A Systematic Review of the Literature on Cystic Echinococcosis Frequency Worldwide and Its Associated Clinical Manifestations

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Abstract. A systematic literature review of cystic echinococcosis (CE) frequency and symptoms was conducted. Studies without denominators, original data, or using one serological test were excluded. Random-effect log-binomial models were run for CE frequency and proportion of reported symptoms where appropriate. A total of 45 and 25 articles on CE frequency and symptoms met all inclusion criteria. Prevalence of CE ranged from 1% to 7% in community-based studies and incidence rates ranged from 0 to 32 cases per 100,000 in hospital-based studies. The CE prevalence was higher in females (Prevalence Proportion Ratio: 1.35 [95% Bayesian Credible Interval: 1.16–1.53]) and increased with age. The most common manifestations of hepatic and pulmonary CE were abdominal pain (57.3% [95% confidence interval [CI]: 37.3–76.1%]) and cough (51.3% [95% CI: 35.7–66.7%]), respectively. The results are limited by the small number of unbiased studies. Nonetheless, the age/gender prevalence differences could be used to inform future models of CE burden.

INTRODUCTION

Echinococcus granulosus is a tapeworm belonging to the family Taeniidae. This zoonotic parasite maintains itself primarily in a lifecycle between domestic dogs (definitive host) and domestic ungulates (intermediate host). Humans become infected by the accidental ingestion of *E. granulosus* eggs shed in the feces of infected canids, resulting in cystic echinococcosis (CE). CE is characterized by cystic lesions, most commonly in the liver and lungs, which can be fatal if not treated with surgery and/or chemotherapy.

Because of the severity of disease that can be caused by CE and its cosmopolitan distribution, CE was included in the World Health Organization (WHO) initiative to assess the global burden of foodborne diseases. As part of this initiative, the Foodborne disease burden Epidemiology Reference Group (FERG) was created as an international experts panel to gather information on the frequency of foodborne infections and their associated manifestations globally. The information reported here was contracted by the FERG to determine the status of current knowledge of the frequency and clinical manifestations of CE globally.

MATERIALS AND METHODS

Search strategy and information sources. Two systematic searches of the literature were conducted for the years 1990–2008 to gather valid information on 1) the prevalence proportion and incidence rate (IR) of CE and 2) the frequency of clinical manifestations associated with CE. PubMed, Commonwealth Agricultural Bureau (CAB) Abstracts, and 22 international databases (Table 1) were screened for articles published from January 1, 1990 to June 1, 2008. In PubMed, the search strategy included the Medical Search Heading (MeSH) terms: “echinococcosis/epidemiology” and “echinococcosis/statistics

or numerical data” for the epidemiology search and the MeSH terms “echinococcosis/complications,” “echinococcosis/history,” “echinococcosis/pathology,” “echinococcosis/radiography,” “echinococcosis/radionuclide imaging,” “echinococcosis/rehabilitation,” and “echinococcosis/ultrasonography” for the search on clinical manifestations associated with CE. Because CAB Abstracts and the international search engines did not allow for searches using MeSH terms, they were queried using the following keywords: “echinococcosis,” “hidatidosis” (the Spanish spelling of the disease), and “hydatidose ou kyste hydatique” (the French spelling of the two terms used for the disease). Searches conducted in CAB Abstracts were further restricted to “humans.”

Only one copy of unduplicated documents was kept for analysis. Studies were selected that included original epidemiological data on CE frequency (epidemiology search) or CE clinical manifestations (clinical manifestations search). Books and conference abstracts were excluded because they were unlikely to present original data or to have sufficient details on methods to judge the validity of the study. Dissertations, theses, and memoirs were included in the search.

Eligibility criteria. All eligibility criteria were defined *a priori*. The exclusion criteria for phase I were: 1) wrong agent (for example, *Echinococcus multilocularis*); 2) animal data only; 3) no original data on the frequency of CE for the epidemiology search or on clinical manifestations associated with CE for the clinical manifestations search; 4) case series with < 20 participants for the clinical manifestations search and case series without an incidence rate (IR) estimate for the epidemiology search; 5) review articles without original data; and 6) editorials or letters to the editor without original data. Documents without abstracts were automatically included in the next phase. Eligible documents after phase I were obtained in full. Articles that could not be located either online or through Texas A&M University or University of Oklahoma Health Sciences Center library searches were requested through interlibrary loan or through the WHO's library. If articles could not be located by these means, an attempt was made to contact the corresponding author of the article in question. If the author could not be contacted or did not respond to the inquiry, the article was not reviewed past phase I.

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TABLE 1

Results of search strategies to identify articles on cystic echinococcosis epidemiology (epi) and clinical manifestations (man) published between January 1, 1990 and June 1, 2008

Database	Link	Hits (epi)	Hits (man)
African Women's Bibliographic Database	http://www.africabib.org/women.html	0	0
African Journals Online	http://www.ajol.info/	1	2
Bibliothèque Santé Tropicale	http://www.santetropicale.com/resume/catalogue.asp	0	0
Bioline International	http://www.bioline.org.br/journals	1	1
CAB Abstracts	http://www.cabi.org/databasesearchtools.asp	470	451
CUIDEN	http://www.index-f.com/	2	0
Ecole Nationale de la Santé Publique	http://www.bdsp.tm.fr	11	0
Find Articles	http://www.findarticles.com/	0	1
GreySource	http://www.greynet.org/greysourceindex.html	0	0
Ind Med	http://indmed.nic.in	4	23
Institute of Tropical Medicine (ITM) in Antwerp Belgium	http://lib.itg.be:8000/webspirs/start.ws	1	5
IranMEDEX	http://www.iranmedex.com/english/index.asp	12	16
Japan Science and Technology Information Aggregator	http://www.jstage.jst.go.jp/browse/	2	0
KoreaMed	http://www.koreamed.org/SearchBasic.php	0	1
Médecine et Pharmacie de l'Université, Bamako	http://www.keneya.net	0	0
MetaBase	http://infolac.ucof.mx/boletin/14_1/innovaciones1.html	0	0
OpenMED@NIC	http://openmed.nic.in	0	0
PUBMED	http://pubmed.org	660	1,690
Science Research Portal	http://scienceresearch.com/search/index.php	11	30
WHO Africa	http://indexmedicus.afro.who.int/	0	1
WHO Eastern Mediter	http://www.emro.who.int/HIS/VHSL	36	141
WHO South-East Asia	http://www.hellis.org	0	0
WHO Western Pacific	http://www.wpro.who.int/information_sources/library_services/wprim.htm	0	2
The Trials Register of Promoting Health Interventions (TRoPHI)	http://eppi.ioe.ac.uk/EPPIWeb/home.aspx?Control=Search&SearchDB=trials&page=/hp/	0	0

