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A community-based study to examine the epidemiology of human cystic echinococcosis in Rio Negro Province, Argentina

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ABSTRACT

Although cystic echinococcosis (CE) is an important public health problem in Rio Negro Province, current epidemiological data for CE, in this region of Argentina, are not available. Therefore, a community-based study, which incorporated diagnostic imaging and a questionnaire, was conducted in Ingeniero Jacobacci, a small town in southern Rio Negro Province. This study sought to assess the prevalence of human CE, in the study population, and to evaluate epidemiologic factors associated with CE transmission within the study area. Of the 560 individuals who volunteered to participate in the study, 189 (34%) were children and 371 (66%) were adults. All study participants were screened for CE using abdominal ultrasound scanning, with CE-positive or suspect individuals also receiving thoracic radiographs. The overall prevalence of CE was 7.1% (40/560), with 1.6% (3/189) of children, and 10% (37/371) of adults diagnosed as CE-positive. Although 92.5% (37/40) of the CE-positive individuals had only hepatic lesions, two participants had both hepatic and pulmonary lesions, and one participant had a single renal lesion. Approximately 92% (340/371) of the adult study participants completed the questionnaire, which was used to identify factors associated with an increased risk for human infection. Age, level of education, dog ownership, and contact with sheep were found to be significantly associated with CE status. This study demonstrated that CE continues to be highly endemic in this region of Rio Negro Province, Argentina. In addition, community-based ultrasound screening surveys are a noninvasive, effective approach to case detection at the community level.

1. Introduction

Cystic echinococcosis (CE) is a zoonotic disease caused by the larval stage of *Echinococcus granulosus*, a taeniid cestode with a worldwide geographical distribution (Eckert et al., 2001). *E. granulosus* is usually transmitted in a cycle between dog definitive hosts and livestock (sheep, goats, cattle and swine) intermediate hosts. Although there are multiple *E. granulosus* transmission cycles, the cycle between domestic dogs and sheep has been shown to have the greatest global public health significance (Craig et al., 2007; Eckert and Deplazes, 2004; McManus et al., 2003). Dogs acquire the infection through the ingestion of cyst-containing offal from infected livestock. *E. granulosus* eggs are shed into the environment with the dogs' feces, contaminating the surrounding soil, water, and pastures. Livestock become infected when they ingest the eggs while grazing on contaminated pastures. Human infection typically occurs as a result of consuming contaminated food or water. Other routes of infection include handling infected dogs, feces from infected dogs, contaminated vegetation, or contaminated soil, followed by direct hand-to-mouth transfer. Once ingested by an intermediate host, *E. granulosus* eggs hatch in the small intestine, releasing oncospheres, which penetrate the intestinal wall, and are subsequently transported via the circulatory system to the organs, where cyst development occurs (Craig and Larrieu, 2006; Eckert and Deplazes, 2004; Moro and Schantz, 2009).

Human CE is typically characterized by slow growing, unilocular cysts which are most commonly located in the liver (~70%),

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or the lungs (~20%), but can also occur in other organs and tissues (Eckert et al., 2001; McManus et al., 2003). During the initial phase of infection, *E. granulosus* cysts are small, well encapsulated, and not associated with morbidity. Due to the slow-growing nature of the cysts, infected individuals may remain asymptomatic for months, years, or even permanently (Eckert and Deplazes, 2004; McManus et al., 2003). CE typically remains asymptomatic until the cyst grows large enough to exert pressure on neighboring organs or other tissues, ruptures, or develops complications such as secondary infection. The clinical presentation of CE is highly variable, and depends on the size and location of the cyst. While symptoms often resemble those of a space-occupying lesion, anaphylaxis may occur if a cyst ruptures, and fever and pain typically occur in conjunction with secondary bacterial infection (Eckert et al., 2001; McManus et al., 2003; Moro and Schantz, 2009).

In humans, CE is diagnosed primarily based on imaging techniques, such as ultrasound, conventional radiography, computed tomography, and magnetic resonance imaging (Brunetti et al., 2010; Eckert and Deplazes, 2004). Ultrasound examination is one of the preferred methods for diagnosing CE in abdominal locations, while conventional radiography is typically used to diagnose pulmonary CE (Brunetti et al., 2010). Ultrasonography is considered a safe, reliable, and cost-effective method for diagnosing the disease at both the individual and community levels (Brunetti et al., 2010; Eckert and Deplazes, 2004; Macpherson et al., 2003).

