Epidemiological studies on caprine arthritis-encephalitis virus infection in Jordan

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Abstract

To investigate the seroprevalence of, and risk factors for, caprine arthritis-encephalitis virus (CAEV) infection in different breeds of goats in Jordan, sera from 1100 goats from three different geographical regions in Jordan were analyzed. Prevalence of antibodies to CAEV was determined using a competitive ELISA test. A semi-structured questionnaire was used to collect information on herd health and management. Questionnaire data were tested in a multivariable logistic regression model to elucidate risk factors associated with CAEV seropositivity. In addition, the incidence of CAEV antibodies was investigated in six goat herds located in the northern part of Jordan. Out of the 69 goat herds investigated, 16 (23.2%) had antibodies against CAEV. Individual goat true seroprevalence to CAEV was 8.9%. The highest CAEV seroprevalence was observed in goats older than 3-years and younger than 6-years of age. The seroprevalence of CAEV in goats was significantly higher (P < 0.05) in the northern part of Jordan than that in central or southern parts of Jordan. The multivariable logistic regression model identified large herd size (OR = 2.0; 95% CI: 1.1, 2.7), addition of new animals to the herd (OR = 1.3; 95% CI: 0.3, 1.6) and contact with other goat herds (OR = 1.1; 95% CI: 0.9, 2.0) as risk factors for CAEV seropositivity. The incidence of CAEV seropositivity in the six herds monitored in the northern part of Jordan ranged from 2.4 to 5.3%.

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1. Introduction

Caprine arthritis-encephalitis virus (CAEV), a single-stranded RNA virus of the family Retroviridae and the sub-family Lentivirinae, causes a persistent infection in goats (Knight and Jokinen, 1982; Pugh, 2002). There are five major clinical presentations associated with CAEV infection including polyarthritis, interstitial pneumonia, mastitis, and progressive weight loss in adult goats, and encephalitis in younger kids (Smith and Sherman, 1994; Matthews, 1999; Pugh, 2002). However, most goats infected with CAEV become asymptomatic carriers. Viral transmission usually occurs horizontally through the ingestion of viral-infected goat milk and/or colostrums (Rowe et al., 1991, 1992; Rowe and East, 1997). Other potential sources of viral transmission include transmission in utero, contact with the vagina of an infected doe during parturition, via saliva or respiratory secretions, via contact with infected blood, viral contamination of milking equipment, needles, tattooing equipment, and breeding (Adams et al., 1983; Rowe et al., 1991, 1992; Rowe and East, 1997).
Since its documentation in goats in early 1970s, the disease has been reported worldwide. In Europe, the disease has been reported with a variable prevalence rate ranges from 12.1% (in Spain) to 56.8% (in Wales) (Houwers and van der Molen, 1987; Krieg and Peterhans, 1990; Cutlip et al., 1992; Greenwood et al., 1995; Literak et al., 1995; Contreras et al., 1998). In the Middle East, CAEV infection was reported in Saudi Arabia, Syria, and Turkey and the prevalence rates ranged from 0.8 to 12.5% (Alluwaimi et al., 1990; Giangaspero et al., 1992; Burgu et al., 1994).

The purpose of this study was to document the presence and the prevalence of CAEV in different breeds of goats in Jordan and to elucidate risk factors associated with seropositivity to CAEV infection.

2. Materials and methods

2.1. CAEV serological survey

2.1.1. Studied animals

A cross-sectional study with a multiple stage design was performed during the period between May 2001 and June 2003 to investigate the epidemiology of major infectious diseases affecting goat herds in Jordan. As a result of this cross sectional survey, recently, we have reported the epidemiology of caprine brucellosis in Jordan (Al-Majali, 2005). In this study, we have used the same materials (data and samples) to investigate the epidemiology of CAEV in Jordan.

Sample size (1100 goats) was calculated using an expected prevalence of 5% and a confidence interval of 95% and then adjusted for the population size of goats in Jordan. To determine the number of goat herds to sample, the sample size (1100 goats) was divided by the number of animals to sample from each herd that will allow detecting at least one positive animal according to the equation published previously (Martin et al., 1987). Therefore, the number of goat herds to sample was 69. Equal number of herds was collected from three main geographical regions in Jordan (north, middle, and south). Herds and animals within each herd were selected by random sampling using a table of random digits. Only goats older than 8 months were sampled. Herds were stratified into three herd size strata: small herds (10–50 heads), medium herds (51–100 heads) and large herds (more than 100 heads). Farmers were asked to fill out a semi-structured questionnaire that contains information on herd size, breed, health status, and herd management. Information regarding herd management include, rearing system (categorized as intensive “animals were kept most of the time indoors and fed manually at least twice per day” and semi-intensive “animals were kept indoors only at night and fed manually just once per day”), raising sheep in addition to goats, presence of regular veterinary service, contact with other goat herds, and addition of new animals. Both types of rearing systems (intensive and semi-intensive) are practiced in all the three studied geographical areas.