Each full document was subjected to a qualitative review (phase II) and a quantitative review (phase III). The exclusion criteria for phase II included all criteria used in phase I in addition to 1) high potential for selection bias, defined as the absence of or incomplete information on the source population for the epidemiology search; 2) data not meeting the diagnostic criteria for CE; or 3) all data from before 1990. Diagnostic criteria for CE included one of the following:

1. Typical organ lesions detected by imaging technique (for example, ultrasound, computed tomography scan, radiography, magnetic resonance imaging)
2. Specific serum antibodies by high sensitivity serological test and confirmed by a separate high specificity serological test
3. Histopathology or parasitology compatible with CE (for example, direct visualization of the protoscolex or hooklets in cyst fluid)
4. Detection of pathognomic macroscopic morphology of cyst(s) in surgical specimens
5. Detection of *E. granulosus* nucleic acid in a clinical specimen

Articles reviewed in full were restricted to languages that at least one member of the research team could read and understand namely English, French, Russian, Ukrainian, Chinese, Italian, Romanian, German, Spanish, and Portuguese. In addition, articles in other languages that were available in electronic format that could be translated into English using an online translator were reviewed if the translation was deemed acceptable. Studies published before 1990 were excluded because it was felt that the prevalence proportion, IR, and manifestations data would be outdated for estimating the global burden of disease between 1995 and 2005, which was the intended use of these data.

Study selection, data collection items, and data items. The search strategy for both reviews was conducted in three phases. In phase I, all documents retrieved were screened based on title and abstract. The full reference of each article, the country where the study was conducted, the decision on inclusion for phase II, the reason for exclusion (if applicable), and the language of the document were entered into an Excel spreadsheet (Microsoft Corp., Redmond, WA). Quality assessment (phase II) and data extraction (phase III) for each document were carried out by two reviewers, when possible. All documents were reviewed by at least one senior researcher (CB or HC). Disagreements or uncertainties were resolved through discussion with other reviewers. Data were entered into standardized electronic forms of the data extraction tool that was developed in Access (Microsoft Corp.) specifically for this review (available from the authors on request). Data were collected on the study characteristics (design, geographic location, period, and duration of the study), participant selection, and ascertainment of outcome. For documents that could potentially be included in the review, but had incomplete or missing data, at least two attempts were made to contact the authors for clarification and/or additional information.

Risk of bias in individual studies. Misclassification bias was reduced by opting not to include studies that relied solely on diagnosing patients using a single serological test. Because participants in community-based studies were rarely selected at random, it was decided to include large community-based studies of volunteers. This undoubtedly introduces a possible selection bias, the direction of which will be discussed later. In terms of hospital-based data, represented hospitals were often referral hospitals that tend to treat the sickest patients. In addition, the source and/or target populations for hospital-based studies were often estimated through the population

size in the catchment area of the hospital. This necessitated relying on a calculation of surgical incidence provided by the author, the accuracy of which could not be assessed.

Risk of bias across studies. Bias across studies was possible because most community and hospital-based studies were conducted in known high endemic areas. In addition, bias could exist because community imaging-based studies were not evenly distributed between high endemic regions caused by large multi-year research programs targeting specific locations (for example, western China) and limited availability of imaging in areas such as sub-Saharan Africa. The inclusion of CE in the list of notifiable diseases also varies across countries, which could impact awareness of the disease and, therefore, the locations where studies take place. An attempt was made to decrease publication bias by including numerous publication languages, including Chinese, Russian, French, and Spanish.

Summary measures. For the epidemiologic review, the prevalence proportion of CE in community-based studies was estimated by dividing the number of individuals who were imaging positive, by the total number of individuals who had imaging. For hospital-based studies, the annual IR of CE hospitalizations was estimated by dividing the number of hospitalized CE cases by the reported catchment population for the hospital being studied (multiplied by the number of years of the study when appropriate). Whenever possible, these estimates were stratified by age and gender. For the review of clinical manifestations, the distribution of manifestations was reported by cyst location (hepatic or pulmonary). For each location, the proportion of each manifestation was estimated by dividing the number of cases with each manifestation by the total number of CE cases with that location.

*Other languages include Arabic, Bosnian, Bulgarian, Croatian, Dutch, Finnish, Hebrew, Japanese, Polish, Turkish

FIGURE 1. Flow chart of cystic echinococcosis epidemiology systematic review.

Data synthesis and additional analysis. Random-effect log binomial models were run to estimate the prevalence of CE in community-based studies for countries with three or more studies and for the proportion of presenting clinical manifestation for surgical hepatic and pulmonary CE cases, using the R META package (Version 0.8-2; by Guido Schwarzer in the R META metagen function) from R statistical software (R Development Core Team, www.R-project.org). Both fixed-effects and random-effects models were investigated, but given the significant variation in the estimated prevalence values, as indicated by the Q statistic, only the random-effects results are presented. The inverse variance method (Cooper H and Hedges LV) was used to pool the proportion estimates in the random-effect models and calculate the appropriate 95% confidence intervals (95% CIs).¹ When available, frequency data were reported by age and sex. A Bayesian random-effect

log-binomial meta-regression was fitted to estimate the prevalence proportion ratios (PPR) and their 95% Bayesian Credible Interval (95% BCI) to evaluate the effect of sex and two age groupings on CE prevalence from community-based studies.²

RESULTS

A total of 1,211 articles were identified through the CE epidemiology search (Table 1). Of these, 528 met the inclusion criteria for phase II review, with studies of the wrong agent, review papers, and case reports being the most common reasons for exclusion. Forty-five articles had data abstracted in phase III, with no frequency data being the most common reason for exclusion. The flow diagram for the CE epidemiology search is presented in Figure 1.

*Other languages include Arabic, Bosnian, Bulgarian, Croatian, Dutch, Finnish, Hebrew, Japanese, Polish, Turkish

FIGURE 2. Flow chart of cystic echinococcosis clinical manifestations systematic review.

