Prevalence of *Giardia lamblia* Infection in Household Dogs

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Abstract

A total of 1035 household dogs were examined for the presence of *Giardia lamblia* (*G. lamblia*) in their feces. Fecal samples from 151 (14.6%) of the dogs were positive for *Giardia*. The protozoan was more often detected in soft feces (26.4%) than in normal (10.0%) or diarrheic feces (13.7%) (*p*<0.001 and *p*<0.01, respectively). The forms of the organisms obtained from the 151 dogs were cysts (77.5%), trophozoites (9.9%), or both cysts and trophozoites (12.6%). Dogs kept indoors had a higher prevalence (18.5%) of *Giardia* than dogs kept outdoors (4.8%) (*p*<0.001). *Giardia* infection was also more prevalent in 1-6 months old puppies (21.7%) compared to other groups (2.4%–7.5%) (*p*<0.001). The prevalence of *Giardia* in dogs originally purchased from pet shops or breeding kennels was extremely high (21.5%) compared to that of dogs from individual households (4.3%) (*p*<0.001).

With regard to human public health, the high infection rate of *Giardia* in puppies and dogs kept indoors is a serious problem because *G. lamblia* in infected dogs may have zoonotic potential. No reports of human giardiasis transmitted from dogs have been made. However, the results of this study suggest that the risk of *Giardia* transmission from household dogs to humans is not negligible. Pet owners should be taught appropriate hygiene measures to prevent *Giardia* transmission from dogs to humans.


Introduction

*Giardia lamblia* (synonyms: *G. intestinalis*, *G. duodenalis*) is a flagellate, protozoan parasite found in the small intestine of dogs and other mammals, including humans¹². This organism is capable of producing acute or chronic diarrhea¹⁰. Since April 1, 1999, a new law for infectious diseases control has become effective in Japan. Under the new law, giardiasis in humans falls into infectious disease category 4. Dogs are often treated as companions, and close relationships often develop between humans and dogs. Thus, the risk of transmitting infectious agents from dogs to humans must be considered. Isolates of *G. lamblia* from infected dogs suggest that these organisms may have zoonotic potential¹². However, only a limited number of studies surveying the presence of *G. lamblia* in dogs in Japan have been reported⁵⁻¹⁰. The purpose
of the present study was to investigate the prevalence of *G. lamblia* in household dogs. Further, potential risk factors for *Giardia* infection, such as breed, age, living condition and origin, were examined.

### Materials and Methods

A total of 1035 household dogs between the ages of 1 month and 15 years (443 males and 592 females) brought to two veterinary clinics in Aomori and Akita Prefecture, Japan, were examined for the presence of *G. lamblia* in their feces. After the condition of the fecal samples was examined (normal, soft or diarrhea), *Giardia* trophozoites and/or cysts were detected using both direct smears and formalin-ethyl acetate sedimentation. The breed, living condition (indoors or outdoors), age (1-6 months, 7 months-1 year, 2-5 years, or over 6 years) and origin (individual households or pet shops/breeding kennels) were also noted for each dog. Statistical significance was analyzed using Fisher's exact probability test.

### Results

Fecal samples from 151 out of 1035 (14.6%) dogs were positive for *Giardia*. With regard to the relationship between fecal condition and the detection of *Giardia*, the protozoan was more often detected in soft feces than in normal or diarrheic feces (p<0.001 and p<0.01, respectively) (Table 1). The forms of the organisms obtained from the 151 dogs were cysts (77.5%), trophozoites (9.9%), and both cysts and trophozoites (12.6%).

The prevalence of *Giardia* was significantly higher in Pomeranians (p<0.001) and Yorkshire terriers (p<0.05), compared to the overall prevalence of 14.6% (Table 2). Though some breeds, such as Great Pyrenees, Akita dogs, Fox terriers and Miniature schnauzers also showed a prominent prevalence, a statistical significance was not demonstrated. In contrast, a significantly lower prevalence was observed in mongrels and Golden retrievers (p<0.001 and p<0.05, respectively). Of the dogs examined, 71.6% were kept indoors, and 28.4% were kept outdoors. Dogs that were kept indoors had a higher prevalence of *Giardia* than those kept outdoors (p<0.001) (Table 3). With regard to age, a higher prevalence of *Giardia* infection was observed in the 1-6 months age group compared to those of the other groups (p<0.001) (Table 4).