2.1.2. Sample collection

Blood samples were collected from the external jugular vein aseptically, while restraining the animal in a standing position, using disposable needles and vacutainer tubes. After separation by centrifugation, serum was stored at −20°C until testing.

2.1.3. Sample analysis

All collected sera were evaluated for anti-CAEV surface envelope (SU) antibodies using a commercially available competitive ELISA kit (cELISA) (VMRD Inc., Pullman, WA, USA). This cELISA kit utilizes 96-well microtiter plates coated with CAEV-63 SU captured by monoclonal antibodies (MAb) F7-299 and measures the displacement of horseradish peroxidase-conjugated MAb GPB74A binding by undiluted goat sera. The kit includes standard positive and negative control goat sera. The sensitivity and specificity of this cELISA kit was previously investigated and were 100 and 96.4%, respectively (Herrmann et al., 2003). Anti-CAEV antibody titers were determined by estimating the end point cELISA reactivity with two-fold or five-fold dilutions of goat sera.

2.2. Incidence of CAEV in goat herds from Northern Jordan

Six goat herds located in the northern part of Jordan were monitored over a year period. Serum samples were collected from about 20% of the total number of goats in each herd. At time of sampling, goats were properly identified by ear tags. Sera were collected from the same goats from each herd in a 3-month interval. Owners of those six herds were asked to record any changes in herd management including new purchases. All collected sera were tested using cELISA as described above.

2.3. Statistical analysis

The true prevalence of serologically positive animals was estimated by adjusting the apparent prevalence to the sensitivity and specificity of the test using the following
equation (Rogan and Gladen, 1978):

\[
TP = \frac{AP + SP - 1}{Se + Sp - 1}
\]

where TP is true prevalence, AP the apparent prevalence, Sp the test specificity, and Se is the test sensitivity.

Univariable analysis was carried out by chi-square analysis. The effect of herd size, breed, health status, and management on CAEV seropositivity was assessed using a multivariable logistic regression model. All variables with \( P < 0.05 \) (two-sided) in the univariable analysis were further tested by the model. Variables were excluded from the model using a backward-stepwise approach. Statistical analyses were performed using SPSS software Version 10 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. CAEV serological survey

Sixteen goat herds (23.2%) were found to have at least one serologically positive animal. One hundred thirty four goats (12.2%) out of the 1100 surveyed were seropositive to CAEV. The true prevalence of seropositive individual animals, as adjust to the specificity and sensitivity of the cELISA test, was 8.9%. Within the 16 positive herds, the highest prevalence of seropositive animals was observed in goats older than 3-years and younger than 6-years of age (Table 1). Significant \( (P < 0.05) \) geographical variation in the prevalence of seropositive herds was observed (Fig. 1). The highest CAEV seroprevalence occurred in the northern part of Jordan (55%).

3.2. Incidence of CAEV infection in northern Jordan

Five out of the six goat herds that were included in the incidence study had at least one positive animal during the first sampling period. After the second sampling, all six herds had at least one positive animal. A total of 510 serum samples were collected during the 1-year observational period of these herds. The incidence of new cases per sampling time was ranged from 2.4 to 5.3% (Table 2).

Table 1

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>N</th>
<th>Sex</th>
<th></th>
<th></th>
<th></th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8–36</td>
<td>332</td>
<td>30</td>
<td>302</td>
<td>28</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>37–60</td>
<td>407</td>
<td>10</td>
<td>397</td>
<td>61</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>61–72</td>
<td>237</td>
<td>47</td>
<td>190</td>
<td>33</td>
<td>13.9</td>
<td></td>
</tr>
<tr>
<td>More than 72</td>
<td>124</td>
<td>38</td>
<td>86</td>
<td>12</td>
<td>9.7</td>
<td></td>
</tr>
</tbody>
</table>

* Statistically significant.

Table 2

<table>
<thead>
<tr>
<th>Herds</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of goats in herd</td>
<td>102</td>
<td>98</td>
<td>83</td>
<td>204</td>
<td>152</td>
<td>67</td>
</tr>
<tr>
<td>Number of goats sampled</td>
<td>21</td>
<td>19</td>
<td>17</td>
<td>41</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Number of times sampled</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Incidence of CAE</td>
<td>5.3</td>
<td>4.8</td>
<td>4.1</td>
<td>3.7</td>
<td>3.2</td>
<td>2.4</td>
</tr>
</tbody>
</table>
Table 3
Univariable analysis of seropositivity to CAEV by cELISA with respect to different exposure factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Category</th>
<th>N</th>
<th>CAEV cELISA</th>
<th>P&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. positive</td>
<td>No. negative</td>
</tr>
<tr>
<td>Herd size</td>
<td>Small</td>
<td>30</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>21</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>18</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Rearing system</td>
<td>Intensive</td>
<td>21</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Semi-intensive</td>
<td>48</td>
<td>11</td>
<td>40</td>
</tr>
<tr>
<td>Presence of sheep</td>
<td>Yes</td>
<td>24</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>45</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Addition of new animals</td>
<td>Yes</td>
<td>37</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>32</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>Contact with other goats</td>
<td>Yes</td>
<td>37</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>32</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>Usage of disinfectants</td>
<td>Yes</td>
<td>39</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>30</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Veterinary service</td>
<td>Yes</td>
<td>29</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>40</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>Breed</td>
<td>Shami</td>
<td>26</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Baladi</td>
<td>21</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>22</td>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

<sup>a</sup> P-values are for comparisons of data for each factor evaluated.

