levels of anxiety and depression after they first receive the diagnosis,[9] although their poor mental state may be alleviated by psychosocial support.[10]

Improvement in veterinary medical care techniques in recent years means that companion animals are living longer and the majority of dogs now die from cancer.[11] Studies conducted in the UK and Japan reported that the most common cause of death in dogs was cancer.[12-14] Therefore, there is a high likelihood that pet owners will at some point receive a diagnosis of cancer in their pets. However, no study has investigated whether pet owners experience depression or anxiety after such a diagnosis. Our hypothesis is that owners of a dog or a cat diagnosed with cancer suffer depression and anxiety similar to that experienced by the family members of human cancer patients. Therefore, it is important to clarify the presence of anxiety and depression in pet owners after a diagnosis of cancer in their pets.

The aim of this study was to examine the psychological effects of owners being notified of a cancer diagnosis in their pets. We focused on the psychological state of pet owners when a dog or a cat was diagnosed with cancer by investigating the presence of anxiety and depression and exploring their predictors.

4

1   **Material and Methods**

2   **Study design and Setting**

3   The study design was a cross-sectional survey. Anxiety and depression symptoms were evaluated in

4   pet owners after a dog or cat was diagnosed with cancer, and their scores were compared with those of

5   owners of healthy dogs and cats. The survey was conducted between August 2013 and November 2016 at

6   three veterinary clinics in Japan. Owners of pets with cancer were recruited from the Japan Small Animal

7   Cancer Center (JSACC) and owners of healthy pets were recruited from the Minamino Veterinary Clinic

8   and Aster Animal Hospital. The JSACC is a referral veterinary medical center specialized in oncology for

9   dogs and cats located in Tokorozawa city, Saitama prefecture, adjacent to the capital Tokyo. A

10   psychological counselor with a veterinarian license interviewed the pet owners at their first visit to the

11   JSACC. The Minamino Veterinary Clinic and Aster Animal Hospital are primary veterinary clinics.

12   When dogs and cats are diagnosed with cancer or suspected to have cancer at these two clinics, their

13   owners can receive a referral to the JSACC if they wish. The Minamino Veterinary Clinic is located in

14   Hachioji, Tokyo, and the Aster Animal Hospital is in Kawaguchi city, Saitama prefecture, and they are

15   located approximately 25 Km and 20 Km from the JSACC, respectively.

16   **Participants**

17   Owners of pets with cancer

18   Pet owners were asked to participate in the study 1–3 weeks after they received a notification of cancer

19   at the JSACC. Cases in which the pet was unlikely to survive for more than a week were excluded. The

20   date for recruiting participants was scheduled in advance and the participants were consecutively

21   recruited on the survey day.

22   Owners of healthy pets

23   Pet owners who visited the Minamino Veterinary Clinic or Aster Animal Hospital for preventive

24   medicines such as vaccination, heartworm prevention, or health promotion were asked to participate in

25   the study. Owners whose dog or cat had suffered from malignant tumors in the past or were currently

26   suffering from severe illness including malignant tumor were excluded. The participants were

27   intermittently recruited at both veterinary clinics.

28

29   Both groups were targeted at owners over 20 years old.

30

31   **Measurement and Variables**

32   1) Main Outcome: Depression

1   Depressive symptoms were assessed using the Japanese version of the Center of Epidemiologic Studies

2 Depression Scale (CES-D),[15] which is a self-report questionnaire developed by the National Institute of

3 Mental Health for the purpose of identifying "depressive disorder" in people aged over 15 years.[16] The

4 frequency of depressive symptoms in the week before the examination was assessed by classifying 20

5 items into 4 levels (0 = rarely or never – less than 1 day, 1 = some or little time – 1–2 days, 2 =

6 occasionally or a moderate amount of times – 3–4 days, and 3 = most or all the time – 5–7 days). Total

7 scores range from 0 to 60 and higher scores indicate more severe depressive symptoms. A CES-D score

8 of 16 or higher was considered to indicate probable depression.[16]

9

10 2）Main Outcome: State Anxiety

11   Anxiety was assessed using the Japanese version of the State-Trait Anxiety Inventory-Form JYZ

12 (STAI-JYZ).[17] The STAI is a self-report questionnaire that measures anxiety as an emotional state

13 (state anxiety) and as individual characteristics (trait anxiety).[18] It consists of 40 questions with 20

14 items in each category and scores range from 20 to 80. Responses are given on a 4-point Likert scale.

15 State-anxiety items measure the respondent's anxiety level over the past two weeks, whereas trait-anxiety

16 items measure the respondent's characteristic anxiety level. Higher scores indicate greater anxiety. The

17 state-anxiety score is classified into 5 grades (20≤35 = very low, 35 ≤45 = low, 45≤55 = moderate,

18 55≤65=high, 65–80 = very high). Respondents who scored over 55 were defined as the high anxiety

19 group.[18]

20

21 3) Predictor variables: characteristics of participants and pets

22   Age, gender, employment (employed or unemployed), animal species (dog or cat), caregiver (main or

23 not main), number of people per household, number of animals per household, and bereavement

24 experience with pets were obtained from a self-report questionnaire for all participants. The owners of

25 pets with cancer were also asked about the pet's prognosis (curable, survival for more than a year, from a

26 few months to less than a year, or several weeks), and presence of symptoms (anorexia, pain, and

27 neurological conditions including convulsion and respiratory distress).

28

Study size

30   Based on the hypothesis that pet owners have high levels of depression and state anxiety after receiving

31 a diagnosis of cancer in their pets, the number of participants required was calculated in advance.

32 Assuming state anxiety scores of 50 and 40 for owners of pets with cancer and owners with healthy pets,

33 respectively, both each with a standard deviation of 11, we calculated the number of participants required

6

1   to identify a statistically significant difference as 26 in each group ($\alpha = 0.05$, $\beta = 0.10$). In a multiple

2   regression model, 20 samples are required for one variable.[19] This study included 9 explanatory

3   variables so 180 participants were required.

4

Analysis and statistical methods

6   Student's *t* test for parametric data and Wilcoxon's rank-sum test for nonparametric data were used to

7   compare CES-D and state and trait-anxiety (STAI) scores between owners of pets with cancer and owners

8   of healthy pets. Fisher's exact test was used to compare the proportion of CES-D score 16 or more for

9   depression and proportion of STAI score 55 or more for state anxiety between owners of pets with cancer

10   and owners with healthy pets.

11   Model 1: To evaluate the independent effects of cancer diagnosis on CES-D (model 1-CESD) and state

12   anxiety (model1-STAI) scores, the regression model included gender, age, employment, animal species

13   (dog or cat), caregiver, number of people/animals per household, bereavement experience with pets, and

14   trait anxiety (model1-STAI only) as potential confounders. The variance inflation factor was calculated to

15   check multicollinearity.

16   Model 2: To identify the factors associated with CES-D (model 2-CESD) and state anxiety (model

17   2-STAI) scores in owners with pets with cancer, the regression model included pet's prognosis (life

18   expectancy from a few months to less than a year, or several weeks), presence of clinical symptoms, and

19   factors that had a *P* value of less than 0.2 in model 1.

20   *P* values of < 0.05 were considered to be statistically significant.

21   CES-D questionnaires that contained more than five items with missing data were excluded from the

22   data analysis. If the number of unanswered items was four items or less, the average value of the

23   answered items was assigned.