TABLE 2
Description of community-based cross-sectional studies reporting the prevalence of hepatic and pulmonary cystic echinococcosis based on imaging

Country (study date)	Reference (language)	Source population	Target population	*Sampling strategy	CE definition	Number of participants/ population (%)	Prevalence of hepatic CE	Prevalence of pulmonary CE	Likelihood for selection bias
China (2002–2003)	³ (English)	People living in Guyuan, Longde, and Xiji counties, Ningxia Hui Autonomous Region	People aged 5 years and older living in these villages	Volunteers/ Census	Abdominal ultrasound	Guyuan: 983/3,990 = 25% Xiji: 3,139/8,655 = 36% Longde: 161/200 = 80% 113/159 = 71%	Guyuan: 3/983 = 0.30% Xiji: 69/3,139 = 2.2% Longde: 1/161 = 0.62% 12/113 = 10.6%	NA	High (2 villages)
China (2001–2002)	⁴ (English)	Population of eastern Xiji county, Ningxia Hui Autonomous Region	People living in the village of Nanwan known for CE family cluster	Census	Abdominal ultrasound			NA	Small
China Altai (1990–1991) Tacheng (1995–1996)	⁵ (English)	Population of Altai and Tacheng Prefectures, Xinjiang Uygur Autonomous Region	People living in the Kekergash or Narenhebuke communities	Volunteers/ Census	Abdominal ultrasound	Tacheng: 1,844/2,631 = 70% Altai: 1,861/6,424 = 29%	Tacheng: 49/1,844 = 2.7% Altai: 17/1,861 = 0.91%	NA	High (1 Prefecture)
China (2002)	⁶ (Chinese)	Population of Habahe and Qinghe Counties, Xinjiang Uygur Autonomous Region	People aged 5 years or older living in Habahe and Qinghe Counties	Census	Abdominal ultrasound	Not available from paper	Habahe: 17/889 = 1.9% Qinghe: 31/536 = 5.8%	NA	High
China (1997–1998)	⁷ (Chinese)	Population of Shiqu and Ganzhi Counties, western Sichuan Province	People in 4 townships from each county	Random (cluster strata)	Abdominal ultrasound	Not available from paper	Shiqu County: 60/1,249 = 4.8% Ganzhi County: 25/2,750 = 0.91% 21/63,199 = 6.8%	NA	Probably high
China (2000–2002)	⁸ (English)	Population of Shiqu County, western Sichuan Province	People living in 26 villages of Shiqu County	Volunteers	Abdominal ultrasound	Not available from paper		NA	Probably high
China (1995–2005)	⁹ (Chinese)	Population of Qinghai Province	People living in this province	Random (cluster strata)	Abdominal ultrasound	Not available from paper	866/2,2675 = 3.8%	NA	Impossible to determine
China (1997–1998)	¹⁰ (English)	Population of Chindu, Zeko and Gade Counties, Qinghai Province	Residents of the 3 counties where the study was advertised	Volunteers	Abdominal ultrasound	Not available from paper	243/3,703 = 6.6%	NA	Probably high
China (2002)	¹¹ (Chinese)	Population of Yushu County, Qinghai Province	People aged 2 years or older living in 4 villages of Yushu County	Random (cluster strata)	Abdominal ultrasound	Not available from paper	28/1,070 = 2.6%	NA	Possibly small (random sampling)
Mongolia (2000)	¹² (English)	Population of Bulgan community, western Mongolia	People living in Bulgan community	Volunteers	Abdominal ultrasound	1,609/6,7300 = 2.4%	4/1,609 = 0.25%	NA	High
Peru (2004)	¹³ (English)	Population of Yanahuanaca district, Pasco department	People older than 5 years of age living in 9 rural communities, Yanahuanaca district	Volunteers	Abdominal ultrasound and thoracic radiographs	949/1,836 = 52%	45/949 = 4.7%	9/829 = 1.1%	High

(Continued)

Table 2
Continued

Country (study date)	Reference (language)	Source population	Target population	*Sampling strategy	CE definition	Number of participants/ population (%)	Prevalence of hepatic CE	Prevalence of pulmonary CE	Likelihood for selection bias
Peru (dates not given)	¹⁴ (English)	Population of Canchayllo village (Peruvian highlands)	People older than 5 years of age living in Canchayllo	Volunteers	Abdominal ultrasound	389/1,245 = 31 %	21/389 = 5.4 %	NA	High
Peru (1994–1995)	¹⁵ (English)	Population of Tupac Amaru farming cooperative (central Peruvian Andes)	People older than 5 years of age living in Tupac Amaru	Volunteers	Abdominal ultrasound and thoracic radiographs	407/887 = 46 %	15/407 = 3.7 %	8/407 = 2.0 %	High
Peru (1997–1998)	¹⁶ (English)	Population of the village of Vichaycocha	People older than 5 years of age in Vichaycocha	Volunteers	Abdominal ultrasound and thoracic radiographs	214/517 = 41 %	12/214 = 5.6 %	8/214 = 3.7 %	High
Morocco (2000–2001)	¹⁷ (English)	Population of Ifrane and Khenifra prefectures	People living in Ifrane and Khenifra	Volunteers	Abdominal ultrasound	Not available from paper (high according to personal communication with MK)	Ifrane: 68/7,282 = 0.93 % Khenifra: 58/4,330 = 1.3 %	NA	Small
Sudan (2002)	¹⁸ (English)	Population of one village of Gezira state	People aged 5–60 years living in the village of Um Zukra	Random (specific method not provided)	Abdominal ultrasound	300/4,000 = 7.5 %	1/300 = 0.33 %	NA	High
Argentina (1984–1986/ 1997–1998)	¹⁹ (English)	Primary school-aged children living in 3 departments, Rio Negro Province	Asymptomatic children (6–14 years of age) from schools in Pilcaniyeu, El Bolson, and Norquinco departments	Census	Abdominal ultrasound	1984–1986: 268/268 = 100 % 1997–1998: 451/451 = 100 %	1984–1986: 15/268 = 5.6 % 1997–1998: 5/451 = 1.1 %	NA	None
Argentina (1997–2002)	²⁰ (English)	Primary school children living in Rio Negro Province	Children (6–14 years of age) attending 85 and 9 schools in 7 endemic and one non endemic department, respectively	Census	Abdominal ultrasound	Endemic: 4,644/5,379 = 86 % Non-endemic: 1,101/1,101 = 100 %	Endemic depts.: 70/4,644 = 1.5 % Non-endemic depts.: 0/1,101 = 0 %	NA	Small
Argentina (1997–1998)	²¹ (English)	Children in the town of Ingeniero Jacobacci, Rio Negro Province	Children (7–14 years of age) attending all schools in Ingeniero Jacobacci	Census	Abdominal ultrasound	1,070/1,070 = 100 %	24/1,070 = 2.2 % (with additional imaging confirmation)	NA	None
Mexico (2002)	²² (English)	Population of rural communities in the State of Mexico	Individuals from the study village	Random (sample of 394 households)	Abdominal ultrasound	Population participating over total village population: 401/1,911 = 21 %	3/401 = 0.7 %	NA	High

(Continued)

