RISK FACTORS FOR ECHINOCOCCUS GRANULOSUS INFECTION: A CASE-CONTROL STUDY

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Abstract. Despite the importance of cystic hydatid disease worldwide, no case-control study evaluating the risk factors for Echinococcus granulosus infection has been published to date. Thus, we carried out a hospital study to quantify different risk factors associated with the disease in a province marked by a high incidence of hydatidosis (Soria, Spain). The study population was composed of 127 cases and 127 controls matched by sex, age, and residence. Odds ratios (ORs) for hydatidosis decreased inversely with size of place of birth and residence, and increased with the number of dogs and years of coexistence with them. The variable involving the possibility of dogs ingesting uncooked viscera or carrion proved to be of greater importance (OR = 3.99, 95% confidence interval = 1.94–8.20). Risk factors for hydatidosis traceable to the family environment are of greater relative importance than those attributable to working directly with livestock. No association could be found between ingestion of raw green vegetables and hydatidosis.

INTRODUCTION

In Europe and Asia, cystic hydatidosis is a disease caused in humans and ungulates by the larval phase of the tapeworm Echinococcus granulosus, whose definitive host is the dog and other canines. In its larval phase, the parasite forms cysts that vary in size and clinical relevance, and which in humans are found predominantly in the liver or lungs, although they can be distributed in tissues throughout the body. Although symptomatic hydatidosis frequently requires surgical management, there are numerous cases of asymptomatic hydatidosis that often go unnoticed and never become clinically manifested. Hydatid disease is endemic around the Mediterranean basin,1 with notable interregional differences in prevalence generally associated with sheep-rearing in the different areas.

Echinococcus granulosus is a parasite that shows great intraspecific variability. There is strong evidence for the existence of at least seven host-adapted strains,1 and five of the seven are geographically widely distributed. In Spain, three strains of E. granulosus have been genetically typed using genetic, isoenzyme, and in vitro vesicular development analysis: these are the “sheep-cattle” strain, which also infects humans, and the “horse” and “pig-goat” strains,2 which do not appear to play any role in human disease.3

The incidence rate per 100,000 population for reported cases in Spain has ranged from 1.68 in 1983 to 1.01 in 1996.4–6 In contrast, the Province of Soria, a hyperendemic area with 92,848 inhabitants (1996 census figures), had a reported case incidence rate of 3.07–26.67 cases per 100,000 population for the same period. Case-definition criteria were not standardized in the study period, but in general reflect surgical incidence. While there has been a downward trend in the number of cases in recent years, wide variations in annual rates are also evident, which probably suggests shortcomings in the reporting of new cases.

The majority of hydatidosis cases in this province are diagnosed and treated at a single public health hospital. In the period from 1981 to 1996, 573 cases of hydatidosis were diagnosed at this medical center; of these, 321 were surgical (Campos A, 1998, unpublished data).

Given the local importance of hydatid disease, we performed a case-control study to evaluate the influence of the various sources of exposure to E. granulosus infection. One of two case-control studies has previously been published,5,6 although both concentrated exclusively on alveolar hydatidosis, which is caused by E. multilocularis and whose clinical presentation and pattern of distribution are different from those of cystic hydatid disease. Furthermore, we sought to identify behavior patterns associated with higher risk of infection, with the aim of suggesting disease-prevention guidelines based on implementation of public health programs.

MATERIALS AND METHODS

Selection of cases. All new cases of hydatidosis diagnosed since 1981, when the Soria Provincial General Hospital, a part of Spain’s Instituto Nacional de la Salud (INSALUD) public health service, was opened, were registered prospectively. For registration purposes, surgical case diagnoses were confirmed by examination of excised tissue and an anatopathologic report compatible with hydatidosis. Inclusion criteria for non-surgical cases were a radiographic image with specific characteristics (daughter cysts, double wall, calcified circular lesion ≥ 4 cm),6 or a suggestive radiographic image without specific characteristics, but with serologic evidence of E. granulosus infection. As this was an observational and retrospective study, no personal identifiers were used.