24   Missing responses to the 20 questions used to calculate the state-anxiety score in the STAI

25   questionnaire were dealt with in two ways: (1) the questionnaire was excluded from the data analysis; and

26   (2) missing responses were assigned a score of 1 (low anxiety) for owners of pets with cancer and 4 (high

27   anxiety) for owners of healthy pets. The two groups were compared using both methods.

28   All statistical analyses were performed using STATA/SE version 13.[20]

29

Ethical considerations

31   The research protocol was approved by the ethics committee of the Jikei University School of

32   Medicine. YN and AN informed the owners of pets with cancer of the purpose and methods of the study

33   and assured them that their privacy would be protected and that they would not be disadvantaged if they

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1 did not agree to participate. Those who agreed to participate gave their signed consent. The personal

2 information of owners of pets with cancer was anonymized and labeled with an identification code. The

3 consolidated table was stored securely by YN at the JSACC. In addition, counseling and medical

4 consultation were recommended for owners with high levels of depression and anxiety. Owners of

5 healthy pets were provided with details of the research in a written document. If the owners of healthy

6 pets answered the questionnaire anonymously, they were regarded as having consented to participate in

7 the study.

8

Results

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Participants

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11 There were 193 participants in total: 99 owners of pets with cancer (cancer group) and 94 owners of

12 healthy pets (healthy group). The participants' characteristics are shown in Table 1. The median period

13 between notification of the cancer diagnosis and completion of the questionnaire survey in the cancer

14 group was 14 days (7–21 days).

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Table. 1 Characteristics of participants

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		Cancer group	Healthy group
Number of participants		99	94
Age, median (range), y		49 (21–75)	46 (22–70)
Gender	Male, no. (%)	26 (26.3)	15 (16.0)
	Female, no. (%)	73 (73.7)	79 (84.0)
Animal species	Dog, no. (%)	83 (83.8)	84 (89.4)
	Cat, no. (%)	16 (16.2)	10 (10.6)
Employment	Employed, no. (%)	68 (68.7)	67 (71.3)
	Unemployed, no. (%)	31 (31.3)	27 (28.7)
Caregiver	Main caregiver, no. (%)	83 (83.8)	84 (89.4)
	Not main caregiver, no. (%)	16 (16.2)	10 (10.6)
Number of people per household	1, no. (%)	7 (7.1)	5 (5.3)
	2+, no. (%)	92 (92.9)	89 (94.7)
Number of animals per household,	1, no. (%)	57 (57.6)	69 (73.4)
	2+, no. (%)	42 (42.4)	25 (26.6)
Bereavement experience with pets	Yes, no. (%)	76 (76.8)	68 (72.3)

Depression

Figure 1 plots the CES-D scores of the two groups. The median CES-D score was 13.34 (25–75 percentile: 7–23) in the cancer group (n=98) and 8 (25–75 percentile: 3–12) in the healthy group (n=94), respectively. The distribution of the two groups was significantly different (Wilcoxon rank-sum test: $p < 0.001$). In addition, 39.8 % (39/98) of the cancer group scored 16 or higher on the CES-D, which was significantly higher than the proportion in the healthy group (11.7 % [11/94], Fisher's exact test: $p < 0.001$). In the multiple regression analysis (model 1-CESD), CES-D scores were significantly higher in the cancer group even after adjustment for potential confounders ($p < 0.001$, Table 2). Among the cancer group, owners who were employed had significantly higher depression scores than those who were unemployed (model 2-CESD) ($p < 0.048$, Table 3).

9

Table 2 Multiple regression analysis of CES-D scores (model 1-CESD).

	Coefficient	95% Confidence interval		p value
Pet with cancer	7.948	5.493	10.403	< 0.001
Age	−0.038	−0.149	0.072	0.495
Female	2.601	−0.722	5.925	0.124
Dog	1.577	−2.034	5.188	0.390
Employed	3.045	0.310	5.779	0.029
Main caregiver	−0.786	−4.663	3.091	0.690
2+ persons per household	0.980	−4.113	6.074	0.705
2+ animals per household	−1.246	−3.911	1.418	0.357
Bereavement of a pet	−0.674	−3.522	2.172	0.641

Table 3 Analysis of predictors associated with depression among the cancer group (model 2-CESD).

	Coefficient	95% Confidence interval		p value
Female	3.799	−0.602	8.200	0.090
Employed	4.224	0.029	8.419	0.048
Prognosis	3.499	−0.446	7.445	0.081
Symptoms	−0.927	−4.993	3.139	0.652

State Anxiety (STAI)

The state-anxiety and trait-anxiety scores from the STAI in the two groups are shown in Figures 2A and 2B. For the cases in which all 20 questions for state anxiety were answered, the median state-anxiety score was 52 (25–75 percentile: 43–59) in the cancer group (n = 93) and 33 (25–75 percentile: 27–42) in the healthy group (n = 91), respectively. The distribution of the two groups was significantly different

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1   (Wilcoxon rank-sum test: $p < 0.001$). In addition, the proportion of owners with levels of high anxiety in

2   the cancer group was 39.8 % (37/93), which was significantly higher than 0 % (0/91) in the healthy group

3   (Fisher's exact test: $p < 0.001$). Similarly, when missing values were imputed, the median state-anxiety

4   score was 52 (25–75 percentile: 43–58) in the cancer group (n = 98), which was significantly higher than

5   33.5 (25–75 percentile: 27–42) in the healthy group (n = 92) ($p < 0.001$). The median trait-anxiety score

6   was 45 (25–75 percentile: 37–52.5) in the cancer group (n = 96) and 34.5 (25–75 percentile: 27–42) in the

7   healthy group (n = 90). The distribution of the two groups was significantly different ($p < 0.001$).

8   In the multiple regression model, after adjustment for potential confounders including trait-anxiety

9   scores, state-anxiety scores were significantly higher in the cancer group (model 1-STAI) ($p < 0.001$,

10 Table 4). Furthermore, in the cancer group, state-anxiety scores were higher in owners with high trait

11 anxiety ($p < 0.001$) and in those with pets with a life expectancy of several months (model 2-STAI) ($p =$

12 0.027, Table 5).

17 **Table 4 Multiple regression analysis of state-anxiety scores (model 1-STAI).**

	Coefficient	95% Confidence interval		p value
Pet with cancer	11.056	8.510	13.601	< 0.001
Age	−0.043	−0.148	0.060	0.409
Female	−0.511	−3.544	2.522	0.740
Dog	−0.849	−4.160	2.461	0.613
Employed	1.495	−1.041	4.032	0.246
Main caregiver	−0.387	−3.939	3.164	0.830
2+ persons per household	3.676	−0.886	8.238	0.114
2+ animals per household	0.463	−2.050	2.976	0.717
Bereavement of a pet	1.388	−1.216	3.993	0.294
Trait anxiety	0.654	0.546	0.761	< 0.001

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Table 5 Analysis of predictors associated with state anxiety among the cancer group (model 2-STAI).

	Coefficient	95% Confidence interval		*p* value
Family	3.614	−3.089	10.319	0.287
Trait anxiety	0.570	0.405	0.734	< 0.001
Prognosis	4.318	0.508	8.128	0.027
Symptoms	3.307	−0.543	7.157	0.091

Discussion

The present study revealed high levels of anxiety and depression among pet owners after receiving a diagnosis of cancer in their pets. In addition, owners who were employed tended to be more depressed than those who were unemployed, and state anxiety was higher in owners with high trait anxiety and in owners of pets with a poor prognosis. This is the first report investigating association between psychological effects on pet owners and a diagnosis of cancer in their pets.

