The relationship between owning a cat and the risk of developing a brain cancer in a prospective study of UK women: comment on Thomas et al.

Domestic cats are the definitive host of *Toxoplasma gondii* and are one source of *T. gondii* infection in human populations, along with consumption of undercooked or cured contaminated meats and vertical transmission during the prenatal and perinatal period [1,2]. Contact with cats or cat faeces may increase the risk of *T. gondii* infection [3,4], although this has not been not found in all studies [5,6].

Thomas et al. recently compared national statistics on the prevalence of antibodies to *T. gondii* infection (seroprevalence ranging from 4% to 67%) with incidence of brain cancer. After adjustment for gross domestic product, sex, mobile phone use and latitude, they found that there was a correlation between the prevalence of antibodies to *T. gondii* and the incidence of brain cancer [7]. They estimated that there was a 1.8-fold increase in brain cancer incidence in countries with the highest prevalence of *T. gondii* antibodies, compared with countries with the lowest prevalence.

We have used data from a large UK prospective cohort of middle-aged women to investigate the relationship between cat ownership and incidence of brain tumours. Information on current ownership of cats, dogs, birds and fishes was obtained from a postal survey of study participants during 2006–2007: the respondents to this survey form the baseline cohort for these analyses. Full details of the study design and methods are described elsewhere [8], and all questionnaires can be viewed at http://www.millionwomenstudy.org. Information on *T. gondii* positivity or consumption of undercooked meats was not available.

In total, 626 454 women aged 64 years on average at baseline were included in the analyses, among whom, 114 614 (18%) owned at least one cat. Table 1 shows the characteristics of the study population by cat ownership. Women who owned a cat as a pet were slightly younger, slightly less likely to be in the upper third of socio-economic status, and more likely to be current smokers and have ever used hormone replacement therapy than women who did not have a pet.

Cancer registrations for the entire population are routinely notified to the study investigators through the National Health Service Central Registers. This information includes the date of each such event and codes the tumour site and morphology using the 10th revision of the International Classification of Diseases (ICD-10) [9]. We calculated relative risks (RRs) and 95% confidence intervals (CIs) for incidence of all tumours of the central nervous system (CNS) (ICD-10 C70, C71, C72.0, C75.1-3, D32, D33, D35.2-4, D42, D43 and D44.3-5), of brain cancer (ICD-10 C70-72) as defined by Thomas et al., and of specified glioma and meningioma in relation to cat ownership using a Cox proportional hazards model with attained age as the underlying time variable. Analyses were stratified by region and by quintiles of socio-economic status, and we adjusted for height, body mass index, hormone replacement therapy use, daily alcohol intake and weekly strenuous exercise. We were unable to assess whether the risk of brain cancer varied with age (as suggested by Vittecoq et al. [10] for brain cancer mortality) owing to the low number of incident cases aged over 64 years.

Eligible women contributed woman-years from the date that they answered the baseline questions about living with a cat until the date of diagnosis with the tumour of interest, date of death, diagnosis of another cancer (except non-melanoma skin cancer) or the end of follow-up, whichever was earliest. During 2 million person-years of follow-up (an average of 3.2 years per woman), 494 CNS tumours were reported, of which 265 were brain tumours as classed by Thomas et al.

Incidence of brain cancer was not increased in women living with a cat (RR = 0.88, 95% CI = 0.62–1.24), when compared with women living with no pets. Similarly, no association was observed for all CNS tumours, or for specified glioma or meningioma (table 1). In conclusion, cat owners in a cohort of middle-aged UK women do not have an increased risk of brain cancer, when compared with non-cat owners. This, however, does not rule out the possibility that *T. gondii* infection from another source may be associated with brain cancer incidence.

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4 Kapperud, G., Jenum, P. A., Stray-Pedersen, B., Melby, K. K., Eskild, A. & Eng, J. 1996 Risk factors for *Toxoplasma*
Table 1. Characteristics of the study population by cat ownership and details of follow-up including relative risks (RRs) and 95% CIs for central nervous system (CNS) tumour incidence.

<table>
<thead>
<tr>
<th></th>
<th>own no pets</th>
<th>own cat(s) onlya</th>
<th>own cat(s) other petsa</th>
<th>own cat(s) onlya</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of women</td>
<td>378 066</td>
<td>114 614</td>
<td>78 825</td>
<td>35 789</td>
</tr>
<tr>
<td>mean age (s.d.)</td>
<td>64.8 (4.9)</td>
<td>63.4 (4.5)</td>
<td>63.4 (4.5)</td>
<td>63.4 (4.5)</td>
</tr>
<tr>
<td>mean height, cm (s.d.)</td>
<td>34.2</td>
<td>32.9</td>
<td>33.3</td>
<td>31.9</td>
</tr>
<tr>
<td>mean body mass index, kg m⁻² (s.d.)</td>
<td>162.2 (6.6)</td>
<td>162.7 (6.7)</td>
<td>162.6 (6.7)</td>
<td>162.6 (6.8)</td>
</tr>
<tr>
<td>strenuous physical activity &gt; 1 h week⁻¹ (%)</td>
<td>26.3 (4.7)</td>
<td>26.6 (4.9)</td>
<td>26.5 (4.9)</td>
<td>26.7 (5.0)</td>
</tr>
<tr>
<td>alcohol intake, ≥70 g week⁻¹ (%)</td>
<td>54.5</td>
<td>56.2</td>
<td>55.2</td>
<td>58.6</td>
</tr>
<tr>
<td>current smoker (%)</td>
<td>7.6</td>
<td>9.4</td>
<td>9.3</td>
<td>9.6</td>
</tr>
<tr>
<td>ever used hormone replacement therapy (%)</td>
<td>51.9</td>
<td>56.6</td>
<td>56.5</td>
<td>56.7</td>
</tr>
</tbody>
</table>

follow-up for CNS tumours
- women-years of follow-up (1000s): 1189.9, 365.3, 251.2, 114.1
- average years of follow-up per woman: 3.15, 3.19, 3.19
- incident CNS tumours (n): 292, 79, 54
- incident brain cancers (n): 159, 41, 25
- incident gliomas (n): 123, 30, 18
- incident meningiomas (n): 71, 21, 14

RR and 95% CIs for CNS tumour incidence
- all CNS tumours: 1, 0.90 (0.70–1.15), 0.89 (0.67–1.20), 0.90 (0.60–1.36)
- all brain cancers: 1, 0.88 (0.62–1.24), 0.78 (0.51–1.19), 1.09 (0.65–1.83)
- glioma: 1, 0.86 (0.58–1.29), 0.75 (0.46–1.23), 1.11 (0.61–2.01)
- meningioma: 1, 0.96 (0.58–1.56), 0.92 (0.51–1.63), 1.05 (0.48–2.29)

*aA subgroup of ‘own cat(s)’ with or without other pets.

*bICD-10 C70-72, as classed by Thomas et al. [7].

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