Analysis of the economic impact of cystic echinococcosis in Spain

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Objective To estimate the overall economic losses due to human and animal cystic echinococcosis (CE) in Spain in 2005.

Methods We obtained data on annual CE incidence from surveillance and abattoir records, and on CE-related treatment and productivity losses (human and animal) from the scientific literature. Direct costs were those associated with diagnosis, surgical or chemotherapeutic treatment, medical care and hospitalization in humans, and condemnation of offal in livestock (sheep, goats, cattle and pigs). Indirect costs comprised human productivity losses and the reduction in growth, fecundity and milk production in livestock. The Latin hypercube method was used to represent the uncertainty surrounding the input parameters.

Findings The overall economic loss attributable to CE in humans and animals in 2005 was estimated at 148 964 534 euros (€) (95% credible interval, CI: 21 980 446–394 012 706). Human-associated losses were estimated at €133 416 601 (95% CI: 6 658 738–379 273 434) and animal-associated losses at €15 532 242 (95% CI: 13 447 378–17 789 491).

Conclusion CE is a neglected zoonosis that remains a human and animal health concern for Spain. More accurate data on CE prevalence in humans (particularly undiagnosed or asymptomatic cases) and better methods to estimate productivity losses in animals are needed. CE continues to affect certain areas of Spain, despite several control initiatives since 1986. Given the high economic burden of CE, additional funding is needed to reduce human and animal infection rates through improved disease surveillance, regular treatment of dogs and greater cooperation between agencies.

Une traduction en français de ce résumé figure à la fin de l'article. Al final del artículo se facilita una traducción al español. الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

Introduction

Cystic echinococcosis (CE or hydatid disease) is a zoonotic infection caused by the larval stage of the taeniid tapeworm *Echinococcus granulosus*. The parasite's life cycle is maintained through dogs (which harbour the adult worm in their small intestine) and a range of domestic livestock that serve as intermediate hosts. *E. granulosus* eggs are excreted in the faeces of infected dogs and may thus contaminate soil, grass and water. Ungulates (hoofed animals) can become infected by grazing on pasture contaminated with dog faeces. Ingested eggs hatch inside the intestine, penetrate the gut wall and are carried by the bloodstream to different organs and tissues (mainly the liver and lungs) where they develop into cysts (metacestodes) that can eventually cause severe pathological damage. Humans can become infected by ingesting eggs through consuming contaminated food or water or from handling the faeces of infected dogs.

As in other countries of the Mediterranean basin, CE is endemic in Spain.[1,2] Most affected regions are the central, north-eastern and western regions of the country, where extensive or semi-extensive farming of livestock (mostly sheep) is common. Since the mid-1980s, a number of prevention and control programmes to reduce *E. granulosus* infection have been implemented in these regions. These programmes have led to a considerable decrease in human and animal CE infection rates.[3–5] However, the disease remains a serious health concern in many of the affected regions. A recent survey showed human CE annual incidence rates in the range of 1.1 to 3.4 cases per 10^5 person-years, in combination with ovine or bovine CE prevalence proportions of up to 23%.[6]

Spain is a developed country with a population of more than 43 million (77% of whom live in urban areas) and a high average income; in 2005, the gross domestic product per head was €18 677.[7] The national public health system provides health services for an estimated 90% of the population; the remaining 10% (mainly from the autonomous regions of Madrid and Catalonia) have both public and private coverage.[8] The national epidemiological surveillance network is based on three interdependent systems – compulsory notifiable diseases, outbreaks alerts and microbiological information. The autonomous regions where CE infection is considered endemic (Aragon, Cantabria, Castile-La Mancha, Castile-León, Catalonia, Ceuta and Melilla, Comunidad Valenciana, Extremadura, La Rioja and Navarre) report human CE to the compulsory notifiable diseases system.[9] The proportion of symptomatic CE cases that are detected and reported to the system has been estimated at 47–57%.[10] However, the completeness of case detection increases to more than 95% when the microbiological information system and computerized hospital discharge records are also considered, and the specificity is 100% (LP Sánchez-Serrano, unpublished data, 2009). Surveillance of CE in livestock is carried out through routine postmortem examination in all national slaughterhouses, with detected cases reported to the Spanish

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Food Safety Agency.[11] Official figures on human and animal CE are subsequently submitted to the European Commission as part of the Spanish Report on Trends and Sources of Zoonoses.[12]

CE affects both human and animal health and has important economic consequences.[13] Human-associated economic losses arise through diagnostic procedures, surgical or chemotherapeutic treatment, hospitalization, convalescence, life impairment and fatalities. Animal-associated economic losses arise from decreases in carcass weight, milk production and fertility rates, and from increased condemnation of viscera. Estimation of the economic burden in humans and livestock is important and should be part of any cost–benefit programme for the control of parasitic zoonoses.[14,15] Early surveys attempting to quantify human and animal CE losses were hampered by the scarcity of reliable epidemiological and economic data.[16–18] Mathematical approaches based on decision-tree analysis and efficient sampling techniques were therefore proposed, to model the inherent uncertainty.[19] Such approaches have been used successfully in various studies.[16,20,21] In Spain, the evaluation of the economic effects of CE has previously been attempted only in the autonomous regions of Extremadura[4] and La Rioja,[5] as part of the control programmes implemented in these regions. However, cost estimates at a national scale are lacking. The aim of this study was to estimate the overall economic losses due to human and animal CE in Spain in 2005.