After being notified that their dog or cat had cancer, 39.8% of owners reported possible symptoms of depression. Two previous studies that investigated depression among family members of cancer patients using the CES-D found that 52.9% and 66.4% of families reported symptoms of depression, respectively.[21,22] Although pet owners were less likely to suffer depression than the family members of cancer patients, almost 40% were affected, which supports the hypothesis that dogs and cats are treated as members of the family.

Owners who were employed were more likely to report depression symptoms than those who were unemployed, possibly because they had insufficient time to care for their pets and take them to a veterinary clinic. Furthermore, a previous study reported that the median CES-D score of owners of pets with chronic or terminal diseases was 19.87,[23] which was higher than the median of 13.34 in this study, which was measured 1–3 weeks after the notification of cancer. Owners' depression may be sustained or increased by the need to provide long-term nursing care for their pets. Therefore, psychosocial support from the early stage after notification is necessary so that these owners do not develop maladjustment or mood disorder.

The median state-anxiety score among owners of pets with cancer was 52, which was significantly higher than the median of 33.5 among owners of healthy pets. Studies that have used the STAI to measure

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1 anxiety in parents of children diagnosed with cancer reported average state-anxiety scores of 56.7 and

2 52.7 for mothers and fathers, respectively.[24] The similarity in the state-anxiety scores of owners of pets

3 with cancer suggests that dogs and cats may play a role as a member of the family. The reasons for such

4 high anxiety among pet owners may include the cost of treatment, the burden of taking the pet to the

5 clinic, providing nursing care, anxiety about mourning, and deterioration of clinical symptoms such as

6 changes in the pet's appearance or increased pain.

7 In this study, anxiety was higher among owners who had a pet with a poor prognosis; i.e., with a life

8 expectancy from several weeks to less than a year, suggesting that anxiety increases as the prospect of

9 bereavement becomes more immediate. Furthermore, owners with high trait anxiety were more likely to

10 suffer worse state anxiety than owners with low trait anxiety. A previous study revealed that cancer

11 patients with high trait anxiety experience stronger psychological distress such as tension and anxiety

12 after a diagnosis of cancer than patients with low trait anxiety.[25] Therefore, trait anxiety may be one

13 factor that affects the state anxiety of owners when their pets are diagnosed with cancer. Moreover, trait

14 anxiety scores in owners of pets with cancer were significantly higher than those in owners of healthy

15 pets (45 vs. 34.5, $p < 0.001$). Although trait anxiety is a personality trait that tends to cause anxiety and is

16 relatively stable, the reason trait anxiety was high among owners of a pet with cancer may be that the

17 situation in which the pet was diagnosed with cancer caused state anxiety, and this temporary mental state

18 was fed back to the chronic personality tendency.

19 The results of our study indicate that companion animals are regarded as an important member of the

20 family. When companion animals suffer from cancer, some pet owners suffer from depression and

21 anxiety that could affect their health. Previous studies have noted that pets should be included in a family

22 genogram.[26,27] Including pets in a family genogram may be useful for medical treatment in

23 family-oriented care by family physicians. We propose that the following information about companion

24 animals should be entered into the family genogram: name, age, animal species, current medical history,

25 animal's prognosis and relationship with the family. Family physicians should pay attention to the health

26 condition of companion animals. It is important not only for family physicians but also for psychiatrists to

27 consider the possibility that owners of pets with cancer may be suffering from depression and anxiety and

28 may need mental health care.

29 A limitation of this study is that it was conducted at a referral veterinary medical center specialized in

30 oncology in an urban area. Therefore, we cannot rule out the possibility that originally enthusiastic

31 owners and owners with a tendency toward depression and high trait anxiety were more likely to visit the

32 referral veterinary medical center. In addition, because a screening test for depression was used in this

33 study, it was uncertain whether the participants had developed an actual mental disorder. The progression

13

of depression and anxiety over the long term is also unknown, as the investigation took place 1–3 weeks

after notification of the diagnosis. The detailed processes that cause depression and anxiety may be

elucidated by investigating depression and anxiety in owners of pets diagnosed with cancer at primary

veterinary clinics and monitoring them over time. Interventions such as counselling for pet owners after

notification of a cancer diagnosis should also be evaluated.

Conclusion

Our findings indicate that some owners tended to become depressed and anxious after receiving a

diagnosis of cancer in their pets. In particular, owners who were employed had a higher rate of depression

than those who were unemployed, and state anxiety was higher in owners with high trait anxiety and in

those whose pets had a poor prognosis. Physicians may find it helpful to include pets in the family

genogram and to consider the pets' health condition when providing medical treatment in family practice.

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Footnotes
Contributors

YN conceived and designed the study, analyzed and interpreted the data, and drafted a manuscript.

MM contributed to conception and design of the study, analysis and interpretation of the data. AN, JH

and EM contributed to conception of the study, acquisition of the data. HW, SY, HI, MK, RM, YS and

EY contributed to interpretation of the data and discussion to help drafting the manuscript. TK

contributed to conception of the study. All authors critically revised the manuscript. All authors approved

the final version of the manuscript and agree to be accountable for the accuracy of the work. YN is the

guarantor.

14

1

2 **Competing interests**

3   All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf

4 and declare: no support from any organization for the submitted work; MM is an adviser of Centre for

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7 the Promotion of Science, MM is a Program Director of Jikei Clinical Research Program for

8 Primary-care; no other relationships or activities that could appear to have influenced the submitted work.

9

10 **Patient consent**

11   Not required.

12

13 **Ethical approval**

14   The ethics committee of Jikei University School of Medicine approved study protocols.

15

16 **Provenance and peer review**

17   Not commissioned; externally peer reviewed.

18

19 **Data sharing statement**

20   No additional data are available.

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1 **Figure 1. Distribution of CES-D scores in the healthy group and the cancer group.**

2 Solid line shows the median CES-D score in each group. Dotted line shows the cut-off point for

3 depression.

4

5 **Figure 2. Distribution of state-anxiety (A) and trait-anxiety (B) scores in the healthy group and the**

6 **cancer group.** Solid lines show the median anxiety score in each group. A: the median state-anxiety

7 score is moderate in the cancer group, but very low in the healthy group. B: the median trait-anxiety score

8 in the cancer group is higher than in the healthy group.

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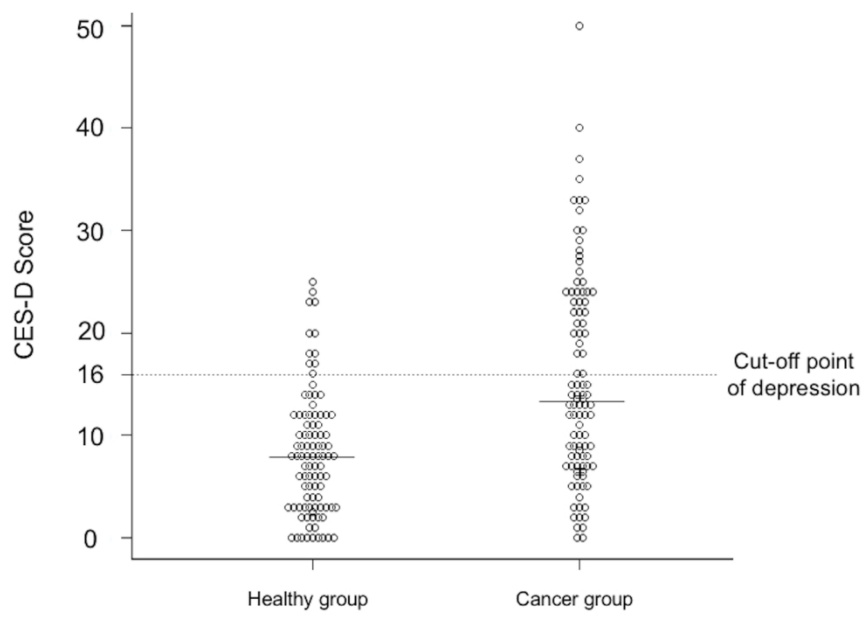49
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Figure 1. Distribution of CES-D scores in the healthy group and the cancer group.
Solid line shows the median CES-D score in each group. Dotted line shows the cut-off point for depression.