Using the patient registry as our starting point, the 127 cases included in this study were selected in one of three ways: 1) patients who came to the hospital for specific follow-up of initially non-surgical hydatidosis (44 cases); 2) patients admitted following a new diagnosis of hydatid cysts or clinical complications arising from a known case of hydatidosis (24 cases); and 3) patients previously diagnosed with hydatidosis who were admitted to the hospital or came for an out-patient examination with other complaints or ailments (59 cases). Hospital admission and outpatient data for the latter two groups were checked at the beginning of each week.

Selection of controls. Controls were selected for each case and matched by sex, date of birth (± 5 years), and usual place of residence (public health district) in the preceding
10 years. As a selection source, patient admission files and case records dealing with outpatients seen in medical visits for different reasons were used. By definition, controls were required to have no symptomatic disease, present or past. To ensure that all eligible controls were free of asymptomatic hydatidosis, which cannot be ruled out by negative serologic test results alone, only patients who, for whatever reason, had recently undergone radiologic tests of the thorax and abdomen (ultrasound or computerized tomography scan) and showed no evidence of hydatid cysts served as controls.

**Data collection.** All case and control interviews were conducted at the hospital by a single interviewer. The questionnaire contained 63 questions that dealt with demographic circumstances and any activities and lifestyles that might be associated with the risk of contracting hydatid disease. The survey was divided into the following sections: personal data (sex, date and place of birth, place of residence, educational level); work (whether or not related to agriculture and livestock farming involving the various animal species); family environment (likewise, with respect to rural activities); ownership of or contact with dogs (plus the conditions in which dogs were kept with regard to ingestion of viscera or offal possibly infested with *E. granulosus* eggs); eating habits (green vegetables possibly contaminated by dog feces); and dwelling type and features (apartment, country home equipped with or without an animal pen, i.e., a fenced enclosure adjoining the dwelling). Since it was difficult to ensure that the interviewer would be ignorant of the interviewee’s case or control status, questions were phrased in such a way that the replies had to be quantitative or carefully selected from a series of mutually exclusive options that covered all possible answers and avoided subjectivity both in the replies and in the interpretations put upon these by the interviewer.

The period of potential exposure to *E. granulosus* infection was taken as the time between the date of birth and the date of the interview. All case and control interviews were conducted in the period from June 1992 to September 1996.

**Statistical analysis.** The analysis was conducted on the basis of 254 interviews (127 cases and 127 controls). A matched analysis was performed, with odds ratios (ORs) and their 95% confidence intervals (CIs) estimated for each variable by conditional logistic regression. Risk estimates reported here have thus been adjusted for age, sex, and place of residence. For continuous variables categorized in the analysis, a test for trend was calculated by assigning an increasing integer to each category.

**RESULTS**

The distribution of cases and controls by age, sex, educational level, and civil status are shown in Table 1. Cases and controls did not show statistically significant differences with respect to educational level and civil status.

The distribution of cases and controls by place of birth and residence is shown in Table 2. The OR for hydatidosis showed a similar decrease with population size for both study variables.

The association of case and controls with dogs is shown in Table 3. Compared with those who had never had dogs, the ORs for those who had owned one or more dogs ex-