Methods

Human epidemiological parameters

The human epidemiological parameters used in the analysis included diagnosed cases (in males and in females); undiagnosed or asymptomatic cases; and diagnosed cases with surgery. The number of reported CE cases by age and gender was obtained from the epidemiology surveillance network[22] and was used to estimate the productivity losses in humans (see below). We assumed that the proportion of reported cases and the frequency of different types of treatment were uniform across age and gender. We also assumed that the proportion of CE cases with surgery followed a triangular distribution – with parameters of 68%, 95% and 100% – as specified in five Spanish studies of hospitalized CE cases.[23–27] Data on the type of surgical intervention undertaken among surgical cases were obtained from the same sources. The burden associated with recurrence was captured in the "per intervention cost" of each surgical case.[28]

Surveys on the proportion of undiagnosed or asymptomatic cases in the Spanish population using mass ultrasound have not been conducted. Therefore, we assumed that the prevalence of undiagnosed or asymptomatic cases was proportional to that estimated in a study conducted in the Florida district of Uruguay. In that study, the prevalence of undiagnosed disease was estimated to be 1.64% by ultrasound, and the annual surgical incidence was 36.1 cases per 10^5 person-years, for a ratio of 45.4.[29] By applying this ratio to the incidence rate of surgical cases in Spain (0.34 cases per 10^5 person-years), we estimated the mean prevalence of undiagnosed or asymptomatic CE to be 0.0154%. However, because of the large uncertainty in this estimate, we used a triangular distribution with a mode of 0.0154% and a range of 0–0.02%.

Diagnosed reported cases, as well as undiagnosed or asymptomatic cases, were assumed to have a reduction in productivity of 2.0% (range: 0.0–4.0%), based on the only reported assumption in the literature.[17] Lost-opportunity costs correspond to the productive time lost due to an infected person working less efficiently than someone who is uninfected. We assumed that the same level of lost opportunity applied to people who were asymptomatic, undiagnosed or diagnosed.

Estimation of human costs

Costs incurred because of CE in humans were divided into direct and indirect costs. Direct costs of standard care procedures, clinical tests and surgical interventions in Spain were obtained from the tariffs for health-care services in public hospitals of the autonomous regions of Aragon and Castile-León,[28,30] which are some of the most affected regions in Spain.[6] The data obtained for the reported surgical costs comprised a composite average for all cyst resection procedures, rather than those specifically associated with CE. Direct cost estimates included separate calculations for surgical and nonsurgical patients. In both cases, a cost-per-patient estimate was calculated using the itemized prices for typical care, and the expected percentage of use for specific services, procedures and treatments.

Average wages according to sex and age were obtained from the 2005 Wage Distribution Survey of the National Statistics Institute.[7] These data were used to calculate the direct and indirect costs associated with length of hospital stay.

Animal epidemiological parameters

The species considered in the analysis were sheep, goats, cattle and pigs. The prevalence of CE in livestock was based on the reported number of infected animals identified through inspection at abattoir.[31] In Spain, data on the prevalence of CE in sheep and goats are reported in combination. We therefore used identical values for both species. To estimate the total number of infected animals, we extrapolated these values to the overall animal populations. Estimates of livestock life expectancy and reproductive rates were kindly provided by Professors Juan de Dios Vargas and Enrique Pérez (Faculty of Veterinary Medicine, University of Extremadura, Spain). Official figures for annual livestock meat and milk production were obtained from the country's Ministry of Agriculture, Fisheries and Food.[32] Data stratified by age (young and adults) were included where available. Various livestock productivity losses associated with CE – including reduction in carcass weight, reduction in milk production and decrease in fecundity – were estimated from the scientific literature.[4,33–35]

Estimation of animal costs

Direct costs (mainly the loss of revenue through offal condemnation) and indirect costs (reductions in the growth, fecundity and milk production of infected animals) were included in the estimate of the total costs associated with CE in livestock, calculated as described below.

Offal condemnation

In Spain, identification of hydatid cysts at meat inspection leads to condemnation of infected offal. We therefore assumed that the number of condemned livers and lungs equalled the total number of infected animals reported. Since only the costs of sheep offal were available, we assumed the costs of goat offal to be the same.

To estimate the total cost of condemned offal in all species for 2005, we calculated the lost revenue for each CE-infected animal, according to the average weight[36–43] and market value[44] of both liver and lung, by species and age at slaughter. Direct costs were estimated from the product of the cost per animal and the number of infected animals in each age–species stratum identified at slaughter, for all species and age groups.

Growth reduction

To calculate growth reduction, we assumed a reduced carcass weight of CE-infected animals at slaughter. We first estimated the difference in income from the sale of a healthy carcass and a CE-infected carcass (which will weigh less) for each species. We then calculated the loss in net profit to the farmer per infected animal as the difference between the estimated income and the annual farmer investment for each species.[45] It was assumed that farmers would invest equally in CE-infected or uninfected animals. For all species, the annual cost for CE-associated growth reduction was calculated from the product of the loss in net profit per infected animal and the number of infected animals identified at slaughter for each species.