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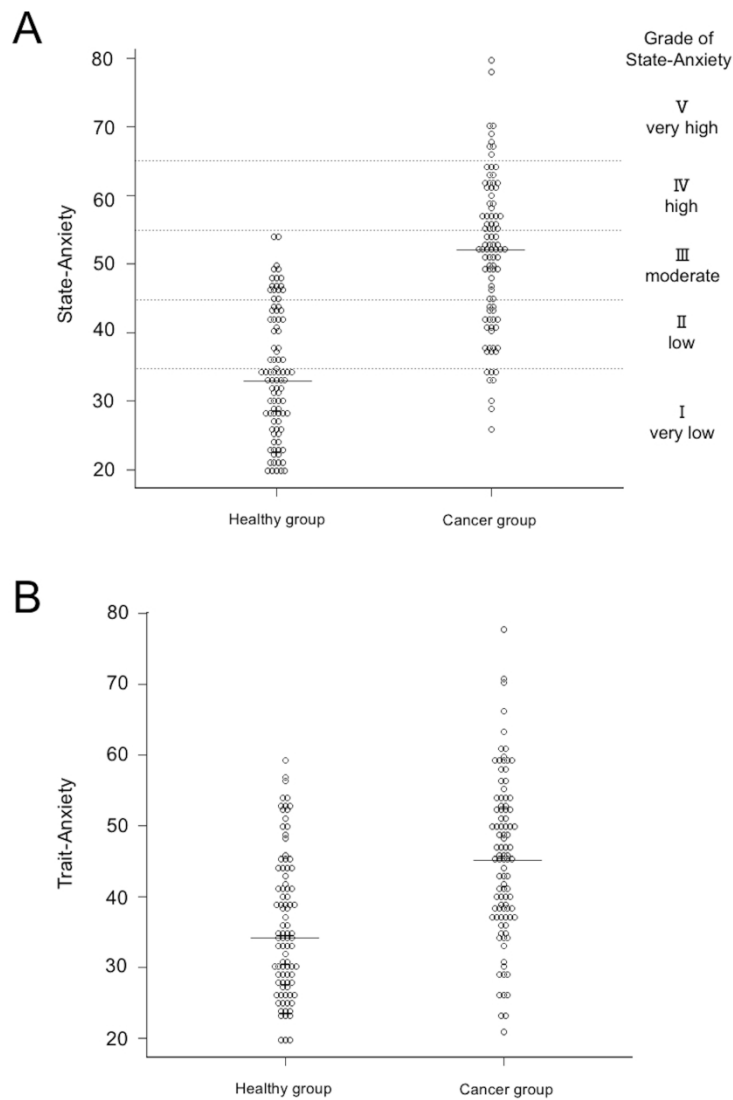51
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Figure 2. Distribution of state-anxiety (A) and trait-anxiety (B) scores in the healthy group and the cancer group. Solid lines show the median anxiety score in each group. A: the median state-anxiety score is moderate in the cancer group, but very low in the healthy group. B: the median trait-anxiety score in the cancer group is higher than in the healthy group.

134x201mm (600 x 600 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6, 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9, 10, 11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 10, 11, 12
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13, 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13,14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Depression and anxiety in pet owners after a diagnosis of cancer in their pets: a cross-sectional study in Japan

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1 **TITLE PAGE**

2 **Title**

3 **Depression and anxiety in pet owners after a diagnosis of cancer in their pets: a**

4 **cross-sectional study in Japan**

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31 **Word count**

32 4005

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1   **ABSTRACT**

2   **Objective** To determine the presence and predictors of depression and anxiety in pet owners after a diagnosis

3   of cancer in their pets.

4   **Design** Cross-sectional study.

5   **Setting** A veterinary medical center specialized in oncology for dogs and cats and two primary veterinary

6   clinics in Japan.

7   **Participants** The participants for analysis were 99 owners of a pet with cancer diagnosis received in the past

8   1–3 weeks and 94 owners of a healthy pet.

9   **Main outcome measures** Self-reported questionnaires were used to assess depression and anxiety.

10 Depression was assessed using the Center of Epidemiologic Studies Depression Scale, and anxiety was measured

11 by using the State-Trait Anxiety Inventory-Form JYZ.

12 **Results** Depression scores were significantly higher in owners of a pet with cancer than owners of a healthy pet,

13 even after adjustment for potential confounders ($p < 0.001$). Within the owners of a pet with cancer, depression

14 was significantly more common in those who were employed than those who were unemployed ($p = 0.048$). State

15 anxiety scores were significantly higher in owners of a pet with cancer than owners of a healthy pet, even after

16 adjustment for potential confounders, including trait-anxiety scores ($p < 0.001$). Furthermore, in owners of a pet

17 with cancer, state anxiety was higher in owners with high trait anxiety ($p < 0.001$) and in owners whose pets had

18 a poor prognosis ($p = 0.027$).

19 **Conclusion** The results indicate that some owners tended to become depressed and anxious after their pets had

20 received a diagnosis of cancer. Employment may be a predictor of depression. High trait anxiety and a pet with a

21 poor prognosis may increase owners' state anxiety. Including the pet in a family genogram and attention to the

22 pet's health condition may be important considerations for family practice.

23 **Keywords**

24 family practice, depression, anxiety, pet cancer, family genogram

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1   **Strengths and limitations of this study**

2   • This is the first report to investigate the psychological effects of a diagnosis of cancer in pets on owners.

3   • This study is the interdisciplinary research between medicine and veterinary medicine, which has not been

4   studied to date.

5   • The study setting was limited to a referral secondary veterinary medical center specialized in oncology, so

6   the generalizability of the results is not clear.

3

Introduction

Since 1973, the birthrate in Japan has continued to decline.[1] Meanwhile, a 2015 survey by the Japanese Pet Food Association determined that 19,791,000 dogs and cats are owned in Japan.[2] Furthermore, this report found that 14.1 % of families own dogs and 10.1 % own cats; of these, 78.9 % of dogs and 82.0 % of cats are raised in the house. Thus, with the declining birthrate, aging society, and a decrease in the number of household members in Japan, it is thought that dogs and cats are becoming treated as companion animals, that is, family members.