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### Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cases</th>
<th>%</th>
<th>Controls</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
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<tr>
<td>&lt;45</td>
<td>41</td>
<td>32.3</td>
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<td>32.3</td>
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<td>40.9</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>58</td>
<td>45.7</td>
<td>58</td>
<td>45.7</td>
</tr>
<tr>
<td>Female</td>
<td>69</td>
<td>54.3</td>
<td>69</td>
<td>54.3</td>
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<tr>
<td>Educational level</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
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<td>5.5</td>
<td>6</td>
<td>4.7</td>
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<tr>
<td>Primary (partial)</td>
<td>67</td>
<td>52.7</td>
<td>60</td>
<td>47.2</td>
</tr>
<tr>
<td>Primary (fully completed)</td>
<td>35</td>
<td>27.6</td>
<td>32</td>
<td>25.2</td>
</tr>
<tr>
<td>High school</td>
<td>5</td>
<td>3.9</td>
<td>7</td>
<td>5.5</td>
</tr>
<tr>
<td>Vocational training</td>
<td>3</td>
<td>2.4</td>
<td>11</td>
<td>8.7</td>
</tr>
<tr>
<td>Diploma or degree graduates</td>
<td>10</td>
<td>7.9</td>
<td>11</td>
<td>8.7</td>
</tr>
<tr>
<td>Civil status</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>24</td>
<td>18.9</td>
<td>25</td>
<td>19.7</td>
</tr>
<tr>
<td>Married</td>
<td>93</td>
<td>73.2</td>
<td>85</td>
<td>66.9</td>
</tr>
<tr>
<td>Widowed or separated</td>
<td>10</td>
<td>7.9</td>
<td>17</td>
<td>13.4</td>
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### Table 2

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cases</th>
<th>%</th>
<th>Controls</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of inhabitants—place of birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>&lt;100</td>
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<td>100–500</td>
<td>40</td>
<td>27</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>501–2,000</td>
<td>15</td>
<td>22</td>
<td>0.985</td>
<td>0.514–1.886</td>
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<tr>
<td>&gt;2,000</td>
<td>11</td>
<td>33</td>
<td>0.379</td>
<td>0.154–0.935</td>
</tr>
<tr>
<td>trend $P = 0.0002$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No. of inhabitants—place of usual residence</td>
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<td></td>
<td></td>
</tr>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>100–500</td>
<td>35</td>
<td>25</td>
<td>0.754</td>
<td>0.322–1.764</td>
</tr>
<tr>
<td>501–2,000</td>
<td>13</td>
<td>24</td>
<td>0.224</td>
<td>0.078–0.646</td>
</tr>
<tr>
<td>&gt;2,000</td>
<td>41</td>
<td>54</td>
<td>0.239</td>
<td>0.086–0.659</td>
</tr>
<tr>
<td>trend $P = 0.00009$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*a* Matched analysis (conditional logistic regression).

† After matching variables were controlled for, conditional logistic regression analyses were adjusted for the variable ingestion of uncooked viscera.

‡ CI = confidence interval.
mators were adjusted for the variable ingestion of uncooked viscera yielded significant ORs. However, when the estimators were adjusted for the variable ingestion of uncooked viscera, the association decreased in magnitude and was not statistically significant.

Our results provided no support for the hypothesis that consumption of raw vegetables grown at ground surface level, and thus more susceptible to being contaminated by oncospheres, might increase the risk of hydatidosis (Table 5). The results obtained for dwelling characteristics indicated that the existence of an animal pen adjacent to the home posed no excess risk of disease. Nevertheless, the results reported did underscore the lower risk for apartment dwellers compared with those who had always lived in rural dwellings.

Table 6 shows the results of fitting a conditional logistic regression model that included the following variables: ingestion of viscera, family environment of the livestock-ranching type, size of place of birth, and rural dwelling. The variable ingestion of uncooked viscera yielded an OR of 3.99 (95% CI = 1.94–8.20). The model also highlighted the association between hydatidosis and residence in rural areas.

**DISCUSSION**

Using those individuals who did not own dogs as a reference, our study provides evidence that coexistence with dogs increases the risk of hydatidosis by more than two-fold and that this risk increases with the number of dogs and...
years of coexistence with them. Similarly, the conditions in which dogs are kept are of great importance. Allowing dogs to remain loose, with the possibility of their ingesting animal offal, increases the risk of disease to a relevant degree. Moreover, the results show that the risk of hydatidosis obtained from work as a livestock rancher in contact with different animal species is in great part affected by coexistence with dogs.