Table 2
Continued

Country (study date)	Reference (language)	Source population	Target population	*Sampling strategy	CE definition	Number of participants/ population (%)	Prevalence of hepatic CE	Prevalence of pulmonary CE	Likelihood for selection bias
Turkey (dates not given)	²³ (English)	Children living in Manisa Province in Western Turkey	Children (7–17 years of age) living in one of the three study villages	Census	Abdominal ultrasound	Not available from paper	2/630 = 0.3%	NA	High
Turkey (dates not given)	²⁴ (English)	Children living in Manisa, Western Turkey	Children (7–14 years of age) in 37 primary schools in Manisa	Random (cluster strata)	Abdominal ultrasound	Population participating over total population of children in primary school 6,093/ 166,766 = 3.6% 1,434/1,537 = 93%	9/6,093 = 0.15%	NA	Small (random sample)
Tunisia (dates not given)	²⁵ (English)	Population of the village of Sisseb Dar Bein Aicha	People (> 5 years of age) in Sisseb Dar Bein Aicha	Census	Abdominal ultrasound	166,766 = 3.6% 1,434/1,537 = 93%	50/1,434 = 3.5%	NA	Small
Libya (dates not given)	²⁶ (English)	Population of northwestern Libya	Residents of 5 rural communities in northwestern Libya	Volunteers	Abdominal ultrasound	Not available from paper	57/4,103 = 1.4%	NA	High
Libya (1994–1995)	²⁷ (English)	Population of coastal areas of Libya	Residents of 36 coastal villages	Volunteers	Abdominal ultrasound	Not available from paper	339/20,200 = 1.7%	NA	High
Ethiopia (1989)	²⁸ (English)	Population of the Hamar tribal group	Residents of Hamar villages in Southern Ethiopia	Random (10% probability proportional sample from these hamlets)	Abdominal ultrasound	990/1,060 = 93.4%	7/990 = 0.71%	NA	Small
Lebanon (1994–1995)	²⁹ (English)	Population of a small village in the Khums area	Residents of a small village in the Khums area	Volunteers	Abdominal ultrasound	485/485 = 100%	22/485 = 4.5%	NA	None
Uruguay (1993–1994)	³⁰ (English)	Population of Florida department	Residents of Florida department	Volunteers	Abdominal ultrasound	9,515/66,000 = 14.4%	156/9,515 = 1.6%	NA	High
Uruguay (1991–1992)	³¹ (English)	Population of the village of La Paloma	Residents of La Paloma	Volunteers	Abdominal ultrasound	1,149/1,388 = 83%	40/1,149 = 3.5%	NA	Small
Uzbekistan 1998	³² (Russian)	Population of Uzbekistan	Residents of Uzbekistan	Random (Specific method not provided)	Abdominal ultrasound and thoracic radiographs	Not available from paper	43/7,842 = 0.55%	6/7,842 = 0.076%	High
Russia (1990–1994)	³³ (Russian)	Population of the Stavropol administrative center	Residents of Stavropol	Volunteers (presumed)	Abdominal ultrasound	Not available from paper	73/10,606 = 0.68%	NA	High

* Census is defined as > 70% participation.

A total of 2,366 articles were identified through the CE clinical manifestations search (Table 1). Of these, 779 met the inclusion criteria for phase II and 25 met the inclusion criteria for phase III. The most common reason for exclusion in both phase I and phase II was case reports or case series with < 20 participants. The flow diagram for the CE manifestations search is presented in Figure 2.

Community-based studies (Tables 2–5, Supplemental Table 1).

Details on source, study population, study design, and measurement are available in Table 2 for community-based ultrasound or radiological cross-sectional surveys estimating the prevalence of CE. We included 31 abdominal ultrasound-based studies that reported prevalence estimates ranging from < 1–7% in 14 countries. Three countries had at least three community-based prevalence estimates that could be combined in a meta-analysis (Figure 3A–C), with resulting pooled

estimates of 3.04% (95% CI: 2.05–4.23%), 1.67% (95% CI: 1.19–2.23%), and 4.82% (95% CI: 3.91–5.81%) in China, Argentina, and Peru, respectively. Four community studies were identified that focused on children, including one from Turkey and three from Argentina (Table 2)^{19–21,23}; the studies from Argentina were all from the same highly endemic area of Rio Negro Province and were the subject of the meta-analysis found in Figure 3C.

A breakdown of available community abdominal ultrasound data by age and sex is presented in Supplemental Table 1. The meta-regression suggested that the prevalence of CE was higher in females than males (PPR: 1.35 [95% BCI: 1.16–1.53]) (Table 3). Two age breakdowns were available from community studies data (0–19, 20–39, 40+ and 0–14, 15–30, 31+), and showed that the prevalence considerably increased with age (Tables 4 and 5).

FIGURE 3. (A) Abdominal ultrasound-based frequency of cystic echinococcosis in endemic areas of China (all ages) NHAR = Ningxia Hui Autonomous Region, XUAR = Xinjiang Uygur Autonomous Region. (B) Abdominal ultrasound-based frequency of cystic echinococcosis in endemic areas of Peru (all ages). (C) Abdominal ultrasound-based frequency of cystic echinococcosis in an endemic area of Argentina (school children).

TABLE 3

Prevalence proportion of cystic echinococcosis cases by sex and prevalence proportion ratio (95% Bayesian Credible Intervals [95% BCI]) of the effect of being female as compared with male in community-based abdominal ultrasound studies

Country	Reference	Female	Male	Prevalence proportion ratio (95% BCI)
China	3	44/2,268 (1.9%)	31/2,505 (1.2%)	1.56 (0.99–2.47)
China	6	22/645 (3.4%)	26/780 (3.3%)	1.48 (1.28–1.71)
China	7	45/2,080 (2.2%)	40/1,919 (2.1%)	1.03 (0.68–1.58)
China	8	134/1,660 (8.1%)	82/1,539 (5.3%)	1.52 (1.16–1.98)
China	9	477/9,918 (4.8%)	296/9,103 (3.2%)	1.48 (1.28–1.71)
Peru	13	30/572 (5.2%)	15/377 (4.0%)	1.31 (0.72–2.42)
Peru	16	4.1%	6.1%	–
Morocco	17	75/6,864 (1.1%)	51/4,747 (1.1%)	1.02 (0.71–1.45)
Tunisia	25	34/793 (4.3%)	16/641 (2.5%)	1.72 (0.96–3.08)
Libya	26	30/2,124 (1.4%)	27/1,979 (1.4%)	1.03 (0.62–1.73)
Libya	27	211/10,356 (2.0%)	128/9,864 (1.3%)	1.57 (1.26–1.95)
Ethiopia	28	7/579 (1.2%)	1/403 (0.25%)	4.87 (0.60–39.45)
Lebanon	29	11/230 (4.8%)	11/255 (4.3%)	1.11 (0.49–2.51)
Uruguay	31	18/584 (3.1%)	22/562 (3.9%)	0.80 (0.43–1.48)
Overall estimate of prevalence proportion ratio from Bayesian log-binomial random-effect model				1.35 (1.16–1.53)

Of the four studies conducting community surveys using portable thoracic radiographs to identify pulmonary CE cases, three were from Peru.^{13,15,16} In the Gavidia and others¹³ study, cysts were located in nine out of 829 (1.08%) study participants. Of the nine pulmonary CE patients identified, seven were female (77.8%). In the Moro and others¹⁶ study, eight out of 214 (3.74%) study participants had cysts identified on portable thoracic radiographs, with five (62.5%) being female. In the Moro and others¹⁵ study, eight out of 407 (1.97%) participants had cysts identified on thoracic radiographs. These studies were combined in a meta-analysis, with a pooled frequency of 2.06% (95% CI: 0.89–3.71%) (Figure 4).