Most pet owners regard their companion animals as family members.[3] Companion animals often play an important role for individuals, couples, and families, and animals that become important family members can make patients comfortable.[4] Living with pets can have positive impacts on mental health, such as reducing the feeling of loneliness, depression, and anxiety.[5, 6] Furthermore, companion animals can provide benefits to pet owners with mental health problems through the intensity of connectivity with pet owners.[7] Conversely, pet ownership can also have negative effects on the management of mental health disorders, which relate to financial costs, housing situations, and mental burden, especially if pets are unruly.[8-11] Another negative aspect is the mourning after the loss of a domestic pet.[12-14] Furthermore, caregiver burden in owners of a pet with chronic or terminal disease has been reported.[15]

The roles and responsibilities of family members of human patients with cancer are significant because families are required to support and care for the patient and deal with social problems. Thus, family members can often feel a great burden. A survey of families of human patients with leukemia found that depression, measured by the Center for Epidemiologic Studies Depression Scale (CES-D), was higher than the healthy level.[16] Another study of families of human cancer patients found that physical symptoms, anxiety and insomnia, social activity disorders, and depression tendency, measured by the General Health Questionnaire Mental Health Survey, were also above healthy levels.[17] In particular, parents of childhood cancer patients experience high levels of anxiety and depression after receiving the diagnosis,[18] although their poor mental state may be alleviated by psychosocial support.[19]

Improvement in veterinary medical care techniques in recent years means that companion animals live longer, and the majority of dogs now die from cancer.[20] Studies conducted in the UK and Japan reported that the most common cause of death in dogs was cancer.[21-23] Therefore, there is a high likelihood that pet owners will at some point receive a diagnosis of cancer in their pets. However, no study has investigated whether pet owners experience depression or anxiety after such a diagnosis.

The aim of this study was to examine the psychological effects of a cancer diagnosis in pets on pet owners. We therefore investigated the presence of anxiety and depression after diagnosis and explored their predictors. Our

4

1   hypothesis was that owners of a dog or a cat diagnosed with cancer suffer from depression and anxiety that is

2   similar to that experienced by family members of human cancer patients.

3

Material and Methods

Study design and Setting

6   The study design was a cross-sectional survey. Anxiety and depression scores in owners of a pet diagnosed

7   with cancer were compared with those of owners of a healthy pet. The survey was conducted between August

8   2013 and November 2016 at three veterinary clinics in Japan. Owners of a pet with cancer were recruited from

9   the Japan Small Animal Cancer Center (JSACC) and owners of a healthy pet were recruited from the Minamino

10 Veterinary Clinic and Aster Animal Hospital. The JSACC is a referral veterinary medical center specialized in

11 oncology for dogs and cats located in Tokorozawa city, Saitama prefecture, next to Tokyo. A psychological

12 counselor with a veterinarian license (AN) interviewed the pet owners at their first visit to the JSACC. The

13 Minamino Veterinary Clinic and Aster Animal Hospital are primary veterinary clinics. When dogs and cats are

14 diagnosed with cancer or suspected to have cancer at these two clinics, their owners can receive a referral to the

15 JSACC if they wish. The Minamino Veterinary Clinic is located in Hachioji, Tokyo, and the Aster Animal

16 Hospital is in Kawaguchi city, Saitama prefecture, and they are located approximately 25 km and 20 km from the

17 JSACC, respectively. This study was designed and reported in line with the Strengthening the Reporting of

18 Observational Studies in Epidemiology (STROBE) guidelines.[24]

19

Participants

Owners of a pet with cancer

22 Pet owners were asked to participate in the study 1–3 weeks after their pets had received a cancer diagnosis at

23 the JSACC. As a procedure, we set in advance the survey date when the counselor/veterinarian (AN) or

24 veterinarian (YN) could investigate without hindrance for daily veterinary practice depending upon the number of

25 patients reserved, which was limited to consultation days in oncology service. Owners of a pet with cancer were

26 consecutively recruited on the survey date. YN and AN informed the owners of a pet with cancer of the purpose

27 and methods of the study and assured them that their privacy would be protected and that they would not be

28 disadvantaged if they did not agree to participate. Those who agreed to participate provided signed consent.

29 Questionnaires were completed by the pet owners and collected in an envelope. All personal information was

30 anonymized and questionnaires were labeled with an identification code.

5

1   The attending veterinarian predicted the survival time, and, for ethical reasons, cases in which the pet was

2   unlikely to survive for more than a week were excluded. Namely, we considered it too invasive for owners

3   notified of imminent death of their pets to be asked to participate.

4

5   **Owners of a healthy pet**

6   Pet owners who visited the Minamino Veterinary Clinic or Aster Animal Hospital for preventive medicines

7   such as vaccination, heartworm prevention, or health promotion were asked to participate in the study on days

8   when the survey could be conducted. The participants were intermittently recruited at both veterinary clinics as a

9   convenient sample. Pet owners that agreed to take part in the survey were provided with details of the research in

10   a written document. Completion of the questionnaire was considered as consent to participate in the study.

11   Questionnaires were collected in an envelope in the same way as for owners of a pet with cancer.

12   Owners whose dog or cat had suffered from malignant tumor in the past or were currently suffering from

13   malignant tumor were excluded. We also excluded owners whose pet had a disease that was deemed to be severe

14   or life threatening by the attending veterinarian, which could have affected the psychological state of pet owners.

15

16   In both groups, pet owners were over 20 years old.

17

18   **Measurement and Variables**

19   **Main Outcome: Depression**

20   Depressive symptoms were assessed using the Japanese version of the CES-D.[25] The CES-D is a self-report

21   questionnaire developed by the National Institute of Mental Health for the purposes of identifying depressive

22   disorder in people aged over 15 years.[26] The frequency of depressive symptoms in the week before the

23   examination was assessed by 20 items that were scored on a 4-point scale (0 = rarely or never – less than 1 day, 1

24   = some or little time – 1–2 days, 2 = occasionally or a moderate amount of times – 3–4 days, and 3 = most or all

25   the time – 5–7 days). Total scores range from 0 to 60 and higher scores indicate more severe depressive

26   symptoms. A CES-D score of 16 or higher was considered to indicate probable depression.[25, 26]

27   CES-D questionnaires that contained more than five items with missing data were excluded from the data

28   analysis. If the number of unanswered items was four items or less, the average value of the answered items was

29   assigned to the missing items.

30

31   **Main Outcome: State Anxiety**

1   Anxiety was assessed using the Japanese version of the State-Trait Anxiety Inventory-Form JYZ
2   (STAI-JYZ).[27] The STAI is a self-report questionnaire that measures anxiety as an emotional state (state
3   anxiety) and as individual characteristics (trait anxiety).[28] It consists of 40 questions with 20 items per category
4   and scores range from 20 to 80. Responses are given on a 4-point Likert scale. State-anxiety items measure the
5   respondent's anxiety level over the past two weeks, whereas trait-anxiety items measure the respondent's
6   characteristic anxiety level. Higher scores indicate greater anxiety. The state-anxiety score is classified into 5
7   grades (20≤35 = very low, 35≤45 = low, 45≤55 = moderate, 55≤65 = high, 65–80 = very high). Respondents who
8   scored over 55 were defined as the high anxiety group.[27, 28]
9   Missing responses to the 20 questions used to calculate the state-anxiety scores in the STAI questionnaire were
10   dealt with in two ways, as follows: (1) the questionnaire was excluded from the data analysis; and (2) missing
11   responses were assigned a score of 1 (low anxiety) for owners of a pet with cancer and 4 (high anxiety) for
12   owners of a healthy pet.
13
14   **Predictor variables: characteristics of participants and pets**
15   Age, gender, employment (employed or unemployed), animal species (dog or cat), caregiver (main or not
16   main), number of people per household, number of animals per household, and bereavement experience with pets
17   were obtained from a self-report questionnaire for all participants. "Employed" included either full-time or
18   part-time workers. "Unemployed" also included retired persons, full-time housewives, those without an
19   occupation, and those with temporary leave from their job.
20   The owners of a pet with cancer were also asked about the pet's prognosis (curable, survival for more than a
21   year, from a few months to less than a year, or several weeks), and presence of pet's symptoms (anorexia, pain,
22   and neurological conditions including convulsion and respiratory distress).
23
24   **Study size**
25   Based on the hypothesis that pet owners have high levels of depression and state anxiety after their pets had
26   received a diagnosis of cancer, the number of participants required was calculated in advance. Assuming state
27   anxiety scores of 50 and 40 for owners of a pet with cancer and owners with a healthy pet, respectively, both each
28   with a standard deviation of 11, we calculated the number of participants required to identify a statistically
29   significant difference as 26 in each group ($\alpha = 0.05$, $\beta = 0.10$). In a multiple regression model, 20 samples are
30   required for one variable.[29] This study included nine explanatory variables, so 180 participants were required.
31
32   **Analysis and statistical methods**

7

1   For comparisons in demographic characteristics between owners of a pet with cancer and owners of a healthy

2   pet, Wilcoxon's rank-sum test for parametric data or Student's *t* test for nonparametric data was used for

3   continuous variables and Fisher's exact test was used for categorical variables.