Despite the importance of echinococcosis worldwide, there are only two case-control studies in the literature dealing with this particular parasitosis.7,8 These studies analyzed 19 and 23 cases of alveolar echinococcosis caused by the larval phase of E. multilocularis that occurred in Alaska and Austria, respectively. In the Alaskan study,7 the risk of disease was associated with dog ownership and residence in a dwelling constructed directly over the tundra. The Austrian study found no association between dog ownership and a higher risk of disease,4 possibly because dogs enjoy greater freedom of movement in Alaska than they do in Austria and the likelihood of Austrian dogs ingesting carrion is therefore

### Table 4

Odds ratios (ORs) for hydatidosis by reference to contact with different species of livestock

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cases</th>
<th>Controls</th>
<th>Model A*</th>
<th>OR 95% CI</th>
<th>OR 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock rancher or farmer</td>
<td>88/39</td>
<td>78/49</td>
<td>1.588</td>
<td>0.866–2.914</td>
<td>0.848–1.739</td>
</tr>
<tr>
<td>Work with§</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>69/40</td>
<td>51/51</td>
<td>2.033</td>
<td>1.065–3.881</td>
<td>1.041–2.191</td>
</tr>
<tr>
<td>Goats</td>
<td>54/40</td>
<td>33/51</td>
<td>2.673</td>
<td>1.280–5.435</td>
<td>1.271–2.913</td>
</tr>
<tr>
<td>Hogs</td>
<td>77/40</td>
<td>62/51</td>
<td>1.793</td>
<td>0.971–3.312</td>
<td>0.982–2.024</td>
</tr>
<tr>
<td>Cows</td>
<td>47/40</td>
<td>31/51</td>
<td>2.073</td>
<td>1.059–4.060</td>
<td>1.052–2.313</td>
</tr>
<tr>
<td>Horses</td>
<td>62/40</td>
<td>49/51</td>
<td>1.799</td>
<td>0.956–3.388</td>
<td>0.889–1.903</td>
</tr>
<tr>
<td>Livestock ranching or farming family</td>
<td>117/10</td>
<td>104/23</td>
<td>3.167</td>
<td>1.265–7.929</td>
<td>1.587–5.576</td>
</tr>
<tr>
<td>Family with¶</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>66/12</td>
<td>54/26</td>
<td>3.006</td>
<td>1.275–7.085</td>
<td>1.386–3.772</td>
</tr>
<tr>
<td>Hogs</td>
<td>103/12</td>
<td>93/26</td>
<td>2.643</td>
<td>1.144–6.106</td>
<td>1.332–3.490</td>
</tr>
<tr>
<td>Cows</td>
<td>64/12</td>
<td>51/26</td>
<td>2.911</td>
<td>1.262–6.713</td>
<td>1.387–3.706</td>
</tr>
<tr>
<td>Horses</td>
<td>71/12</td>
<td>73/26</td>
<td>2.302</td>
<td>0.986–5.374</td>
<td>1.191–3.238</td>
</tr>
</tbody>
</table>

* Matched analysis (conditional logistic regression).
† After matching variables were controlled for, conditional logistic regression analyses were adjusted for the variable ingestion of uncooked viscera.
‡ CI = confidence interval.
§ Taking subjects who have never worked with livestock as reference.
¶ Taking subjects whose families are not livestock ranchers as reference.