Milk production

To estimate total milk not produced because of infection, we used estimates of total annual milk production and current CE prevalence in dairy species. From these data we calculated the potential percentage considered losses from unborn diary animals, as explained below.

Decreased fecundity

Animals not born because of CE infection represent losses of potential earnings from live-animal and carcass sales, and from the sale of milk in dairy species. To estimate the cost of reduced fecundity, we assumed that the prevalence of CE at slaughter would be the same in breeding and nonbreeding animals. We calculated the population birth rate given the current prevalence in each species by dividing the mean annual fecundity by the number of female animals of reproductive age.[32] To simulate the birth rate in the absence of infection, we estimated the number of animals born to infected individuals and ascribed a 5.5% increase in birth rate for this proportion. We estimated the total number of "unborn" animals by calculating the difference between the potential and actual births for the infected reproductive proportion in each species.

To avoid overestimating the potential opportunity costs, we assumed an equivalent prevalence of infection in unborn animals. To estimate the potential loss at abattoir, we used the 2005 market value for meat in euros (€) and the average carcass weight, considering that a percentage of unborn individuals would also be infected and would thus have reduced carcass weights. For milk-producing species we used the respective infection rates of dairy and meat animals to estimate the proportion of dairy and meat animals unborn because of infection. For unborn dairy animals, losses related to milk production were calculated based on average annual yield and the market value of milk for each species. Because most dairy animals are eventually slaughtered for meat, losses at abattoir were also calculated with respect to the different average carcass weights for dairy animals, where applicable.

Uncertainty and sensitivity

To account for the uncertainty for parameters not available in the literature, we assigned distributions based on a

Table 1. **Epidemiological parameters used to estimate the human economic losses associated with CE in Spain, 2005**

Parameter	Value	Distribution	Reference
Total no. of diagnosed cases (*n* = 159)			
in males, by age group, in years			
0–19	3	Fixed	22
20–29	4	Fixed	22
30–39	14	Fixed	22
40–49	17	Fixed	22
50–59	11	Fixed	22
60–69	12	Fixed	22
70–79	22	Fixed	22
≥ 80	3	Fixed	22
in females, by age group, in years			
0–19	5	Fixed	22
20–29	2	Fixed	22
30–39	10	Fixed	22
40–49	8	Fixed	22
50–59	5	Fixed	22
60–69	14	Fixed	22
70–79	18	Fixed	22
≥ 80	11	Fixed	22
Undiagnosed or asymptomatic cases	0–0.0154–0.02	Triangular	see text
Diagnosed cases with surgery	68–95–100	Triangular	23–27
Percentage of			
Radical pericystic resection among surgical cases (%)	63	Fixed	23–27
Partial pericystic resection among surgical cases (%)	18	Fixed	23–27
Cholecystectomy or coledocotomy among surgical cases (%)	18	Fixed	23–27
Length of hospital stay in days	1–14–35–136	Beta	46
Productivity loss as % per year	0–4	Uniform	17

CE, cystic echinococcosis.

Table 2. **Economic parameters used to estimate the economic losses associated with CE in humans, Spain, 2005**

Economic parameter	Value	Distribution	Range	Reference
Average yearly wage, in €, for males, by age group, in years				
< 25	13 758	Fixed	NA	[7]
25–34	18 265	Fixed	NA	[7]
35–44	23 029	Fixed	NA	[7]
45–54	26 601	Fixed	NA	[7]
≥ 55	26 201	Fixed	NA	[7]
Average yearly wage, in €, for females, by age group, years				
< 25	11 226	Fixed	NA	[7]
25–34	14 727	Fixed	NA	[7]
35–44	16 383	Fixed	NA	[7]
45–54	18 076	Fixed	NA	[7]
≥ 55	18 416	Fixed	NA	[7]
Direct cost and distribution of diagnostic procedures and medical treatment/care, as € per case				
Chest X-ray	18.8	Fixed	NA	[28,30]
CT	84.45	Fixed	NA	[28,30]
MRI	216.76	Fixed	NA	[28,30]
Urography	71.67	Fixed	NA	[28,30]
Arteriography	97.75	Fixed	NA	[28,30]
Ultrasonography	89.76	Fixed	NA	[28,30]
Serologic testing	15–25[a]	Uniform	15–25	Unpublished[b]
Chemotherapy (Mbz/Albz)[c]	11.26	Fixed	NA	[28,30]
Outpatient medical care	174.7	Fixed	NA	[28,30]
Direct cost of surgical procedures, as € per case				
Radical pericystic resection	5 531.62	Fixed	NA	[28,30]
Partial pericystic resection	2 420.02	Fixed	NA	[28,30]
Cholecystectomy or coledocotomy	1 629.49	Fixed	NA	[28,30]

CE, cystic echinococcosis; CT, computed tomography; €, euro; Mbz/Albz, mebendazole/albendazole; MRI, magnetic resonance imaging; NA, not applicable.
[a] A wide range of serological tests is available for human hydatidosis. This range reflects the fact that the price depends on the particular type of test.
[b] D Carmena, unpublished data, 2009.
[c] Chemotherapy was measured in € per day.