Hospital-based studies (Tables 6–8). A description of the epidemiologic characteristics of the hospital-based studies included in the systematic review of the epidemiology of CE is available in Table 6. Eleven of the 12 included studies reported an estimate of the IR from the author themselves, whereas the denominator corresponding to the population under study for one study was determined using the Food and Agriculture Organization of the United Nations (FAO) database for the corresponding years.⁴⁸ Eight studies reported on surgical CE cases only, which underestimates the true frequency of cases.

IRs reported from hospital-based studies (Tables 7 and 8). We included 12 studies reporting IRs of CE by catchment population person-years. Tables 7 and 8 summarize the estimated IRs of all CE cases and of surgical CE cases, respectively. In general, National estimates of the IRs of surgical CE were lower (range of 2.3 to 5.3 surgical cases per 100,000

person-years) than studies conducted in smaller areas where the disease was known to be endemic (i.e., 32 surgical cases/100,000 person-years in the City of Chinchá, Peru) (Table 8). A similar trend was observed for the estimate of the IRs of all CE cases, although only one National estimate from Turkey was available (IR = 4.4 cases/100,000 person-years) (Table 7). One study reported IR estimates from several regions of the country (Egypt), and showed a wide variation of estimates from 0 to 2.6 CE cases per 100,000 person-years.³⁴

Proportion of CE cases among different types of patients from hospital-based studies (Table 9, Supplemental Table 2).

Three studies reported on the proportion of different types of patients that were diagnosed with CE (Table 9). The estimates were extremely variable and were most likely the result of what population was chosen for the denominator rather than the true difference in the frequency of CE among countries. Available age and sex-stratified hospital-based data are available in Supplemental Table 2.

Distribution of manifestations of hepatic and pulmonary CE (Tables 10–12). Table 10 summarizes the characteristics of the studies included in the systematic review on the distribution of manifestations associated with surgical hepatic CE (7 studies from 6 countries) and surgical pulmonary CE (19 studies from 6 countries). Abdominal pain was by far the most common manifestation of surgical hepatic CE, with a pooled estimate of 57.3% (95% CI: 37.3–76.1%). Presenting clinical manifestations associated with surgical cases of hepatic and pulmonary CE can be found in Tables 11 and 12. Results from random-effects models for the proportion of

TABLE 4

Prevalence proportion of cystic echinococcosis by age grouping 0–19 years, 20–39 years, and 40+ years of age and prevalence proportion ratios (95% Bayesian Credible Intervals [95% BCI]) in community-based ultrasound surveys

Country	Reference	Age group			Prevalence proportion ratio (95% BCI)	
		0–19	20–39	40+	20–39 vs. 0–19	40+ vs. 0–19
China	3	1/1,750	10/774	64/2,249	22.6 (2.9–176.3)	49.8 (6.9–358.6)
China	9	94/5,486	316/6,230	340/3,777	3.0 (2.4–3.8)	5.3 (4.3–6.6)
Peru	16	1/96	3/40	8/78	7.2 (0.8–67.2)	9.9 (1.3–77.0)
Tunisia	25	9/597	11/450	30/387	1.6 (0.7–3.9)	5.1 (2.5–10.7)
Ethiopia	28	1/482	1/287	5/213	1.7 (0.1–26.7)	11.3 (1.3–96.3)
Overall estimate of prevalence proportion ratio from Bayesian log-binomial random-effect model					3.1 (1.1–10.0)	7.5 (3.2–26.4)

TABLE 5

Prevalence proportion of cystic echinococcosis by age grouping 0–14 years, 15–30 years, and 31+ years of age and prevalence proportion ratios (95% Bayesian Credible Intervals [95% BCI]) in community-based ultrasound surveys

Country	Reference	Age group			Prevalence proportion ratio (95% BCI)	
		0–14	15–30	31+	15–30 vs. 0–14	31+ vs. 0–14
China	10	17/1,054	79/1,178	147/1,440	4.7 (2.8–7.8)	6.7 (4.1–11.0)
Libya	26	2/1,203	6/1,205	49/1,695	3.0 (0.6–14.8)	17.4 (4.3–71.4)
Libya	27	47/8,368	111/5,754	181/6,098	3.4 (2.4–4.8)	5.3 (3.8–7.3)
Lebanon	29	7/263	8/130	7/92	2.3 (0.9–6.2)	2.9 (1.0–7.9)
Overall estimate of prevalence proportion ratio from Bayesian log-binomial random-effect model					3.3 (1.2–7.2)	6.3 (1.4–29.4)

surgically treated hepatic CE patients that presented with abdominal pain, fever, jaundice, nausea/vomiting, and weight loss can also be found in Table 11. In addition to presenting manifestations, a pooled estimate of 27.8% (16.2–39.7%) of patients presented with an abdominal mass. This was reported in six studies and the frequency ranged between 2.4–52% of patients. Table 12 shows the results from random-effects models evaluating the distribution of various clinical manifestations associated with pulmonary CE (cough, chest pain, fever, hemoptysis, dyspnea, cyst content expectoration, and no identifiable clinical manifestations). Cough was the most common manifestation associated with pulmonary CE cases, with a pooled estimate of 51.3% (95% CI: 35.7–66.7%).

DISCUSSION

This is the first systematic review looking at both the epidemiology and clinical manifestations associated with CE, taking into account study type. Results from community-based studies suggest that the prevalence of CE in endemic areas is < 10% and > 1%. Although this remains a large range of values, it indicates that this disease is relatively common in the areas studied. These estimates are only available from a small number of regions, thought to be endemic, which limits our ability to extrapolate the results to a global estimate of the prevalence of CE. This is particularly true for the poorest areas of the world that do not have the funds or access to the technology for field diagnosis of CE.