### Table 5

Odds ratios (ORs) for hydatidosis by reference to variables dealing with food source and dwelling characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cases</th>
<th>Controls</th>
<th>Model A*</th>
<th>OR 95% CI</th>
<th>OR 95% CI</th>
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<tbody>
<tr>
<td>Ingestion of lettuces</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>≤1 day/week</td>
<td>13</td>
<td>19</td>
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<td></td>
<td>1</td>
</tr>
<tr>
<td>2–3 days/week</td>
<td>15</td>
<td>23</td>
<td>0.973</td>
<td>0.386–2.451</td>
<td>0.942–2.855</td>
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<tr>
<td>&gt;3 days/week</td>
<td>99</td>
<td>85</td>
<td>1.641</td>
<td>0.780–3.452</td>
<td>1.321–3.192</td>
</tr>
<tr>
<td>trend P = 0.090</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>No. of years eating produce family</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vegetable garden</td>
<td>22</td>
<td>23</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>0–10</td>
<td>7</td>
<td>13</td>
<td>0.502</td>
<td>0.148–1.710</td>
<td>0.627–2.724</td>
</tr>
<tr>
<td>&gt;10</td>
<td>98</td>
<td>91</td>
<td>1.122</td>
<td>0.551–2.282</td>
<td>0.501–1.368</td>
</tr>
<tr>
<td>trend P = 0.487</td>
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<td></td>
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<td>No. of years in rural dwelling, with animal pen</td>
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<td>0–10</td>
<td>36</td>
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<td></td>
<td>1</td>
</tr>
<tr>
<td>1–20</td>
<td>21</td>
<td>25</td>
<td>0.747</td>
<td>0.340–1.640</td>
<td>0.482–1.294</td>
</tr>
<tr>
<td>&gt;20</td>
<td>70</td>
<td>69</td>
<td>0.937</td>
<td>0.527–1.667</td>
<td>0.429–2.011</td>
</tr>
<tr>
<td>trend P = 0.884</td>
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<td>0.033</td>
</tr>
<tr>
<td>No. of years in apartment</td>
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<td>1–20</td>
<td>29</td>
<td>33</td>
<td>0.593</td>
<td>0.313–1.124</td>
<td>0.952–2.085</td>
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<td>&gt;20</td>
<td>18</td>
<td>35</td>
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<td>0.464–1.725</td>
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<td>trend P = 0.002</td>
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<td>0.161</td>
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* Matched analysis (conditional logistic regression).
† After matching variables were controlled for, conditional logistic regression analyses were adjusted for the variable ingestion of uncooked viscera.
‡ CI = confidence interval.
Table 6

<table>
<thead>
<tr>
<th>Variables</th>
<th>OR</th>
<th>95% CI</th>
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</thead>
<tbody>
<tr>
<td>Dogs with ingestion of uncooked viscera</td>
<td>3.985</td>
<td>1.936–8.203</td>
</tr>
<tr>
<td>Livestock ranching or farming family</td>
<td>1.076</td>
<td>0.268–4.327</td>
</tr>
<tr>
<td>No. of inhabitants—place of birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>100–500</td>
<td>1.159</td>
<td>0.565–2.374</td>
</tr>
<tr>
<td>501–2,000</td>
<td>0.784</td>
<td>0.245–2.282</td>
</tr>
<tr>
<td>&gt;2,000</td>
<td>0.411</td>
<td>0.145–1.165</td>
</tr>
<tr>
<td>No. of years in rural dwelling with/without animal pen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1–20</td>
<td>7.138</td>
<td>0.642–79.357</td>
</tr>
<tr>
<td>&gt;20</td>
<td>3.717</td>
<td>0.378–36.583</td>
</tr>
</tbody>
</table>

*Matched analysis (conditional logistic regression).
†CI = confidence interval.

lower. Nevertheless, cat ownership was significantly associated with *E. multilocularis* infection, a variable not considered in the Alaskan study.

While similarities exist between alveolar echinococcosis and hydatidosis, especially in the role of the dog as one of the definitive hosts, these two diseases differ widely with regard to many of their clinical and epidemiologic characteristics. Thus, conclusions drawn from a case-control study on alveolar hydatidosis cannot be simply superimposed upon those drawn from one on cystic hydatid disease. In our study, the higher incidence of hydatidosis in the study area rendered it possible to work with a greater number of cases, thereby yielding more consistent results. Furthermore, there are different risk factors for the same disease in different parts of the world.

In our study, every effort was made to ensure that the control group included no subjects with asymptomatic hydatidosis by thoroughly checking all hospital radiology, tomography, and echography records. All interviews with cases and controls were conducted on hospital premises, under identical conditions, using the structured questionnaire described in the Materials and Methods. In addition, the questions included in the questionnaire were easy to answer, with there being no reason to believe that recall of dog ownership and/or occupational habits might be any better among cases than controls.