likely range of values to each parameter. We generated 10 000 iterations of the final model using Latin hypercube random sampling of input parameter values based on the assigned distributions. The 50th percentile of the distribution of the 10 000 iterations represents the median, and the 2.5th and 97.5th percentiles represent the 95% credible intervals (CIs) for the total cost of CE. A stepwise linear regression of the estimated costs against the input parameter values was performed to assess the impact of each input parameter on the overall cost estimate. A separate sensitivity analysis was undertaken, excluding parameters associated with asymptomatic cases, because of the uncertain nature of the implicated parameters. The estimates from models with and without asymptomatic cases and the resulting figures illustrating the impact of input parameters were generated using @Risk© Version 5 software (Palisades Corporation, Ithaca, New York, NY, USA), running as an add-in to Microsoft Excel©.

Results

Table 1 and Table 2 show the epidemiological and economic parameters, respectively, used to estimate the economic losses associated with CE in humans. Table 3 (available at: http://www.who.int/bulletin/volumes/88/01/09-066795/en/index.html) and Table 4 show the epidemiological and economic parameters, respectively, used to estimate the economic losses associated with CE in livestock.

The median economic losses associated with CE in humans and animals in Spain in 2005 were estimated at €148 964 534 (Table 5). The table shows that human productivity losses constituted most (89.1%) of this total cost estimate, mainly through the potential impact of wage losses in undiagnosed or asymptomatic populations. Losses associated with CE in livestock contributed 10.4% of the total cost, mainly through indirect losses; direct losses in livestock constituted only 0.12% of the total cost. The estimated normalized regression coefficients were below 0.01, except for those for the percentage reduction in productivity in cases (0.81) and for the percentage of undiagnosed or asymptomatic cases (0.51), which suggests that these two parameters strongly influenced the overall estimate.

The sensitivity analysis excluding all undiagnosed or asymptomatic cases and their associated productivity losses resulted in a reduction of the median economic cost in 2005 to €16 442 870 (Table 5). The table shows that indirect costs associated with animal CE constituted most (93.5%) of the total cost (mainly due to reduced fecundity and reduced carcass weight in cattle). Losses associated with CE infection in humans were much smaller; they constituted only 5.3% of the total cost (mainly due to work absences associated with illness). The normalized regression coefficient values in Fig. 1 illustrate the impact of uncertain parameters on the overall costs after removing asymptomatic human cases from the model; under these conditions, several animal parameters become more important in determining the overall costs.

Table 4. **Cost parameters used to estimate the economic losses associated with CE in livestock, Spain, 2005**

Parameter	Average cost, in € per kg[a]	Reference
Sheep		
Lamb carcass	6.83	32
Sheep carcass	0.60	Extrapolated from 44
Sheep liver	0.65	44
Sheep lung	0.09	44
Sheep's milk at farm gate[a]	79.11	32
Farmer investment	1.59	45
Goats		
Kid carcass	8.40	Extrapolated from 44
Goat carcass	0.90	Extrapolated from 44
Goat liver	0.65	Extrapolated from 44
Goat lung	0.09	Extrapolated from 44
Goat's milk at farm gate[a]	51.63	32
Farmer investment	1.59	45
Cattle		
Calf carcass	3.80	Extrapolated from 44
Bull carcass	1.72	Extrapolated from 44
Young live cow	1.76	32
Beef carcass	3.35	45
Cow liver	0.85	44
Cow lung	0.06	44
Cow's milk at farm gate[a]	31.25	32
Farmer investment/kg	2.04	45
Pigs		
Pig liver at abattoir	0.54	44
Pig lungs at abattoir	0.06	44
Pig carcass	1.42	32
Piglet carcass	1.42	Extrapolated from 44
Farmer investment	1.06	45

CE, cystic echinococcosis; €, euro.
[a] Average cost of milk was measured in € per 100 L.

Discussion

This is the first study to produce a comprehensive estimate of the annual economic burden of CE in humans and animals in Spain. Studies that estimate the burden of disease at a regional level provide data that enable decision makers to prioritize allocation of limited resources. The preferred way to capture both the human and agricultural effect of a zoonosis is to estimate its economic impact.[19] This has been undertaken for CE in a number of European countries, including Wales,[18] and in Jordan[16] and Tunisia.[21] However, direct comparison of data is difficult due to lack of standard methods for estimating the costs of the infection and to differences among countries in human and animal population sizes, disease prevalence, inherent socioeconomic patterns and period of valuation.

The Latin hypercube method used in this study to represent the uncertainty surrounding the input parameters is particularly suitable for estimating indirect costs where accurate human and animal epidemiological data are scarce. To make the estimates more robust, we stratified rates of human CE infection and average wages by age and gender. For livestock, we used age-stratified prevalence proportions, where available.