4   Student's *t* test was used for between-group comparisons of parametric CES-D score and state and

5   trait-anxiety (STAI) scores and Wilcoxon's rank-sum test for between-group comparisons of nonparametric

6   CES-D score and state and trait-anxiety (STAI) scores. Fisher's exact test was used for between-group

7   comparisons of the proportion of participants with a CES-D score of 16 or more for depression and the proportion

8   of those with a STAI score of 55 or more for state anxiety.

9   Model 1: To evaluate the independent effects of cancer diagnosis on the CES-D (model 1-CESD) and state

10   anxiety (model 1-STAI) scores, the regression model included gender, age, employment, animal species (dog or

11   cat), caregiver, number of people/animals per household, bereavement experience with pets, and trait anxiety

12   (model 1-STAI only) as potential confounders. The variance inflation factor was calculated to check

13   multicollinearity.

14   Model 2: To identify factors associated with the CES-D (model 2-CESD) and state anxiety (model 2-STAI)

15   scores in owners of a pet with cancer, the regression model included pet's prognosis (life expectancy from a few

16   months to less than a year, or several weeks), presence of clinical symptoms, and factors that had a *P*-value of

17   less than 0.2 in model 1.

18   A *P*-value of < 0.05 was considered to be statistically significant. All statistical analyses were performed using

19   STATA/SE version 13.[30]

20

21   **Ethical considerations**

22   The research protocol was approved by the ethics committee of The Jikei University School of Medicine

23   (Ethics number: 25-049 7184). A psychological counselor with a veterinarian license (AN) interviewed the pet

24   owners at their first visit to the JSACC. In owners of a pet with cancer, counseling and/or medical consultation

25   were supposed to be recommended for owners with high levels of depression and anxiety which were based on an

26   attending veterinarian's decision at consultation.

27

28   **Patient and Public Involvement**

29   No participants were involved in the development of the research question, outcome measures, or design or

30   implementation of the study. No participants were involved in the analysis or write up of the study. There are no

31   plans to disseminate our overall results to the study participants.

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1 **Results**

2 **Participants**

3   The questionnaires from 100 owners of a pet with cancer and 100 owners of a healthy pet were obtained. One

4 owner of a pet with cancer was excluded for analysis due to missing data of some demographic variables. Six

5 owners of a healthy pet were excluded for analysis due to the presence of past cancer history of pet (n=2), no

6 information on past cancer history of pet (n=2), no response to CES-D/STAI (n=1), or exclusion criteria of age

7 (n=1, we asked the mother to respond to questionnaires: however, her son responded). Data from a total of 193

8 participants were analyzed (99 owners of a pet with cancer and 94 owners of a healthy pet). The participants'

9 characteristics are shown in Table 1. Except for the number of animals per household, there were no significant

10 differences between the two groups in demographic variables as shown in Table 1. The median period between

11 notification of the cancer diagnosis and completion of the questionnaire survey in the owners of a pet with cancer

12 was 14 days (range, 7–21 days).

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Table 1. Participant characteristics

		Owners of a pet with cancer	Owners of a healthy pet	P-value
Number of participants		99	94	
Age, median (range), y		49 (21–75)	46 (22–70)	0.144
Gender	Male, no. (%)	26 (26.3)	15 (16.0)	0.112
	Female, no. (%)	73 (73.7)	79 (84.0)	
Animal species	Dog, no. (%)	83 (83.8)	84 (89.4)	0.297
	Cat, no. (%)	16 (16.2)	10 (10.6)	
Employment	Employed, no. (%)	68 (68.7)	67 (71.3)	0.754
	Unemployed, no. (%)	31 (31.3)	27 (28.7)	
Caregiver	Main caregiver, no. (%)	83 (83.8)	84 (89.4)	0.297
	Not main caregiver, no. (%)	16 (16.2)	10 (10.6)	
Number of people per household	1, no. (%)	7 (7.1)	5 (5.3)	0.768
	2+, no. (%)	92 (92.9)	89 (94.7)	
Number of animals per household,	1, no. (%)	57 (57.6)	69 (73.4)	0.024
	2+, no. (%)	42 (42.4)	25 (26.6)	
Bereavement experience with pets	Yes, no. (%)	76 (76.8)	68 (72.3)	0.511

Student's *t* test was used for comparison in age between two groups.

Depression

Figure 1 shows the CES-D scores of the two groups. The median CES-D score was 13.34 (25–75 percentile: 7–23) in the owners of a pet with cancer (n = 98) and 8 (25–75 percentile: 3–12) in the owners of a healthy pet (n = 94). The distribution of the two groups was significantly different (Wilcoxon rank-sum test: $p < 0.001$). In addition, 39.8 % (39/98) of the owners of a pet with cancer scored 16 or higher on the CES-D, which was significantly higher than the proportion in the owners of a healthy pet (11.7 % [11/94], Fisher's exact test: $p < 0.001$). In the multiple regression analysis (model 1-CESD), CES-D scores were significantly higher in the owners of a pet with cancer even after adjustment for potential confounders ($p < 0.001$, Table 2). Among the owners of a pet with cancer, owners who were employed had significantly higher depression scores than those who were unemployed (model 2-CESD) ($p < 0.048$, Table 3).

Table 2. Multiple regression analysis of CES-D scores (model 1-CESD)

	Coefficient	95% Confidence interval		*P*-value
Pet with cancer	7.948	5.493	10.403	< 0.001
Age	−0.038	−0.149	0.072	0.495
Female	2.601	−0.722	5.925	0.124
Dog	1.577	−2.034	5.188	0.390
Employed	3.045	0.310	5.779	0.029
Main caregiver	−0.786	−4.663	3.091	0.690
2+ persons per household	0.980	−4.113	6.074	0.705
2+ animals per household	−1.246	−3.911	1.418	0.357
Bereavement of a pet	−0.674	−3.522	2.172	0.641

Table 3. Analysis of predictors associated with depression among the cancer group (model 2-CESD)

	Coefficient	95% Confidence interval		*P*-value
Female	3.799	−0.602	8.200	0.090
Employed	4.224	0.029	8.419	0.048
Prognosis	3.499	−0.446	7.445	0.081
Symptoms	−0.927	−4.993	3.139	0.652

State Anxiety (STAI scores)

The state-anxiety and trait-anxiety scores of the two groups are shown in Figures 2A and 2B. For the cases in which all 20 questions for state anxiety were answered, the median state-anxiety score was 52 (25–75 percentile: 43–59) in the owners of a pet with cancer (n = 93) and 33 (25–75 percentile: 27–42) in the owners of a healthy pet (n = 91). The distribution of the two groups was significantly different (Wilcoxon rank-sum test: *p* < 0.001). The proportion of owners with levels of high anxiety in the owners of a pet with cancer was 39.8 % (37/93),

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which was significantly higher than 0 % (0/91) in the owners of a healthy pet (Fisher's exact test: $p < 0.001$).