Observation of case and control characteristics (Table 1) showed no marked variations in educational level, thus limiting the possibility of any bias in the influence exerted on the risk of contracting disease due to disparities between the two groups arising from differences in cultural levels and hygienic habits.

A comparison of the distribution of the groups by the size of the place of birth versus place of usual residence (Table 2) shows the demographic changes that have taken place in recent decades, and provides evidence of a trend toward the growth of larger towns compared with smaller towns, even within the same province. Birthplace population size continues to be an important risk factor, since people who move to larger towns make frequent return trips to their towns of origin. Moreover, given the long incubation period of hydatidosis, it is conceivable that such persons might have contracted the disease before emigrating.

With respect to the results on contact with dogs (Table 3), there are some aspects that need more detailed comment. It appears that persons who have coexisted with more than 15 dogs over their lifetimes run a lower risk than those who have coexisted with 7–15 dogs. This might be explained by the fact that in the study region of Spain, multiple dog owners tend to be hunters. Such individuals keep packs of dogs that are usually housed in kennels and thus less likely to have the opportunity of ingesting infested offal. Our results fail to support the hypothesis that persons who engage in cleaning kennels may increase their risk of infection on being exposed to dog stools. Indeed, the fact that such persons clean kennels may be associated with keeping their dogs in better sanitary and health conditions than owners who allow their dogs to remain loose and unleashed.

The study on risk attributable to work or contact with different livestock species was aimed at ascertaining variations associated with the different strains of *E. granulosus*. Nevertheless this objective was hindered by the scant number of persons who were in contact with just one species of animal, with the majority being simultaneously exposed to several species (59% of the cases and 49% of the controls). However, special mention should be made of the reduction in the effect brought about by inclusion of the variable ingestion of uncooked viscera in the models B (Tables 2, 4, and 5).

It can be deduced from the results of our study that disease risk factors linked to family environment (animal husbandry, residence in small towns, contact with dogs) are of greater importance than direct work with livestock. While women may help with livestock farming in Spain, they tend to be less active in this regard than men. In most areas endemic for hydatidosis, the disease incidence is very similar in both sexes, thus suggesting that the occupational component of the risk is less relevant than that attributable to other environmental conditions. This is not the case with other endemic zoonosis in Spain, e.g., brucellosis, which although similarly associated with cattle, is not associated with dogs, and in which the importance of the occupational risk is reflected in a higher disease incidence in males compared with females.

Hydatidosis can be contracted through ingestion of green vegetables contaminated with oncospheres. Dogs may find access to crops under intensive cultivation difficult, yet family vegetable gardens are generally unfenced, thus giving rise to the possibility of the dogs belonging to a family and other dogs entering and depositing their excrement. Green vegetables posing the greatest risk can be assumed to be those that are grown on a family plot at ground surface level and eaten raw (e.g., lettuce). This could be the mode of infection in patients who have always lived in an urban environment and have no other risk factors. In a study undertaken in another endemic area in Spain, 8.7% of the green vegetables from the central vegetable market in Zaragoza were found to have tapeworm eggs. Nonetheless, we found no conclusive results linking the habit of eating fresh lettuce or home-grown produce to hydatidosis. Similarly, in the studies carried out in Alaska and Austria on *E. multilocularis*, no
association was found between alveolar echinococcosis and ingestion of wild fruit.

The highly endemic nature of hydatidosis in the Province of Soria is a consequence of the E. granulosus cycle being maintained over many years. Correct disposal of livestock corpses, conducting of a dog census, control of dog movement, and deworming campaigns continue to be the basic preventive measures targeted at halting this cycle. Although compliance with these health regulations is mandatory by law at the national, regional and local level, in practice only dog deworming is carried out but only incompletely. As long as compliance with these regulations cannot be fully guaranteed, all residents of rural areas, including those who state that they have never handled or stroked a dog, will be at risk of contracting the disease. Health education must strive to change risk behaviors, insisting on strict hygienic practices being maintained with regard to dogs.

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