Our results indicate that CE continues to affect human health and livelihood in Spain, especially when the indirect costs of reduced productivity and annual wages lost due to disease are taken into account. The human consequences of CE in Spain in 2005 were estimated to incur a median of €133 million when productivity losses in undiagnosed or asymptomatic cases were considered, but only €0.9 million when these losses were excluded. This large difference emphasizes the need for more accurate baseline estimates of real CE prevalence in humans (to minimize the potential impact of the uncertainty of this parameter); better methods for estimating productivity losses associated with undiagnosed or asymptomatic cases; and improved capacity for distinguishing asymptomatic cases from misdiagnosed or untreated cases (because respective productivity losses may vary considerably between groups).

Regarding the need for more accurate baseline estimates, mass screening studies of infection with *E. granulosus*, based on the detection of circulating antibodies to the parasite, have been undertaken in different Spanish regions to determine the infection's prevalence.[47,48] However, this approach assesses lifelong exposure to the parasite rather than the prevalence of active infection. An alternative is ultrasonography, which is a reliable and accurate diagnostic tool for reporting infection status in human asymptomatic populations.[49] Because this technique has not been used for field epidemiological surveys in Spain, we had to estimate the prevalence of undiagnosed or asymptomatic cases by extrapolating from other data.[29] Undiagnosed or asymptomatic cases incur productivity losses and costs due to the partial disability caused by the chronic effect of the infection.[50] A theoretical estimate of a 2% reduction in work productivity

Table 5. **Median direct, indirect and total costs associated with CE in humans and livestock, including and excluding asymptomatic or undiagnosed productivity losses, Spain, 2005**

Category	Asymptomatic or undiagnosed productivity losses			
	Included		Excluded	
	Median cost, in €	95% CI	Median cost, in €	95% CI
Human				
Direct	603 671	499 200–662 638	603 427	499 967–662 628
Indirect	132 795 199	5 967 994–378 695 718	274 643	59 094–717 779
Subtotal	133 416 601	6 658 738–379 273 434	872 414	630 181–1 327 733
Animal				
Direct	177 985	161 656–194 432	177 968	161 545–194 439
Indirect	15 353 863	13 273 648–17 610 439	15 367 200	13 287 583–17 798 384
Subtotal	15 532 242	13 447 378–17 789 491	15 546 700	13 468 193–17 798 384
Total losses	148 964 534	21 980 446–394 012 706	16 442 870	14 330 767–18 732 759
Direct	781 032	675 524–844 564	781 343	676 839–844 711
Indirect	148 189 492	22 200 164–395 747 574	15 670 240	13 543 961–17 964 120

CE, cystic echinococcosis; CI, credible interval; €, euro.

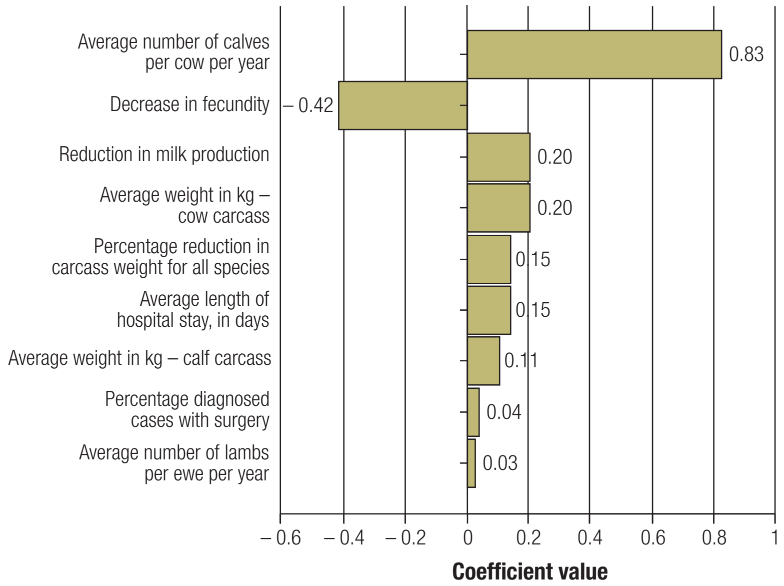
in asymptomatic cases (for estimating work productivity losses) has been proposed.[17] More research on the socioeconomic effects of ill health caused by CE is needed to better quantify these parameters and generate more accurate estimates.

Another limitation of this study is that we used national-level average wages to estimate the loss-of-opportunity costs. Using wages as the sole indicator for human productivity does not capture the value of labour in localized, informal or nonregulated employment sectors (e.g. family caregiving); hence, societal burden may have been underestimated. Also, this approach does not capture any psychological burden that may be associated with the infection.

In livestock, indirect losses account for almost 99% of the total cost associated with CE, whereas the direct losses were negligible. As with humans, the scarcity of specific data on productivity losses makes accurate estimates of the economic losses of CE in livestock difficult to perform.

Another limitation of the estimated costs of surgical treatment for CE in humans is that these were based on the average cost of surgical interventions for all types of cysts (because data were not available on therapies specific to *E. granulosus* infections). Thus, the estimates may over or underestimate the true costs associated with the removal of cystic echinococcosis cysts. However, we do not believe that this would result in an important difference in the overall costs.

Fig. 1. **Estimated normalized regression coefficients showing the associations between uncertain parameters and total losses due to CE, excluding asymptomatic or undiagnosed productivity losses, Spain, 2005**



CE, cystic echinococcosis.

