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# Schizophrenia Research

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## Letter to the Editor

### Specificity and nature of the associations of twenty-four neuropsychiatric disorders with contacts with cats and dogs



**Keywords:**  
Epidemiology  
Risk factor  
Animals' related injury  
Zoonosis  
*Toxoplasma*  
*Bartonella*

Dear Editors

About 80% of human parasites are zoonotic; most of them were acquired from cats and dogs. Although an association of schizophrenia and bipolar disorder with keeping cats has been repeatedly shown to exist (Torrey et al., 2015; Torrey and Yolken, 2005, 2014), research of parasitic impact on mental health has been rather neglected. We used Facebook-based snowball technique for performing a large scale, cross-sectional study on a cohort of 8864 nonclinical subjects to search

for pet keeping-risk factors of 24 neuropsychiatric disorders (see similar study (Flegl and Horáček, 2017) for technical details). The subjects were asked to rate the intensity of their current and previous contacts with dogs and cats and the intensity of sustained animal-related injuries (biting by a dog, scratching by a cat) using 6-points scales. The participants were also asked which of 24 neuropsychiatric disorders on a list did they suffer.

The Table 1 shows associations between contacts with cats and risk of many disorders. After correction for multiple tests, no association with the number of dogs but ten positive associations with the number of cats were significant. To ascertain the nature of contact with animals possibly responsible for the associations, the multivariate analysis was performed using the age, the sex, the size of community, the numbers of cats and dogs presently in the house, total years of keeping cats and dogs in the past, years of keeping cats and dogs before the age of 13, the intensity of dog bites in the past, and the intensity of cat scratches in the past as independent risk factors. After correction for multiple tests, the number of cats in the house was associated with bipolar disorder (OR = 2.66, CI<sub>95</sub>: 1.3–5.45); keeping cats before age of 13 was positively associated with Asperger disorder (OR = 3.97, CI<sub>95</sub>: 2.08–7.59), and negatively with anxiety disorder (OR = 0.71, CI<sub>95</sub>: 0.52–0.96) and phobia (OR = 0.79, 0.63–0.98). The intensity of cat scratches was positively associated with thirteen disorders, namely unipolar depression

**Table 1**  
The prevalence of various neuropsychiatric disorders and the strength of associations between particular disorder and number of cats and dogs in the responder's house.

	Healthy men	affected men	Healthy women	Affected women	OR (CI <sub>95</sub> ) cats	OR (CI <sub>95</sub> ) dogs
Unipolar depression	2572	100 (3.74%)	3363	255 (7.05%)	1.87 (1.17–2.99)	0.94 (0.44–2.00)
Bipolar disorder	2608	64 (2.4%)	3504	114 (3.15%)	2.02 (1.07–3.83)	2.14 (0.82–5.61)
Schizophrenia	2638	34 (1.27%)	3584	34 (0.94%)	1.05 (0.34–3.22)	4.61 (1.08–19.74)
Anxiety disorder	2500	172 (6.44%)	3124	494 (13.65%)	1.78 (1.24–2.56)	1.11 (0.63–1.96)
Alcohol use disorder	2511	161 (6.03%)	3516	102 (2.82%)	0.84 (0.42–1.67)	1.89 (0.80–4.46)
Gambling	2595	77 (2.88%)	3594	24 (0.66%)	0.90 (0.30–2.71)	4.37 (1.25–15.25)
Parkinson disease	2659	13 (0.49%)	3610	8 (0.22%)	1.05 (0.12–9.12)	2.99 (0.28–32.16)
Epilepsy	2628	44 (1.65%)	3555	63 (1.74%)	0.62 (0.22–1.76)	2.15 (0.62–7.46)
Drug use disorder	2604	68 (2.54%)	3569	49 (1.35%)	1.49 (0.61–3.62)	1.62 (0.45–5.89)
Posttraumatic stress disorder	2625	47 (1.76%)	3452	166 (4.59%)	1.03 (0.58–1.83)	0.53 (0.19–1.51)
Obsessive compulsive disorder	2528	144 (5.39%)	3407	211 (5.83%)	1.14 (0.67–1.94)	1.10 (0.50–2.44)
Panic disorder	2578	94 (3.52%)	3400	218 (6.03%)	1.06 (0.59–1.90)	0.7 (0.29–1.67)
Insomnia primary	2559	113 (4.23%)	3436	182 (5.03%)	1.19 (0.68–2.09)	0.82 (0.35–1.92)
Learning disabilities	2337	335 (12.54%)	3342	276 (7.63%)	1.77 (1.19–2.64)	1.4 (0.77–2.55)
Borderline person disorder	2630	42 (1.57%)	3533	85 (2.35%)	2.32 (1.13–4.78)	1 (0.85–1.16)
Antisocial pers. disorder	2578	94 (3.52%)	3500	118 (3.26%)	2.43 (1.36–4.36)	1.82 (0.73–4.57)
Attention deficit hyperact. dis.	2558	114 (4.27%)	3525	93 (2.57%)	1.71 (0.9–3.26)	2.15 (0.85–5.47)
Phobia	2146	526 (19.69%)	2407	1211 (33.47%)	1.30 (0.99–1.71)	1.20 (0.80–1.79)
Bulimia, anorexia	2656	16 (0.6%)	3486	132 (3.65%)	0.84 (0.37–1.90)	1.68 (0.57–5.02)
Burn-out syndrome	2359	313 (11.71%)	3215	403 (11.44%)	1.45 (1.00–2.12)	0.96 (0.46–2.00)
Sexual disorder	2510	162 (6.06%)	3474	144 (3.98%)	1.57 (0.92–2.68)	1.81 (0.84–3.91)
Asperger syndrome	2606	66 (2.47%)	3546	72 (1.99%)	1.23 (0.54–2.82)	0.78 (0.22–2.78)
Autism	2641	31 (1.16%)	3601	17 (0.47%)	0.6 (0.11–3.29)	3.72 (0.62–22.3)
Other disorder	2596	76 (2.84%)	3511	107 (2.96%)	1.30 (0.66–2.55)	1.93 (0.75–4.92)