Similarly, when missing values were imputed, the median state-anxiety score was 52 (25–75 percentile: 43–58) in the owners of a pet with cancer (n = 98), which was significantly higher than 33.5 (25–75 percentile: 27–42) in the owners of a healthy pet (n = 92) ($p < 0.001$). The median trait-anxiety score was 45 (25–75 percentile: 37–52.5) in the owners of a pet with cancer (n = 96) and 34.5 (25–75 percentile: 27–42) in the owners of a healthy pet (n = 90). The distribution of the two groups was significantly different ($p < 0.001$).

In the multiple regression model, after adjustment for potential confounders including trait-anxiety scores, state-anxiety scores were significantly higher in the owners of a pet with cancer than in owners of a healthy pet (model 1-STAI) ($p < 0.001$, Table 4). Furthermore, in the owners of a pet with cancer, state-anxiety scores were higher in owners with high trait anxiety ($p < 0.001$) and in those with pets with a life expectancy of several months (model 2-STAI) ($p = 0.027$, Table 5).

Table 4. Multiple regression analysis of state-anxiety scores (model 1-STAI)

	Coefficient	95% Confidence interval		P-value
Pet with cancer	11.056	8.510	13.601	< 0.001
Age	−0.043	−0.148	0.060	0.409
Female	−0.511	−3.544	2.522	0.740
Dog	−0.849	−4.160	2.461	0.613
Employed	1.495	−1.041	4.032	0.246
Main caregiver	−0.387	−3.939	3.164	0.830
2+ persons per household	3.676	−0.886	8.238	0.114
2+ animals per household	0.463	−2.050	2.976	0.717
Bereavement of a pet	1.388	−1.216	3.993	0.294
Trait anxiety	0.654	0.546	0.761	< 0.001

Table 5. Analysis of predictors associated with state anxiety within the cancer group (model 2-STAI)

	Coefficient	95% Confidence interval		P-value

2+ persons per household	3.614	−3.089	10.319	0.287
Trait anxiety	0.570	0.405	0.734	< 0.001
Prognosis	4.318	0.508	8.128	0.027
Symptoms	3.307	−0.543	7.157	0.091

Discussion

The present study revealed high levels of anxiety and depression among owners of pets that had received a diagnosis of cancer. Within the owners of a pet with cancer, depression was significantly more common in those who were employed than those who were unemployed. The state anxiety was higher in owners with high trait anxiety and in owners of a pet with a poor prognosis. This is the first report to investigate the psychological effects of pet cancer on their owners.

After being notified that their dog or cat had cancer, 39.8% of owners reported symptoms of depression. Two previous studies that investigated depression among family members of cancer patients using the CES-D found that 52.9 % and 66.4 % of families reported symptoms of depression, respectively.[31, 32] Although pet owners were less likely to suffer depression than the family members of cancer patients, almost 40 % were affected.

Owners who were employed were more likely to report depression symptoms than those who were unemployed. Insufficient time available to care for their pets and visit a veterinary clinic due to working hours may have led to a sense of guilt. This feeling is likely similar to guilt felt when a pet owner with mental health problems cannot manage unruly pets.[8-11] Furthermore, a previous study reported that the median CES-D score of owners of a pet with chronic or terminal diseases was 19.87,[15] which was higher than the median of 13.34 in this study, which was measured 1–3 weeks after the notification of pet cancer. Owners' depression may be sustained or increased by the need to provide long-term nursing care for their pets. Therefore, psychosocial support from the early stage after notification is necessary so that these owners do not develop maladjustment or mood disorder.

The median state-anxiety score among owners of a pet with cancer was 52, which was significantly higher than the median of 33.5 among owners of a healthy pet. Studies that have used the STAI to measure anxiety in parents of children diagnosed with cancer reported average state-anxiety scores of 56.7 and 52.7 for mothers and fathers, respectively.[33] The similarity in the state-anxiety scores of owners of a pet with cancer suggests that dogs and cats may play a role as a member of the family. The high anxiety in owners of a pet with cancer could have been caused by the cost of treatment, the burden of taking the pet to the clinic, providing nursing care, anxiety about death of a pet, and deterioration of clinical symptoms such as changes in the pet's appearance or increased pain.

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1   In this study, anxiety was higher among owners who had a pet with a poor prognosis; i.e., with a life

2   expectancy from several weeks to less than a year, which suggests that anxiety increases as the prospect of

3   bereavement becomes more immediate. Furthermore, owners with high trait anxiety were more likely to suffer

4   from state anxiety than owners with low trait anxiety. A previous study revealed that cancer patients with high

5   trait anxiety experience stronger psychological distress such as tension and anxiety after a diagnosis of cancer

6   than patients with low trait anxiety.[34] Therefore, trait anxiety may be one factor that affects the state anxiety of

7   owners when their pets are diagnosed with cancer. Moreover, trait anxiety scores in owners of a pet with cancer

8   were significantly higher than those in owners of a healthy pet (45 vs. 34.5, $p < 0.001$). Although trait anxiety, a

9   personality trait that tends to cause anxiety, is relatively stable, the high trait anxiety seen in owners of a pet with

10   cancer may have been caused by the state anxiety induced by their pet's cancer diagnosis.

11   The results of our study are consistent with the idea that companion animals are regarded as important family

12   members, as found by previous studies [3, 4, 35] because there is similarity between the degree of anxiety after

13   notification of pet cancer and that of human cancer. Baker et al. reported that the relationships between typical

14   pet owners/dog enthusiasts and companion dogs were similar to relationships with a spouse, child, and parents;

15   this research measured the distance between pet owners and pets, and owners and family members, using the

16   Family Life Space Diagram.[35] Furthermore, previous studies have noted that pets should be included in the

17   family genogram.[36, 37] Including pets in a family genogram may be useful for medical treatment in

18   family-oriented care by family physicians. Therefore, we propose that the following information about

19   companion animals should be entered into the family genogram: name, age, animal species, current medical

20   history, animal's prognosis, and relationship with the family. Family physicians should pay attention to the health

21   condition of companion animals. In addition, family physicians should recognize the social environment of pet

22   owners, such as employment status. It is important not only for family physicians but also for psychiatrists to

23   consider the possibility that owners of a pet with cancer may be suffering from depression and anxiety and may

24   need mental health care. Our study is the first attempt to describe the psychological impact such as depression

25   and anxiety on the pet owners after notification of pet cancer. This information is necessary for family physicians

26   who see a patient with depressive and/or anxiety feelings as the first encounter. Also, this is an important

27   message for veterinarians because they should pay more attention to tell the bad news more carefully and

28   consider the impact on pet owners.

29   One limitation of this study is the generalizability of results because the study setting was limited to a referral

30   secondary veterinary medical center specialized in oncology in an urban area. Therefore, we cannot rule out the

31   possibility that originally enthusiastic owners and owners with a tendency toward depression and high trait

32   anxiety were more likely to visit the referral veterinary medical center. The proportion of pet owners with

depression and anxiety may be lower than that identified in the present study when conducting surveys in all area of Japan, including the countryside, and surveys conducted at a primary care clinic. Second, while our results are valid in Japanese culture, they remain to be replicated in other cultures. Similar results may be obtained in countries in which pets are treated as family members. Third, we used convenience sampling rather than consecutive sampling, which may have led to a selection bias. In addition, because a screening test for depression was used in this study, it was uncertain whether the participants had developed an actual mental disorder. The progression of depression and anxiety over the long term is also unknown, as the investigation took place 1–3 weeks after notification of the diagnosis. The detailed processes that cause depression and anxiety may be elucidated by investigating depression and anxiety in owners of a pet diagnosed with cancer at primary veterinary clinics and monitoring them over time. Interventions such as counselling for pet owners after notification of a cancer diagnosis should also be considered.