In our analysis, the prevalence of CE was assumed to be identical in sheep and goats because reported official figures do not distinguish between these species, and no relevant studies were found in the literature. Removing goats from the model had little effect on the results, since goats contributed less than €5000 of the total cost. However, in countries where goats represent a more important ruminant population, CE prevalence in sheep and goats should be considered independently.

The epidemiological parameters we used to calculate indirect animal costs were estimated averages and did not capture variations that would be expected to occur due to factors such as animal breed, type of exploitation and management, diet, neonatal and perinatal mortality rates, and comorbidity status.

Conclusion

Our findings indicate that CE imposes a significant economic burden on Spain. They also emphasize the importance of maintaining or reinforcing current control measures to consolidate the progress achieved and to reduce human and animal infection rates. Further work is required to evaluate the cost–effectiveness and cost–benefit of any control programmes implemented, and to guide decision makers and stakeholders on the best approach to take with the resources available. Better coverage and accuracy of the current surveillance systems are needed, as are improvements in the cooperation between the central and regional administrations, and the institutions responsible for collecting, providing and publishing data of epidemiological relevance. In regions of Spain where CE is epidemic, mass screening studies using ultrasonography would improve estimates of the actual prevalence of undiagnosed or asymptomatic cases. ■

Competing interests: None declared.

Résumé

Analyse de l'impact économique de l'échinococcose kystique en Espagne

Objectif Estimer les pertes économiques total dues à l'échinococcose kystique (EK) humaine et animale en Espagne en 2005.

Méthodes Nous avons obtenu des données sur l'incidence annuelle de l'EK à partir de la surveillance et des dossiers d'abattoir, et sur le traitement et les pertes de productivité (humaines et animales) liés à cette maladie à partir de la littérature scientifique. Les coûts directs étaient ceux afférant au diagnostic, au traitement chirurgical ou non chirurgical, aux soins médicaux et à l'hospitalisation pour les humains et ceux afférant à la condamnation des abats pour le bétail (ovins, caprins, bovins et porcins). Les coûts indirects couvraient les pertes de productivité humaine et la diminution de la croissance, de la fécondité et de la production laitière chez le bétail. La méthode de l'hypercube latin a été appliquée pour représenter l'incertitude entourant les paramètres d'entrée.

Résultats La perte économique total attribuable à l'EK humaine et animale en 2005 a été estimée à 148 964 534 euros (€) (intervalle de crédibilité à 95 %, IC : 21 980 446 - 394 012 706). Les pertes se rapportant aux humains ont été estimées à € 133 416 601 (IC à 95 % : 6 658 738 - 379 273 434) et celles associées aux animaux à € 15 532 242 (IC à 95 % : 13 447 378 - 17 789 491).

Conclusion L'EK est une zoonose négligée, qui demeure préoccupante pour la santé humaine et animale en Espagne. Il faudrait disposer de données plus précises sur la prévalence de cette maladie chez l'homme (notamment sur les cas non diagnostiqués et les cas asymptomatiques) et de meilleures méthodes pour estimer les pertes de productivité concernant les animaux. L'EK continue de toucher certaines zones de l'Espagne, malgré plusieurs initiatives de lutte contre cette maladie depuis 1986. Compte tenu du lourd fardeau économique que représente l'EK, il faudrait aussi investir davantage dans la réduction des taux d'infection humains et animaux à travers une meilleure surveillance de la maladie, un traitement régulier des chiens et un renforcement de la coopération entre les agences ministérielles.

Resumen

Análisis del impacto económico de la hidatidosis en España

Objetivo Estimar las pérdidas económicas totales ocasionadas por la hidatidosis humana y animal en España en 2005.

Métodos Los datos sobre la incidencia anual de la hidatidosis se obtuvieron a partir de los registros de vigilancia epidemiológica y de los mataderos. Los datos sobre el tratamiento y la pérdida de productividad (humana y animal) relacionada con la enfermedad se obtuvieron a partir de la literatura científica. Los costes directos fueron los asociados al diagnóstico, el tratamiento quirúrgico o farmacológico, la atención médica y la hospitalización en humanos, y los decomisos de vísceras infectadas en animales de abasto (ganado ovino, caprino, bovino y porcino). Los costes indirectos comprendieron la pérdida de productividad en humanos y la reducción de las tasas de crecimiento, fecundidad y producción de leche en el ganado. Para representar la incertidumbre asociada a los parámetros analizados se utilizó el método del hipercubo latino.

Resultados Las pérdidas económicas totales atribuibles a la hidatidosis humana y animal fueron estimadas en 148 964 534 euros (€) (intervalo de credibilidad del 95%, IC95%: 21 980 446–394 012 706). Las pérdidas estimadas de origen humano fueron de € 133 416 601 (IC95%: 6 658 738–379 273 434), y de € 15 532 242 (IC95%: 13 447 378–17 789 491) las de origen animal.