Prevalence of particular disorders reported by participants (4089 men, age: 34.4, S.D. 12.9 and 4775 women, age 31.8, S.D. 12.0) of the study. The last two columns show range odds ratio OR with 95% confidence interval CI<sub>95</sub> computed with logistic analyses with dependent variable disorder and independent variables size of place of living in childhood, total years keeping cats, and total years keeping dogs as independent factors (Quasi-Newton estimation method, maximum likelihood loss function, casewise deletion of missing data). False discovery rate (preset to 0.25) was controlled with Benjamini-Hochberg procedure (Benjamini and Hochberg, 1995).

(OR = 2.97, 1.86–4.77), burn-out syndrome (OR = 1.88, CI<sub>95</sub>: 1.33–2.66), panic disorder (OR = 2.18, CI<sub>95</sub>: 1.31–3.63), drug use disorder (OR = 3.3, CI<sub>95</sub>: 1.45–7.53), antisocial personality disorder (OR = 2.02, CI<sub>95</sub>: 1.1–3.7), sexual disorder (OR = 1.77, CI<sub>95</sub>: 1.06–2.97), obsessive compulsive disorder (OR = 1.63, CI<sub>95</sub>: 1.02–2.61), phobia (OR = 1.28, CI<sub>95</sub>: 1.0–1.65), borderline personality disorder (OR = 2.16, CI<sub>95</sub>: 1.0–4.68), anxiety disorder (OR = 1.4, CI<sub>95</sub>: 0.98–2.0), bulimia & anorexia (OR = 1.94, CI<sub>95</sub>: 0.95–3.96), alcohol use disorder (OR = 1.61, CI<sub>95</sub>: 0.93–2.81), and other disorders (OR = 1.67, CI<sub>95</sub>: 0.89–3.14). Total years of keeping dogs were negatively associated with Asperger disorder (OR = 0.18, CI<sub>95</sub>: 0.1–0.34); and years of keeping dogs before the age of 13 positively with bulimia & anorexia (OR = 2.25, CI<sub>95</sub>: 1.25–4.02). Intensity of dog bites was associated positively with learning disabilities (OR = 1.94, CI<sub>95</sub>: 1.42–2.65), posttraumatic stress syndrome (OR = 2.05, CI<sub>95</sub>: 1.27–3.31), insomnia (OR = 1.77, CI<sub>95</sub>: 1.16–2.7), attention deficit hyperactivity disorder (OR = 1.89, CI<sub>95</sub>: 1.14–3.13), Parkinson disease (OR = 6.46, CI<sub>95</sub>: 1.32–31.63), and bipolar disorder (OR = 1.88, CI<sub>95</sub>: 1.09–3.23). All results of logistic regressions are shown in the Supplementary Table S1 <https://figshare.com/s/31367ab33ecd4f7c5861>.

We confirmed the existence of the association between the intensity of contact with cats and bipolar disorder (Torrey et al., 2015), but not with schizophrenia. It is usually (but not always, see (Flegr, 2010) suggested or implicitly expected that oral infection with a cat parasite *Toxoplasma* is responsible for this association (Torrey et al., 2012; Torrey and Yolken, 2013). However, most of the associations were observed between mental health disorders and cats- and dogs-related injuries. The association between unipolar depression and cat scratches agreed with results of Hanauer et al. (2013) and Flegr and Hodny (2016). Current study suggests that the cat related injuries, and therefore probably the *Bartonella* infection (Flegr and Hodny, 2016), could be responsible for a much broader spectrum of neuropsychiatric disorders. Noteworthy, this spectrum has no intersect with the set of dog biting-associated disorders suggesting that the associations are specific and do not result from higher probability of reporting feelings of hurt or injustice by subjects with neuropsychiatric disorders (or generally by subjects in bad psychological conditions). It is, of course, possible that pets more frequently injure patients than healthy subjects, and even that subjects with different disorders have different probabilities to be attacked by cats and by dogs.

The incidences of particular disorders could be biased due to self-selection of the responders. Moreover, statistical association does not mean causality and no cross-sectional study could discriminate between the cause and the effect. One must be especially cautious with interpretation of the results concerning the low-incidence disorders, e.g. Parkinson's disease ( $N = 21$ ), because here the incidence of errors, e.g. mistyping- or self-diagnostic errors, could easily approach to, or even surpass the incidence of the disorder in the population. A major limitation of this study is that the participants provided information about their disorders themselves, resulting in less reliable information. It should be stressed, however, that such a stochastic error could cause only getting a false negative results (the failure to detect weak risk

factors) in contrast to identifying a non-existing risk factor (Flegr and Horáček, 2017).

The Facebook-based snowball method can be effectively used in exploratory studies to generate new hypotheses, such as that on possible role of *Bartonella* in etiology of many neuropsychiatric disorders, however, all results should be considered preliminary and should be replicated on a patient sample with verified diagnoses.

#### Conflict of interest

Authors have no conflict of interests.

#### Authors' contribution

JF designed the study and performed the analyses. MV collected and preprocessed the data. Both authors contributed to and have approved the final manuscript.

#### Acknowledgement

We would like to thank Raymon Gongora, Lenka Příplatová, and Jinka Boušová for their help with the final version of the paper. The work was supported by Charles University (UNCE 204004) and the Czech Science Foundation (Grant No. P407/16/20958).

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24 January 2017