Another limitation of the available literature is that several studies were conducted among volunteers, which could bias the prevalence estimates in either direction. A meta-regression analysis run on six studies of volunteers in China where participation proportion was available (data not shown) showed that, although not statistically significant, the prevalence of infection tended to increase with participation proportion. This suggests that those with undiagnosed infection may feel too sick to attend community screenings and, therefore,

may suffer from some disability. This is in agreement with a study conducted in western China, which showed that the quality of life of CE cases detected through ultrasound was lower than that of individuals without CE.⁷³ Hence, the relatively high prevalence of CE in combination with its associated disability would be important to consider in future global burden of disease assessments.

Our meta-regression of community-based surveys showed that females had a greater prevalence of infection than males. This may be caused by gender roles in endemic regions, which result in women more often taking care of the daily needs of dogs, tending gardens, and preparing food. In almost all community-based ultrasound studies, CE prevalence increased with age, which would be expected with a chronic infection such as CE. These data could be used in future studies to predict, with some uncertainty, the prevalence of CE in the regions where CE is known to be endemic.

Hospital-reported data have been largely used to estimate the IR of either surgical or symptomatic CE cases. These studies result in estimates of CE much lower than that found in community-based surveys, with IR values being about 1,000 times less than the prevalence values. If we assume that the average duration of CE from the asymptomatic phase to the symptomatic phase is about 10 years, the hospital-based studies result in estimates 100 times lower than that seen from community-based studies. This is to be expected because only a small proportion of patients will develop symptoms that are severe enough to seek medical attention and will have resources to pay for treatment. Studies using a smaller catchment population estimate as the denominator tended to result in larger estimates of IRs. This may reflect a more accurate estimate from smaller studies or, on the contrary, an underestimation of the size of the catchment population. As more community-based ultrasound and hospital-based IR data become available, models could be developed from areas where both types of estimates are available to predict the frequency of CE. The gender distribution of hospital cases

FIGURE 4. Portable thoracic radiograph-based frequency of cystic echinococcosis in endemic areas of Peru

TABLE 6
Description of hospital-based studies for cystic echinococcosis epidemiology

Country	Reference (language)	Region	Design	Diagnostic methods	Source population	Target population	IR available (source of denominator)	Number of cases reported (charts reviewed)
Egypt	³⁴ (English)	National	Cohort	Chart review: Imaging, serology, therapy, and histopathology or analysis of cyst fluid	Catchment population of 14 generalized and specialized hospitals	CE cases treated at the 14 hospitals from 1997–99	Yes (author)	133 CE cases (492,953 patients admitted)
Peru	³⁵ (English)	Chincha, Peru (185 km south of Lima)	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of 2 hospitals of the city of Chincha	Surgical CE cases admitted at the 2 hospitals in 1996–98	Yes (author)	50 surgical CE cases (6 liver, 39 lung, 5 liver/lung)
Kyrgyzstan	³⁶ (English)	Bishkek, Kyrgyzstan	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of the main Bishkek surgical hospital	Surgical CE cases admitted at the hospital in 1990–2000	Yes (author)	846 surgical CE cases
Palestinian Authority	³⁷ (English)	West Bank, Palestinian territory	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of all 7 public and 5 private hospitals on the West Bank	Surgical CE cases (Palestinian) admitted in 1990–97	Yes (author)	390 surgical CE cases
Bulgaria	³⁸ (English)	National	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of all Bulgaria hospitals	Surgical CE patients diagnosed from 1983–95	Yes (author)	3,780 CE cases
Italy	³⁹ (English)	National	Cohort	Chart review: In-hospital ultrasonography	Catchment population of 19 Italian Echographic Departments	CE patients diagnosed in 1988–90	No	424 CE cases (242,299 patients imaged)
Italy	⁴⁰ (Italian)	Sardinia	Ecological	Surveillance registry: Surgically confirmed CE cases and diagnosed non surgical CE cases	Population of Sardinia	Surgical and non surgical CE cases reported in 1990–91	Yes (author)	68/54 surgical CE cases 43/36 new CE cases
Morocco	⁴¹ (French)	National	Cross-sectional	Surgically confirmed CE cases	Catchment population of all provincial hospitals (Morocco population)	Surgical CE cases admitted in 1992	Yes (author)	1,347 surgical CE cases
Spain	⁴² (Spanish)	Salamanca	Cross sectional	Chart review: ICD-9 code 122.0 and 122.9	Catchment population of the Salamanca University Hospital (Salamanca population)	CE patients treated in 1996–2003	Yes (author)	313 CE cases (252 liver, 25 lung, 21 other)
Iraq	⁴³ (English)	Arbil Province	Cohort	Surgical records review: Surgically and histopathologically confirmed CE cases	Catchment population of the 2 main hospitals in Arbil Province	CE patients diagnosed in 1990–98	No	99 surgical CE cases (4971 surgical records)
Chile	⁴⁴ (Spanish)	Valdivia Province	Ecological	Surgical records review: Surgically confirmed CE cases	Catchment population of the Valdivia regional hospital (Valdivia population)	Surgical CE cases admitted in 1987–91	Yes (author)	137 surgical CE cases
Turkey	⁴⁵ (Turkish)	National	Cohort	Hospital medical charts and Ministry of Health surveillance system: Surgically confirmed CE cases	Population of Turkey	Hospitalized cases and reported cases in 2001–05	Yes (FAO)	14,789 CE cases
Jordan	⁴⁶ (English)	National	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of major government, military and private hospitals (Jordan population)	Surgical CE cases admitted in 1994–2000	Yes (author)	472 surgical CE cases
Libya	⁴⁷ (English)	Benghazi area of Eastern Libya	Cohort	Surgical records review: Surgically confirmed CE cases	Catchment population of the 6 main hospitals in Benghazi (eastern Libya population)	Surgical CE cases admitted from 4/91–6/02	Yes (author)	306 surgical CE cases

TABLE 7
Summary of incidence rate estimates of all CE cases from hospital-based studies

Country	Ref	Region	Denominator	Years	Incidence rate (IR) (per 100,000 person-years)
Turkey	45	National	68,143,000 (2005 pop.)	2001–2005	4.42
Egypt	34	Giza	4,554,464–4,751,950	1997–1999	0.8–1.16
	34	Matrough	2,683,728–2,800,097	1997–1999	1.34–2.6
	34	Alexandria	3,515,238–3,667,662	1997–1999	0.65–0.85
	34	Menoufia	194,019–202,432	1997–1999	0.27–0.83
	34	Cairo	7,450,857–7,773,934	1997–1999	0.05–0.27
	34	Suez	394,063–411,150	1997–1999	0.00–0.40
	34	North Sinai	121,111–126,363	1997–1999	0.00–0.00
Italy	40	Sardigna	1,648,000	1990	14.9
	40	Sardigna	1,648,000	1991	11.9
Spain	42	Salamanca	347,639	1996–2003	10.8