Conclusión La hidatidosis es una zoonosis desatendida que en España sigue constituyendo un problema de salud humana y animal. Son necesarios datos más exactos sobre la prevalencia de la hidatidosis en humanos (sobre todo en los casos no diagnosticados o asintomáticos) y mejores métodos para calcular la pérdida de productividad en animales. La hidatidosis sigue afectando a ciertas zonas de España pese a las varias campañas de control emprendidas desde 1986. Dada la gran carga económica de la hidatidosis, es necesaria una mayor financiación para reducir las tasas de infección humana y animal mediante mejoras en la vigilancia de la enfermedad, el tratamiento periódico de los perros y la cooperación entre organismos oficiales.

ملخص

تحليل التأثير الاقتصادي لداء المشوكات الكيسي في أسبانيا

الغرض: تقدير الخسائر الاقتصادية الإجمالية الناجمة عن إصابة البشر والحيوانات بداء المشوكات الكيسي في أسبانيا في 2005.

الطريقة: جُمعت البيّنات الخاصة بمعدل الوقوع السنوي لداء المشوكات الكيسي من سجلات الترصد ومجازر الحيوانات، وبيّنات معالجات داء المشوكات الكيسي والخسائر الإنتاجية (البشرية والحيوانية) من النشريات العلمية. وتعتبر التكاليف المباشرة هي التكاليف المتعلقة بالتشخيص، والمعالجة الجراحية أو المعالجة الكيميائة، والرعاية الطبية، والتنويم في المستشفيات بالنسبة للبشر، وتلك المتعلقة بالفضلات الحيوانية (الغنم، والماعز، والبقر، والخنازير). وتشمل التكاليف غير المباشرة الخسائر الإنتاجية البشرية، وانخفاض النمو والخصوبة وقلة إدرار اللبن في الحيوانات. وقد استخدمت طريقة Latin hypercube لتمثيل الشك المحيط بمدخل المتثابتات.

الموجودات: قُدرَ إجمالي الخسائر الاقتصادية الناجمة عن داء المشوكات الكيسي في البشَر والحيوانات في عام 2005 بمقدار 148964534 يورو (فترة الثقة CI 95%: 21980446 – 394012706). وقُدرَت الخسائر البشرية بمقدار 133416601 يورو (فترة الثقة CI 95%: 6658738 – 379273434) والخسائر الحيوانية بمقدار 15532242 (فترة الثقة CI 95%: 13447378 – 17789491).

الاستنتاج: يعتبر داء المشوكات الكيسي من الأمراض الحيوانية المهملة التي تظل مثيرة للقلق لكل من الإنسان والحيوان في أسبانيا. وهناك حاجة للبيّنات الأكثر دقة حول انتشار داء المشوكات الكيسي بين البشر (لاسيما الحالات التي لم يتم تشخيصها أو الحالات غير المصحوبة بأعراض) والطرق الأفضل لتقدير الخسائر الإنتاجية في الحيوانات. ومازال داء المشوكات الكيسي يصيب بعض المناطق في أسبانيا بالرغم من المبادرات المتعددة لمكافحته منذ عام 1986. ومع الأخذ في الحسبان العبء الاقتصادي الثقيل لداء المشوكات الكيسي، فإن هناك حاجة لتمويل إضافي لخفض معدلات العدوى في الإنسان والحيوان من خلال تحسين ترصد المرض، والمعالجة المنتظمة للكلاب، والمزيد من التعاون بين الهيئات.

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Table 3. **Epidemiological parameters used to estimate the economic losses associated with CE in livestock, Spain, 2005**

Parameter	Value	Distribution	Range	Unit	Reference
Sheep					
Total population[a]	22 749 000	Fixed	NA	Individuals	44
Lambs[a]	3 974 000	Fixed	NA	Individuals	44
Lambs for slaughter	18 497 000	Fixed	NA	Individuals	32
Adults[a]	18 775 000	Fixed	NA	Individuals	44
Adults for slaughter	894 000	Fixed	NA	Individuals	32
No. of sheep slaughtered per year	19 390 776	Fixed	NA	Individuals	44
Prevalence of infection at inspection[b]	0.57	Fixed	NA	% of infected animals at slaughter	31
Lambs	0.14	Fixed	NA	% of infected animals at slaughter	31
Adults	0.43	Fixed	NA	% of infected animals at slaughter	31
No. of dairy sheep	2 850 177	Fixed	NA	Individuals	32
Average weight					
Lamb carcass	9.80	Uniform	9.6–10.0	Kg	44
Sheep carcass	20.00	Uniform	18.0–22.0	Kg	44
Lamb liver	0.85	Uniform	0.8–0.9	Kg	40,43
Lamb lung	0.60	Uniform	0.5–0.7	Kg	40,43
Sheep liver	1.00	Uniform	0.9–1.1	Kg	Extrapolated from 42
Sheep lung	0.70	Uniform	0.6–0.8	Kg	Extrapolated from 42
Mean lambing per year					
Dairy sheep	1.5	Uniform	1.4–1.6	Lambs per ewe per year	See text
Meat sheep	1	Uniform	0.9–1.1	Lambs per ewe per year	See text
Average milk yield of dairy sheep	170	Uniform	160–170	Kg per year	Extrapolated from 44
No. unborn lambs	87 089		NA	Individuals	Calculation
Goats					
Total population[a]	2 904 000	Fixed	NA	Individuals	44
Kids[a]	385 000	Fixed	NA	Individuals	44
Kids for slaughter	1 401 000	Fixed	NA	Individuals	32
Adults[a]	2 519 00	Fixed	NA	Individuals	44
Adults for slaughter	179 000	Fixed	NA	Individuals	32
No. goats slaughtered	1 580 549	Fixed	NA	Individuals	44
Prevalence of infection at inspection[b]	0.57	Fixed	NA	% of infected animals at slaughter	31
Kids	0.14	Fixed	NA	% of infected animals at slaughter	31
Adults	0.43	Fixed	NA	% of infected animals at slaughter	31
No. of dairy goats	1 261 135		NA	Individuals	32
Average weight					
Kid carcass	10.35	Uniform	10.0–10.7	Kg	44
Goat carcass	23.50	Uniform	21–26	Kg	44
Kid liver	0.85	Uniform	0.8–0.9	Kg	Extrapolated from 40,43
Kid lung	0.60	Uniform	0.5–0.7	Kg	Extrapolated from 40,43
Goat liver	1.00	Uniform	0.9–1.1	kg	Extrapolated from 42
Goat lung	0.70	Uniform	0.6–0.8	Kg	Extrapolated from 42
Mean kidding per year					
Dairy goat	1.60	Uniform	1.5–1.7	Kids born per goat per year	See text
Meat goat	1.30	Uniform	1.2–1.4	Kids born per goat per year	See text
Average milk yield of dairy goat	383	Uniform	380–386	Kg per year	Extrapolated from 44
No. unborn kids	14 360		NA	Individuals	Calculation