The prevalence of *Giardia* was much higher in dogs originally purchased at pet shops or breeding kennels compared to that of those obtained from individual households (p<0.001) (Table 4). A significant difference in *Giardia* infection was not observed among the age groups of individual household dogs. In the pet shop/breeding kennel dogs, a higher prevalence of *Giardia* infection was observed in the 1-6 months age group compared to other age groups (p<0.001-0.05). Furthermore, after comparing prevalence according to age groups of individual household dogs and pet shop/breeding kennel dogs, a significantly higher
prevalence of infection was observed in pet shop/breeding kennel dogs in the 1–6 months age group (p<0.001) (Table 4). Regional differences in Giardia infection were not observed (Table 5).
Table 4 Prevalence of *Giardia lamblia* infection according to animal origin and age

<table>
<thead>
<tr>
<th>Origin</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1–6 months</td>
</tr>
<tr>
<td>Individual households</td>
<td>123</td>
</tr>
<tr>
<td>Positive for <em>G. lamblia</em></td>
<td>3</td>
</tr>
<tr>
<td>Prevalence of <em>G. lamblia</em></td>
<td>2.4%&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pet shops/breeding kennels</td>
<td>468</td>
</tr>
<tr>
<td>Positive for <em>G. lamblia</em></td>
<td>125</td>
</tr>
<tr>
<td>Prevalence of <em>G. lamblia</em></td>
<td>26.7%&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Individual households + Pet shops/breeding kennels</td>
<td>591</td>
</tr>
<tr>
<td>Positive for <em>G. lamblia</em></td>
<td>128</td>
</tr>
<tr>
<td>Prevalence of <em>G. lamblia</em></td>
<td>21.7%&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Significant difference:

- a)–b): $p < 0.001$
- f)–g): $p < 0.001$
- f)–h): $p < 0.001$
- b)–c): $p < 0.05$
- f)–i): $p < 0.001$
- b)–d): $p < 0.001$
- b)–e): $p < 0.01$
- j)–k): $p < 0.001$
- c)–d): $p < 0.01$

Table 5 Prevalence of *Giardia lamblia* infection according to region

<table>
<thead>
<tr>
<th>Region</th>
<th>Aomori</th>
<th>Akita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examined number</td>
<td>902</td>
<td>133</td>
</tr>
<tr>
<td>Positive for <em>G. lamblia</em></td>
<td>137</td>
<td>14</td>
</tr>
<tr>
<td>Prevalence of <em>G. lamblia</em></td>
<td>15.2%</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

Discussion

Since *Giardia* is capable of infecting a wide range of hosts<sup>13</sup>, *G. lamblia* has been detected in a wide range of mammals, including humans and dogs<sup>12</sup>. Whether *Giardia* isolates from dogs are capable of zoonotic transmission to humans is a serious problem. The results of cross-transmission studies to determine if humans are susceptible to infection with animal isolates of *Giardia* and vice versa have been inconclusive<sup>13</sup>. However, Majewska et al. <sup>14</sup> reported an infection in a human volunteer inoculated with *Giardia* from a Gambian giant pouched rat. Hewlett et al. <sup>15</sup> demonstrated the experimental infection of dogs with strains of *Giardia* isolated from humans. Isaac-Renton et al. <sup>16</sup> described the role of the beaver as a reservoir of human giardiasis in a waterborne outbreak of the disease in a specific geographical area in Canada. Genetic analysis has enabled major advances in the understanding and interpretation of *G. lamblia*. Monis et al. <sup>17</sup> classified this organism into seven groups of assemblages (A to G) according to differences in genotype. All isolates from humans belong to assemblages A or B. Though most isolates from dogs belong to assemblages C or D, a few isolates from dogs that belong to assemblages A or B have been obtained. The biological characteristics of *G. lamblia* from dogs in assemblages A or B are similar to isolates from
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humans, and infections in suckling mice and *in vitro* cultures of these isolates have been established\(^4\)\(^7\). Assemblage A has two subgroups; A-1 consists of a mixture of closely related animal and human isolates, whereas A-2 consists entirely of human isolates\(^9\). Assemblage B is comprised of a genetically diverse group of genotypes isolated principally from humans and some other mammals\(^1\). Thus, some of the genotypes appear to have a limited host range, whereas others have a wider range of host species. In domestic and urban environments of Australia, genotypes from assemblages A or B and ‘dog’ genotypes (assemblages C or D) are equally common in dogs\(^1\). Thus, two cycles of transmission are thought to occur in domestic and urban environments, and the possibility of zoonotic transmission of assemblage A or B genotypes between dogs and humans has not been negated\(^1\).