TABLE 8
Summary of incidence rate estimates of surgical cystic echinococcosis (CE) cases from hospital-based studies

Country	Ref	Region	Denominator	Years	Incidence rate (IR) (per 100,000 person-years)
Jordan	46	National	4,827,000 (2000 pop.)	1994–2000	2.3
Bulgaria	38	National	8,357,000 (1995 pop.)	1983–1995	3.35
Morocco	41	National	25,547,000	1992	5.3
Palestine	37	West Bank	1,900,000	1995–1997	3.1
Lybia	47	Benghazi area	700,000	1991–2002	4.2
Chile	44	Province of Valdivia	259,000	1987–1991	9.1
Peru	35	City of Chincha	52,661	1996–1998	32.0
Kyrgystan	36	National	4,955,000	2000	18.0

TABLE 9
Summary of proportion of all cystic echinococcosis (CE) cases from different populations in hospital-based studies

Country	Ref	Region	Source	Years	Denominator	Proportion (per 1,000)
Egypt	34	7 regions throughout Egypt	14 hospitals	1997–1999	Number of cases admitted to the hospitals	0.27
Italy	39	National	19 echographic departments	1988–1990	Number of patients imaged	1.75
Iraq	43	Arbil Province	2 major hospitals	1990–1998	Number of patients with surgeries	19.92

TABLE 10
Descriptive summary of the studies included for estimating the distribution of manifestations associated with surgical hepatic and pulmonary cystic echinococcosis (CE)

Reference (language)	Country, year(s) of study	Source population	Target population	Study sample size
49 (English)	Morocco, 1990–2004	CE patients treated in Surgery Department “A” at the Ibn Sina University Hospital in Rabat	672 patients with hepatic CE	664
50 (English)	Pakistan, 1986–1995	CE patients treated in Surgical Unit-I at Liaquat Medical College in Jamshoro/Hyderabad	48 patients with hepatic CE	48
51 (English)	Turkey, 1991–2002	CE patients treated in the Department of General Surgery at Karadeniz Technical University in Trabzon	102 patients with hepatic CE	102
52 (English)	Turkey, 1995–2005	CE patients treated at the General Surgery Clinic at Izmir Ataturk Research and Training Hospital in Izmir	73 patients with hepatic CE	73
53 (French)	Algeria, Specific dates not provided	CE patients operated on by the same surgical team at the surgical units of the Zeralda Hospital and the Central Clinic of Algiers	100 patients with hepatic CE	100
54 (English)	Jordan, 1973–1999	CE patients treated at the Department of General Surgery, Jordan University Hospital	169 patients with hepatic CE	169
55 (English)	Iran, 1995–2005	Pediatric CE patients treated at the Children Medical Center Hospital in Tehran	31 patients with CE	15 (hepatic) 24 (pulmonary)
56 (English)	Syria, 1993–2002	CE patients treated at the Department of Thoracic Surgery, Almouassat University Hospital Medical School, Damascus	206 patients with pulmonary CE	206

(Continued)

Table 10
Continued

Reference (language)	Country, year(s) of study	Source population	Target population	Study sample size
57 (English)	Egypt, 1995–2004	CE patients treated at the Cardiothoracic Surgery Department, Mansoura University, Mansoura, Dakahlia	56 patients with pulmonary CE	56
58 (English)	Iran, 1990–2002	CE patients treated at regional and private hospitals in Iran	120 patients with pulmonary CE	120
59 (English)	Turkey, 1985–2001	CE patients treated at the Department of Thoracic Surgery, Ankara University School of Medicine, Ankara	1032 patients with pulmonary CE	1032
60 (English)	Turkey, 1978–1993	CE patients treated at the Department of Thoracic and Cardiovascular Surgery, Faculty of Medicine, University of Cukurova, Adana	405 patients with pulmonary CE	405
61 (English)	Turkey, 1989–1998	CE patients treated at the Department of Thoracic Surgery or the Sureyyapasa Center for Chest Diseases and Thoracic Surgery, Maltepe, Istanbul	288 patients with pulmonary CE	288
62 (English)	Turkey, 1990–2005	CE patients treated at two thoracic surgery clinics in Kayseri	107 patients with pulmonary CE	107
63 (English)	Turkey, 1997–2000	CE patients treated at Ataturk University, Erzurum	70 patients with pulmonary CE	70
64 (English)	Turkey, 1990–2002	CE patients treated at the Thoracic Surgery Department, Dicle University School of Medicine, Diyarbakir	139 patients with pulmonary CE	139
65 (English)	Libya, 1985–1991	Pediatric CE patients treated at the Al-Jala Hospital in Benghazi	43 patients with pulmonary CE	43
66 (English)	Turkey, 1994–2003	Pediatric CE patients treated at two pediatric surgery clinics in Istanbul	112 patients with pulmonary CE	112
67 (English)	Turkey, 1990–2001	Pediatric CE patients treated at the Department of Thoracic Surgery, Ataturk Medical Faculty, Ezurum	102 patients with pulmonary CE	102
68 (English)	Turkey, Specific dates not provided	Pediatric CE patients treated at the School of Medicine, Zonguldak Karaelmas University, Kozlu/Zonguldak	47 patients with pulmonary CE	47
69 (English)	Turkey, 1990–2000	Pediatric CE patients treated at the Department of Thoracic Surgery, Ankara University School of Medicine, Ankara	33 patients with pulmonary CE	33
70 (French)	Morocco 2002–2005	Pediatric CE patients treated at the Department of Thoracic Surgery, Military Training Hospital Mohamad-V, Rabat	23 patients with pulmonary CE	23
71 (English)	Turkey 1998–2002	CE patients treated at the Department of Thoracic Surgery, Inonu University Faculty of Medicine, Turgut Ozal Medical Center, Malatya	67 patients with pulmonary CE	34 (intact cysts) 33 (complicated cysts)
72 (English)	Turkey 1986–1996	Pediatric CE patients treated at the Yedikule Gogus Hastanesi Hospital in Istanbul, Turkey or the University of Vienna Medical School in Vienna	33 patients with pulmonary CE	20 (intact cysts) 14 (ruptured cysts) (1 patient had both intact and ruptured cysts)

TABLE 11

Most commonly reported presenting manifestations among surgically treated cases of hepatic cystic echinococcosis*