Conclusion

Our findings indicate that some owners tended to become depressed and anxious after their pets had received a diagnosis of cancer. Owners who were employed had a higher rate of depression than those who were unemployed, and state anxiety was higher in owners with high trait anxiety and in those whose pets had a poor prognosis. Physicians may find it helpful to include pets in the family genogram and to consider the pets' health condition when providing medical treatment in family practice.

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Footnotes

Author contributions

YN conceived and designed the study, analyzed and interpreted the data, and drafted the manuscript. MM contributed to the conception and design of the study and analysis and interpretation of the data. AN, JH, and EM contributed to the conception of the study and acquisition of the data. HW, SY, HI, MK, RM, YS, and EY contributed to the interpretation of the data and discussions to help draft the manuscript. TK contributed to the

1

1 conception of the study. All authors critically revised the manuscript. All authors approved the final version of

2 the manuscript and agree to be accountable for the accuracy of the work. YN is the guarantor.

3

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Competing interests

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16 activities that could appear to have influenced the submitted work.

17

Patient consent

19 Not required.

20

Ethical approval

22 The ethics committee of The Jikei University School of Medicine approved study protocols (Ethics number:

23 25-049 7184).

24

Provenance and peer review

26 Not commissioned; externally peer reviewed.

27

Data sharing statement

29 No additional data are available.

30

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2   cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

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1 **Figure 1. Distribution of CES-D scores in the owners of a health pet and the owners of a pet with cancer**

2 The solid line shows the median CES-D score in each group. The dotted line shows the cut-off point for

3 depression.

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5 **Figure 2. Distribution of state-anxiety (A) and trait-anxiety (B) scores in the owners of a healthy pet and**

6 **the owners of a pet with cancer**

7 The solid lines show the median anxiety score in each group. A: the median state-anxiety score was moderate in

8 the owners of a pet with cancer, but very low in the owners of a healthy pet. B: the median trait-anxiety score in

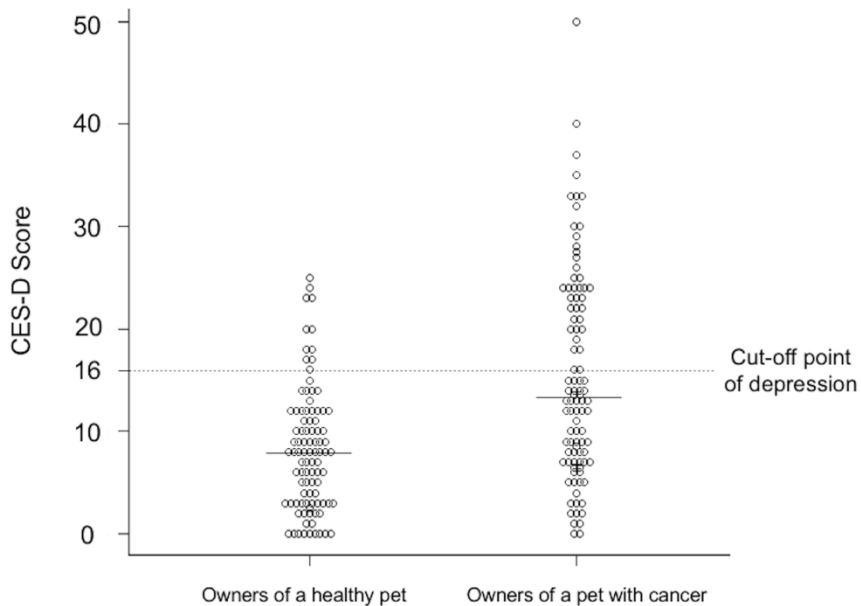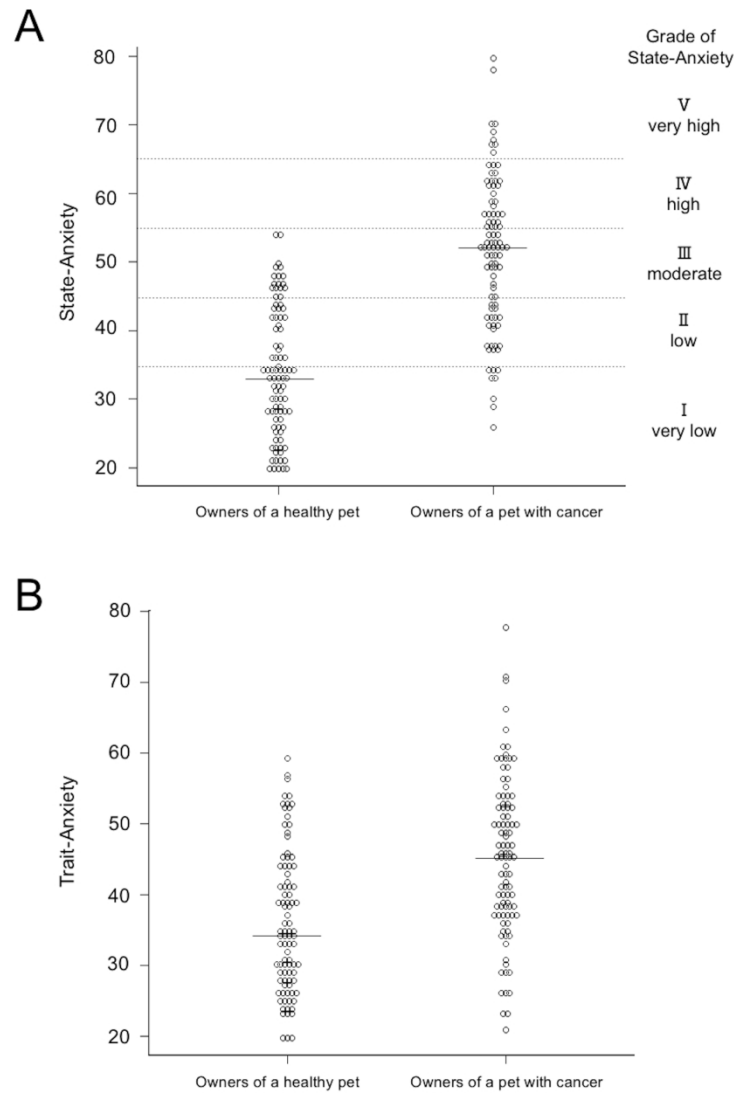9 the owners of a pet with cancer was higher than in the owners of a healthy pet.

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Figure 1. Distribution of CES-D scores in the owners of a health pet and the owners of a pet with cancer
The solid line shows the median CES-D score in each group. The dotted line shows the cut-off point for depression.

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Figure 2. Distribution of state-anxiety (A) and trait-anxiety (B) scores in the owners of a healthy pet and the owners of a pet with cancer
The solid lines show the median anxiety score in each group. A: the median state-anxiety score was moderate in the owners of a pet with cancer, but very low in the owners of a healthy pet. B: the median trait-anxiety score in the owners of a pet with cancer was higher than in the owners of a healthy pet.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6, 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9, 10, 11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 10, 11, 12
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13, 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13,14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.