Information on *Giardia* infection in household dogs is undoubtedly needed for human public health. Unfortunately, only a few surveys on *Giardia* infection in dogs have been performed in Japan\(^5\)\(^-\)\(^10\). Asano *et al.*\(^8\) reported that the prevalences of *Giardia* in household dogs were 1.9% (5/260) and 5.3% (14/262). Saito *et al.*\(^9\)\(^10\) reported prevalences of 5.6% (28/500) and 2.8% (19/677). In addition, Arashima *et al.*\(^7\) reported a prevalence of 9.3% (169/1811) in dogs from individual houses. The overall prevalence of 14.6% (151/1035) obtained in this study is higher than those of previous studies. Regional differences are clearly not related to the high prevalence obtained in this study because no significant difference was obtained for the prevalences in Aomori and Akita. Although the reason for the higher prevalence in this study is not clear, the composition of the ages and origins of the dogs examined are suspected to be important factors. In particular, dogs under the age of 1 year are more likely to be infected than older animals\(^3\)\(^6\)\(^7\). Dogs housed in crowded conditions, such as in kennels, pet shops and laboratory animal facilities, also often have higher prevalences of *Giardia* infection\(^1\)\(^3\)\(^6\)\(^7\)\(^18\) because *Giardia* transmission easily occurs via cysts that are strongly resistant to environmental factors. Moreover, cysts may be transmitted readily among animals in kennels and similar facilities, and it is difficult to keep such facilities free of *Giardia*\(^3\). Therefore, the high percentage of 1–6 months old puppies (57.1%) and dogs originating from pet shops or breeding kennels (59.9%) are probably related to the high prevalence of *Giardia* in this study. The high prevalence in breeds such as Pomeranians and Yorkshire terriers may result from the fact that most of these animals (90.1% and 93.1%, respectively) were derived from pet shops or breeding kennels. In contrast, the low infection rate in mongrels may be due to the fact that most of them (96.8%) were obtained from individual households and kept alone, with little opportunity for infection. Golden retrievers also exhibited a low prevalence, even though approximately half of the animals were 1–6 months old (54.3%) and derived from pet shops or breeding kennels (51.4%). Infection among these animals is thought to be uncommon because Golden retrievers are usually kept in separate kennels because of their large size. Breed-related resistances or susceptibilities to giardiasis have not been identified\(^3\).

The high prevalence of *Giardia* infection in dogs kept indoors may be related to the ages and origins of the dogs in this study. Actually, 71.0% of dogs kept indoors belonged to the 1–6 months age group, and 79.8% of dogs kept indoors were derived from pet shops or breeding kennels. On the other hand, 22.1% of outdoor dogs belonged to the 1–6 months age group, and only 9.9% of outdoor dogs were derived from pet shops or breeding kennels. These results suggest that the higher prevalence of *Giardia* in younger dogs may be due to the immaturity of their immune systems\(^13\). Previous studies in mice indicate that the host immune response to *Giardia* infection involves both cellular and humoral mechanisms\(^13\)\(^19\). In contrast, the lower prevalence in older dogs is thought to be related to the development of the host’s immune sys-

平成13年8月20日
Approximately 70% of the dogs examined in this survey were kept indoors. This percentage indicates that many humans and dogs have a close relationship. The high Giardia infection rate in puppies and dogs kept indoors, where human contact is frequent, is a serious problem for public health since the possibility of zoonotic transmission cannot be dismissed\(^1\)\(^2\)\(^4\). In addition, Giardia infected dogs do not always exhibit clinical signs, such as diarrhea. No reports of human giardiasis transmitted from dogs have been made. However, the results of this study suggest that the risk of Giardia transmission from household dogs to humans is not negligible. Thus, pet owners, including pet shop or breeding kennel managers, should be instructed with regard to proper hygiene measures to prevent Giardia transmission from dogs to humans. Furthermore, the genetic analysis of Giardia isolated from domestic dogs and humans in Japan is necessary to elucidate the biological characteristics of these protozoans.

References

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剣栄イヌのジアルジア感染状況

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要 旨
一般家庭で飼育されているイヌ1035頭について、Giardia lamblia (G. lamblia)の感染状況を調査した。その結果、1,035頭中151頭（14.6%）のイヌの糞便からG. lambliaが検出された。室内で飼育されているイヌのG. lamblia感染率（18.5%）は、室外で飼育されているイヌ（4.8%）に比較して有意に高かった（p<0.001）。また、1〜6カ月齢群のイヌにおける感染率（21.7%）は、他の年齢群の感染率（7カ月〜1歳齢群：7.5%，2〜5歳齢群：4.5%，6歳齢以上群：2.4%）に比較して有意に高かった（それぞれp<0.001）。さらに、ペットショップ・ブリーダー由来のイヌの感染率（21.5%）は、一般家庭由来のイヌ（4.3%）に比較して有意に高かった（p<0.001）。

ヒトとの接触機会が多い幼齢および室内飼育のイヌに於けるG. lambliaの高い感染率は、イヌ由来G. lambliaの一部が人畜共通の寄生虫である可能性が指摘されていることから、ヒトの公衆衛生生学上、重要な問題である。今回の調査における成績は、イヌからヒトへのG. lamblia感染の危険性は、無視できないことを示している。イヌからヒトへのG. lamblia感染を防御するため、飼い主に対する積極的な衛生学的指導が必要であると考える。