Country	Ref	Total hepatic CE	Abdominal pain	Fever	Jaundice	Nausea/vomiting	Weight loss	Asymptomatic
Morocco	49	664	260 (39.2%)	75 (11.3%)	66 (9.9%)	—	59 (8.9%)	98 (14.8%)
Pakistan	50	48	14 (29.2%)	4 (8.3%)	—	—	2 (4.2%)	—
Turkey	51	102	80 (78.4%)	14 (13.7%)	10 (9.8%)	22 (22.0%)	12 (11.8%)	12 (11.8%)
Turkey	52	73	59 (80.8%)	—	7 (9.59%)	10 (13.7%)	—	—
Algeria	53	100	82 (82.0%)	20 (20.0%)	2 (2.00%)	11 (11.0%)	—	—
Jordan	54	169	50 (29.6%)	28 (16.6%)	27 (16.0%)	—	11 (6.5%)	—
Iran	55†	15	10 (66.7%)	15 (100%)	—	4 (26.7%)	9 (60.0%)	—
Proportion (95% CI)‡			57.3% (37.3–76.1%)	14.1% (10.7–17.9%)	9.4% (5.7–14.0%)	15.6% (9.9–22.4%)	8.6% (6.7–10.6%)	—

*Other clinical manifestations included pulmonary symptoms, urticaria, cholangitis, hematemesis, and back pain.

†Pediatric cases only.

‡Excluding reports of only pediatric cases and estimated for manifestations reported by at least three articles.

TABLE 12
Most commonly reported presenting manifestations among cases of pulmonary cystic echinococcosis treated in hospitals*

Country	Ref	Total pulmonary CE	Cough	Chest pain	Fever	Hemoptysis	Dyspnea	Cyst content expectoration	Asymptomatic
Syria	56	206	112 (54.4%)	75 (36.4%)	—	39 (18.9%)	52 (25.2%)	21 (10.2%)	—
Egypt	57	56	19 (17.8%)	16 (28.6%)	6 (10.7%)	12 (21.4%)	15 (26.8%)	3 (5.4%)	4 (7.1%)
Iran	58	120	75 (62.5%)	10 (8.3%)	20 (16.7%)	10 (8.3%)	—	—	5 (4.2%)
Turkey	59	1032	846 (82.0%)	629 (60.9%)	124 (12.0%)	217 (21.0%)	258 (25.0%)	155 (15.0%)	165 (16.0%)
Turkey	60	405	101 (24.9%)	208 (51.3%)	8 (2.0%)	1 (0.2%)	—	—	65 (16.0%)
Turkey	61	288	155 (53.8%)	142 (49.3%)	40 (13.9%)	61 (21.2%)	29 (10.1%)	14 (4.9%)	30 (10.4%)
Turkey	62	107	43 (40.2%)	30 (28.0%)	16 (14.9%)	2 (1.9%)	—	8 (7.5%)	22 (20.6%)
Turkey	63	70	38 (54.3%)	33 (47.1%)	22 (31.4%)	—	21 (30.0%)	11 (15.7%)	—
Turkey	64	139	68 (48.9%)	48 (34.5%)	39 (28.0%)	11 (7.91%)	—	—	18 (12.9%)
Iran	55	24 (ped)	22 (91.7%)	10 (41.7%)	20 (83.3%)	2 (8.3%)	11 (45.8%)	—	—
Libya	65	43 (ped)	30 (69.8%)	2 (4.7%)	16 (37.2%)	9 (20.9%)	—	—	2 (4.7%)
Turkey	66	112 (ped)	79 (70.5%)	27 (24.1%)	38 (33.9%)	2 (1.8%)	—	2 (1.8%)	—
Turkey	67	102 (ped)	57 (55.9%)	41 (40.2%)	19 (18.6%)	9 (8.8%)	21 (20.6%)	8 (7.8%)	—
Turkey	68	47 (ped)	35 (74.5%)	17 (36.2%)	21 (44.7%)	2 (4.3%)	—	—	—
Turkey	69	33 (ped)	22 (66.7%)	11 (33.3%)	6 (18.2%)	10 (30.3%)	—	—	—
Morocco	70	23 (ped)	—	20 (86.9%)	—	5 (21.7%)	2 (8.7%)	—	4 (12.1%)
Turkey	71	34† (intact)	9 (26.5%)	17 (50.0%)	4 (11.8%)	2 (5.9%)	6 (17.6%)	—	2 (8.7%)
Turkey	71	33† (ruptured)	15 (45.4%)	16 (48.5%)	12 (36.4%)	11 (3.3%)	14 (42.4%)	5 (15.1%)	9 (26.5%)
Turkey	72	20† (intact-ped)	13 (65.0%)	10 (50.0%)	7 (35.0%)	2 (10.0%)	8 (40.0%)	1 (5.0%)	1 (3.0%)
Turkey	72	14† (ruptured-ped)	14 (100%)	8 (57.1%)	7 (50.0%)	8 (57.1%)	3 (21.4%)	8 (57.1%)	1 (5.0%)
Proportion (95% CI) - All ages			51.3% (35.8–66.7%)	39.9% (29.8–50.4%)	14.8% (9.3–21.3%)	12.6% (5.6–21.8%)	23.7% (17.1–31.0%)	8.8% (5.1–13.3%)	12.8% (9.8–16.0%)
Proportion (95% CI) - Pediatric cases only			70.3% (61.2–78.6%)	36.5% (21.4–53.1%)	38.1% (23.4–54.0%)	12.3% (5.5–21.3%)	24.1% (9.5–42.7%)	—	10.2% (4.9–17.3%)

* Other clinical manifestations included tachypnea, sweating, infectious symptoms, pleuritis, pneumothorax, weight loss, purulent sputum, allergic reactions, malaise, nausea and vomiting, abdominal pain, and headache.

† Not included in meta-analysis.

were similar to that found in community-based studies. This suggests the absence of a gender bias in seeking medical care for CE. Therefore, the overall estimates of the PPRs from the Bayesian log-binomial random-effect models for distribution of community CE cases by sex should be appropriate to use with hospital-based data.

In contrast to what was seen in community-based prevalence surveys, data from hospital studies indicated that young adults and middle-aged individuals made up the largest proportion of surgical cases. Two possible reasons could lead to this observation. First, older individuals diagnosed in community studies have been infected for a long period of time, but did not develop significant clinical manifestations. Second, older patients may be less likely to seek medical attention because they may not work anymore and may not be as affected by the symptoms.

Abdominal pain was the most commonly reported presenting complaint for hepatic CE and cough the most commonly reported presenting complaint for pulmonary CE. Those manifestations would be associated with only small disability weights, further emphasizing the need for more representative studies of undiagnosed cases and their level of disability.

In conclusion, this is the first systematic review of both CE epidemiology and clinical manifestations. Although the unequal distribution of the origin of published literature and poor official reporting are acknowledged, the data obtained through this review can be used to inform and improve upon models assessing the global burden of CE.

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