Higher incidence (P < 0.05) occurred directly after the end of the kidding season (October–January). Most of the new seropositive cases (58%) were in kids less than 2 months of age. The incidence rate remained constant for five of the six herds. In one herd, the incidence rate increased after the first sampling time.

### 3.3. Multivariable logistic analysis

The different studied variables were distributed among goat herds that were CAEV seropositive (Table 3). Four variables had P(\(\chi^2\)) < 0.05 and were further evaluated using the multivariable logistic regression model. The model revealed three statistically significant (P < 0.05) risk factors (large herd size, addition of new animals and contact with other goat herds) for CAEV seropositivity (Table 4).

### 4. Discussion

This study is the first to investigate the epidemiology of CAEV infection in different breeds of goats in Jordan. Herd seroprevalence in this study (23.2%) was higher than that reported in Turkey (1.9%), southern Mexico (3.6%), and Great Britain (10.3%) (Dawson and Wilesmith, 1985; Burgu et al., 1994; Torres-Acosta et al., 2003). On the other hand, the herd prevalence reported in this study was lower than that reported in Central Mexico (28.6%), Wales (56.8%), Australia (82%), and USA (73%) (Adams et al., 1984; Grewal et al., 1986; Cutlip et al., 1992; Greenwood et al., 1995). However, individual seroprevalence in this study (8.9%) was lower than that reported in Syria (12.1%), Switzerland (42%), and USA (31%) (Grewal et al., 1986; Krieg and Peterhans, 1990; Giangaspero et al., 1992). On the contrary, this individual goat seroprevalence was significantly higher than that reported in Saudi Arabia (1.9%) (Alluwaimi et al., 1990).

A statistical difference was observed in the seroprevalence in respect to the three studied geographical regions. The northern part of Jordan had the highest seroprevalence rate. About 55% of the total population of goats in

Table 4
Logistic regression analysis of variables associated with goat herd seropositivity to CAEV in Jordan

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>S.E.</th>
<th>OR</th>
<th>95% Cl&lt;sub&gt;OR&lt;/sub&gt;</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.2</td>
<td>0.10</td>
<td>–</td>
<td>–</td>
<td>0.004</td>
</tr>
<tr>
<td>Large herd size</td>
<td>0.5</td>
<td>0.08</td>
<td>2.0</td>
<td>1.1, 2.7</td>
<td>0.03</td>
</tr>
<tr>
<td>Adding new animals</td>
<td>1.5</td>
<td>0.25</td>
<td>3.8</td>
<td>1.3, 6.0</td>
<td>0.04</td>
</tr>
<tr>
<td>Contact with other goat herds</td>
<td>1.7</td>
<td>0.27</td>
<td>5.7</td>
<td>1.9, 16.8</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Likelihood ratio of chi square (LR<sub>\(\chi^2\)) = 112 on 12 degrees of freedom.
Jordan is located in the northern part of the kingdom. In this region, the majority of herds (72%) are of large herd size, which increase the stocking density and eventually increase the likelihood of transmission. This could explain the high seroprevalence rate of CAEV in this region when compared to that of the central or southern parts of Jordan. More detailed epidemiological studies are needed to elucidate other factors, such as climate that could contribute to high CAEV seroprevalence in the northern part of Jordan.

In this study, goats older than 3 years of age were more likely to be CAEV seropositive than younger goats. Similar finding were reported previously (Dawson and Wilesmith, 1985; Greenwood et al., 1995). Other studies suggested that CAEV infection occurs in goats older than one year with the same magnitude (Rowe et al., 1991, 1992). Cutlip et al. (1992) suggested that herd size has no impact on seropositivity to CAEV. Addition of new animals and contact with other goat herds has been suggested as important transmission factors for many infectious diseases including CAEV infection (Rowe and East, 1997).

Previous studies have reported significant reduction in herd seroprevalence to CAEV in goat herds reared on pasteurized milk (East et al., 1987; Rowe et al., 1991; Peretz et al., 1994). In this study, we were not able to study this factor since pasteurized rearing is not practiced in Jordan. However, rearing system (intensive versus semi-intensive) has no impact on CAEV seropositivity.

The incidence of CAEV infection in Jordan has been increased directly by the end of the kidding season. Most of the new cases (58%) were in kids less than 2 months of age. It is possible that those kids became seropositive during their perinatal period. Previous reports have suggested the perinatal period a critical period for CAEV transmission (Robinson and Ellis, 1985; Rowe et al., 1992; East et al., 1993).

References


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