Toxoplasmosis is a zoonosis caused by infection with *Toxoplasma gondii* and is prevalent worldwide under various climatic conditions. It is usually asymptomatic, but infection in pregnant women can pose serious health problems for the fetus. However, epidemiological information regarding toxoplasmosis in Japanese pregnant women is limited. This study aimed to determine the prevalence of anti-*Toxoplasma* antibodies, the primary infection rate, and the risk factors for toxoplasmosis in Japanese pregnant women. We measured anti-*Toxoplasma* antibody titers in 4,466 pregnant women over a period of 7.5 years and simultaneously conducted interviews to identify the risk factors for toxoplasmosis. The overall prevalence of anti-*Toxoplasma* antibodies was 10.3%, and it was significantly higher in women aged above 35 years. The rate of primary *Toxoplasma* infection during pregnancy was estimated to be 0.25%. A possibility of infection in the later stages of pregnancy was identified for those women who were not infected in the early stages. A history of raw meat intake was identified to be a risk factor related to toxoplasmosis. Therefore, to lower the risk of toxoplasmosis, pregnant women should refrain from eating raw and undercooked meat and maintain personal hygiene.
After obtaining informed consent from the participants, we measured anti-Toxoplasma antibodies in maternal blood. Pregnant women were tested for the presence of anti-Toxoplasma antibodies using an assay kit for Toxoplasma latex agglutination (LA) microtiters, called Toxotest-MT Eiken (provided by Eiken Chemical Co., Ltd., Japan), according to the manufacturer’s instructions. In this kit, LA titers of 1:32 or more are regarded to be a positive result. A χ² test was used to verify the rate of anti-Toxoplasma antibody prevalence from the viewpoint of maternal age. Moreover, to determine the primary infection rate during pregnancy, we calculated the anti-Toxoplasma antibody seroconversion rate in 2,696 subjects. Their antibodies were measured in both early and late pregnancy. The sampling interval was usually between the 14th and 16th week in early pregnancy and between the 30th and 32nd week in the late stage of pregnancy. The mean interval between antibody measurement in early and late pregnancy was 16.2 weeks. The focus of this survey was on lifestyle-related risk factors for toxoplasmosis. Therefore, owing to these significant trends, we also performed multivariate analysis for the history of raw meat intake and residence in the South Kyushu region. The results revealed that residence in the South Kyushu region was not a risk factor (95% CI, 0.359 to 0.785; P = 0.015) for toxoplasmosis. Despite the fact that the prevalence of anti-Toxoplasma antibodies in Japan was 10.3%, with regard to age, the prevalence was significantly higher in women above 35 years of age than in women below 35 years. In general, the prevalence of anti-Toxoplasma antibody was almost 1 in every 5 pregnant women above 35 years of age. This suggests that the probability of coming into contact with sources of infection increases with age. As the number of high-risk pregnancies, including late childbearing, has continued to increase in recent years (8), the probability of contacting potential sources of infection may also increase. Older pregnant women should be followed carefully through antenatal care.

**DISCUSSION**

In this study, the prevalence of anti-Toxoplasma antibodies in Japanese pregnant women was 10.3%. With regard to age, the prevalence was significantly higher in women above 35 years of age than in women below 35 years. In general, the prevalence of anti-Toxoplasma antibody was almost 1 in every 5 pregnant women above 35 years of age. This suggests that the probability of coming into contact with sources of infection increases with age. As the number of high-risk pregnancies, including late childbearing, has continued to increase in recent years (8), the probability of contacting potential sources of infection may also increase. Older pregnant women should be followed carefully through antenatal care.

**RESULTS**

**Prevalence of anti-Toxoplasma antibodies.** Among 4,466 pregnant women, 459 tested positive for anti-Toxoplasma antibodies; therefore, the overall anti-Toxoplasma antibody prevalence was 10.3% in this study. In generational terms, the prevalence of anti-Toxoplasma antibodies was as follows: late teenage years, 5/126 (4.0%); early 20s, 89/1,057 (8.4%); late 20s, 172/1,886 (9.1%); early 30s, 135/1,100 (12.3%); late 30s, 55/268 (20.5%); and 40s, 3/29 (10.3%) (Fig. 1). The rate of Toxoplasma infection was significantly higher among women above 35 years of age (58/297) than among women below 35 years of age (401/4,169) (P < 0.001).

**Seroconversion rate during pregnancy.** Of the 2,969 subjects in whom anti-Toxoplasma antibodies were detected both in early and in late pregnancy, 3 subjects (0.1%) exhibited seroconversion during pregnancy. The backgrounds of these three pregnant women are presented in Table 1; they all lived in the South Kyushu region (two in Miyazaki Prefecture and one in Kagoshima Prefecture) and had a history of raw meat intake.

This result indicated that pregnant women who are not infected by Toxoplasma in the early stages of pregnancy can be infected during the later stages. The mean interval between the two antibody measurements (early and late pregnancy) was 16.2 weeks. Therefore, we estimated the average gestational period to be 40 weeks, and the rate of Toxoplasma infection during pregnancy was estimated to be 0.25%.

**Risk factors for toxoplasmosis.** A total of 4,035 women completed the interview on the risk factors for toxoplasmosis. The history of raw meat intake was considered a risk factor (95% confidence interval [CI], 0.543 to 0.936; P = 0.02). Conversely, cat ownership was not significantly related to the infectious risk of Toxoplasma (95% CI, 0.680 to 1.001; P = 0.05). When the prevalence of anti-Toxoplasma antibodies in the South Kyushu region, which consists of three prefectures (Miyazaki, Kagoshima, and Kumamoto), was compared with that in the other areas of Japan, the rate was significantly higher in the former than in the latter (95% CI, 1.161 to 2.769; P = 0.01). Therefore, owing to these significant trends, we also performed multivariate analysis for the history of raw meat intake and residence in the South Kyushu region. The results revealed that residence in the South Kyushu region was not a risk factor (95% CI, 0.523 to 1.070; P = 0.11), whereas history of raw meat intake was identified to be an independent risk factor (95% CI, 0.359 to 0.785; P = 0.0015) for toxoplasmosis.

**TABLE 1.** Characteristics of three pregnant women who demonstrated seroconversion during pregnancy

<table>
<thead>
<tr>
<th>Case</th>
<th>Maternal age (yr)</th>
<th>Early stage of pregnancy</th>
<th>Late stage of pregnancy</th>
<th>History of raw meat intake</th>
<th>History of owning a cat</th>
<th>Residence in the South Kyushu region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>16</td>
<td>&lt;1:16</td>
<td>1:128</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>16</td>
<td>1:16</td>
<td>1:32</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>19</td>
<td>&lt;1:16</td>
<td>1:64</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

* LA, latex agglutination.
The rate of primary infection with *Toxoplasma* during pregnancy was estimated to be 0.25%. Although the seroconversion rate was low, it did not rule out the possibility that pregnant women not infected in the early stages of pregnancy could be infected during the later stages. Therefore, continuous monitoring for toxoplasmosis and its risk factors should be performed during the entire duration of pregnancy. Prospective monitoring of changes in anti-*Toxoplasma* antibody titers should be a useful approach for diagnosing primary infection during pregnancy.

Consumption of raw meat was a risk factor for *Toxoplasma* infection. This finding is consistent with those of previous reports. Monitoring for *Toxoplasma* infection among pregnant women in Aydin province, Turkey. BMC Public Health 5:666.

**REFERENCES**