Cystic echinococcosis is an important public health and economic concern in many areas throughout the world, with the greatest impact occurring in agricultural and pastoral regions (Eckert and Deplazes, 2004; Moro and Schantz, 2009). As is the case in other South American countries, including Brazil, Chile, Peru, and Uruguay, CE is endemic in Argentina (Craig and Larrieu, 2006; Moro and Schantz, 2006; Moro and Schantz, 2009). Rio Negro Province is in the Patagonia region of southern Argentina, which is one of the most severely impacted areas in South America (Larrieu et al., 2004a; Moro and Schantz, 2006; Pierangeli et al., 2007). Due to the climate and geography of Rio Negro Province, extensive livestock production is an important sector of the provincial economy.

In Argentina, healthcare providers are required to report all newly diagnosed human CE cases to the Ministry of Health (Ministerio de Salud, 2009). In Rio Negro Province, the provincial CE control program screens schoolchildren between 6 and 14 years of age for the presence of CE (Del Carpio et al., 2009). However, adults are not routinely screened for the disease, and there are no recently published community-based studies for Rio Negro Province. As a result, the current prevalence of CE and the risk factors associated with the disease, particularly among the adult population, in Rio Negro Province, are not known. Therefore, a community-based screening survey was conducted in a highly endemic region of Rio Negro Province in order to obtain current data, which can be used by program coordinators to evaluate, and potentially improve the present CE control program in this region of the province. Abdominal ultrasonography was used to evaluate the prevalence of human CE, and a questionnaire was incorporated to identify locally relevant risk factors for human infection in this population. While both children and adults were included in the abdominal ultrasound portion of the study, the questionnaire was designed to focus on adults due to the overall lack of available risk factor data for this demographic.

2. Materials and methods

2.1. Study area

The study was conducted in Ingeniero Jacobacci, in southern Rio Negro Province, Argentina. Ingeniero Jacobacci is a small town with a population of approximately 8000 individuals. Extensive livestock production is the primary agricultural activity, in this area, with sheep and goats being the most common livestock species. Other important economic activities, in the region, include the meat processing and mining industries. Ingeniero Jacobacci has one hospital, tasked with serving people in a catchment area of approximately 15,520 km^2, and six healthcare outposts. Nurses, paramedics, and other clinical officers, who staff the healthcare outposts, provide basic primary care to residents (Del Carpio et al., 2012). The climate and geography of the area can make travel difficult, as many of the roads are unpaved and winters can be very harsh. Therefore, the healthcare outposts are set up to make healthcare more accessible to residents of Ingeniero Jacobacci.

2.2. Study design

In October 2009, all residents of Ingeniero Jacobacci were invited to participate in a community-based cross sectional CE screening survey, which incorporated abdominal ultrasonography, thoracic radiography, and a questionnaire. In order for the screening survey to be accessible to a greater proportion of the population, the study was conducted in four locations in Ingeniero Jacobacci, including the hospital and three healthcare outposts. All study participants were examined via abdominal ultrasound for the presence of cysts compatible with a diagnosis of CE. Study participants who received a CE-positive diagnosis, based on the abdominal ultrasound examination, were also examined using thoracic radiography. All study participants who were found to be positive for CE, based on diagnostic imaging, were referred to a physician for follow-up and treatment, in accordance with the guidelines set by the Ministry of Health for Rio Negro Province (Del Carpio et al., 2009). All adults (≥18 years of age), who participated in the study, were asked to complete an epidemiological questionnaire before their abdominal ultrasound examination. The adult study participants who were found to be CE-positive, and completed the questionnaire, formed the "CE-positive" group, while the CE-negative adults who completed the questionnaire, were included in the "CE-negative" group.

2.3. Diagnostic imaging

All abdominal ultrasound examinations were performed by experienced physicians using two SonoSite Titan portable ultrasound machines with 2–5 MHz curved array transducers (SonoSite, Bothell, WA, USA). With participants in the supine position, the entire abdominal cavity was scanned in four basic planes, as described by Del Carpio et al. (2012). Ultrasonographic evidence of cysts was categorized based on the World Health Organization Informal Working Group on Echinococcosis (WHO-IWGE) recommended ultrasound classification system for CE, which classifies cysts as active (CE1 and CE2), transitional (CE3), or inactive (CE4 and CE5) based on their appearance (Brunetti et al., 2010; WHO, 2003). In addition, because the guidelines used for treating asymptomatic cases of CE, set forth by the Ministry of Health, are based on the diameter of the cyst, the diameter of each cyst was recorded (Ministerio de Salud, 2009). Anteroposterior and lateral thoracic radiographs were obtained using Dinan 500/125 radiographic imaging equipment (Rayos X Dinan, Buenos Aires, Argentina). A radiologist examined all radiographic images for the presence of pulmonary cysts compatible with a diagnosis of CE.

2.4. Questionnaire

A structured questionnaire was designed with guidance from physicians, veterinarians, epidemiologists, and local public health experts. The questionnaire was administered in Spanish, after being translated from English into Spanish and then back-translated into