(Table 3, cont.)

Parameter	Value	Distribution	Range	Unit	Reference
Cattle					
Total population[a]	6 484 000	Fixed	NA	Individuals	44
Calves (< 1 year)[a]	2 254 000	Fixed	NA	Individuals	44
Calves for slaughter	246 944	Fixed	NA	Individuals	44
Young animals (> 1 but < 2 yr old)[a]	748 000	Fixed	NA	Individuals	44
Young animals for slaughter	769 645	Fixed	NA	Individuals	44
Adults (> 2 yr old)[a]	3 464 000	Fixed	NA	Individuals	44
For slaughtering (cows)	400 576	Fixed	NA	Individuals	44
For slaughtering (bulls)	1 340 393	Fixed	NA	Individuals	44
For milk production	1 008 000	Fixed	NA	Individuals	44
No. of cattle slaughtered per year	2 757 558	Fixed	NA	Individuals	44
No. of infected cattle slaughtered per year	19 824	Fixed	NA	Individuals	31
Prevalence of infection at inspection	0.7	Fixed		% of infected animals at slaughter	31
Average weight					
Calf carcass	155.0	Uniform	150–160	Kg	44
Cow carcass	275.00	Uniform	270–280	Kg	44
Young cow carcass	242.25	Uniform	239.0–245.5	Kg	44
Bull carcass	282.50	Uniform	278–287	Kg	44
Calf liver	3.20	Uniform	2.9–3.5	Kg	36,37,41
Calf lung	3.75	Uniform	3.5–4.0	Kg	36,37,41
Cow liver	6.35	Uniform	5.4–7.3	Kg	36,37,41
Cow lung	6.15	Uniform	5.2–7.1	Kg	36,37,41
Mean calving per year					
Dairy cow	0.75	Uniform	0.7–0.8	Calves per cow per year	See text
Beef cow	0.65	Uniform	0.6–0.7	Calves per cow per year	See text
Annual cow milk production	6 552 700	Fixed	NA	Tonnes	32
Average milk yield of dairy cow	6 281	Fixed	NA	Kg per year	44
No. of unborn calves	19 038			Individuals	Calculation
Pigs					
Total population[a]	24 884 000	Fixed	NA	Individuals	44
No. of piglets[a]	6 762 000	Fixed	NA	Individuals	44
No. of pigs slaughtered	38 705 240	Fixed	NA	Individuals	44
No. of infected pigs slaughtered per year	10 320	Fixed	NA	Individuals	31
Prevalence of infection at inspection	0.03	Fixed	NA	% of infected animals at slaughter	31
Average weight					
Piglet carcass	6.70	Uniform	6.5–6.9	Kg	44
Pig carcass	85	Uniform	80–90	Kg	44
Pig lung	0.41	Uniform	0.38–0.43	Kg	38,39
Pig liver	1.01	Uniform	0.98–1.04	Kg	38,39
Piglet lung	0.075	Uniform	0.05–0.10	Kg	Extrapolated from 39
Piglet liver	0.075	Uniform	0.05–0.10	Kg	Extrapolated from 39
Mean no. of piglets per year	19	Uniform	18–20	Piglets/sows per year	See text
No. of unborn pigs	1 448 783		NA	Individuals	Calculated
Productivity losses – all livestock					
Decrease in fecundity	5.5	Uniform	0.0–11.0	% decrease per year	35
Decrease in carcass weight	6.25	Uniform	2.5–10.0	% decrease per year	4,34
Decrease in milk production	2.5	Uniform	0.0–5.0	% decrease per year	4,34

CE, cystic echinococcosis; NA, not applicable.
[a] Census at 31 December 2005.
[b] CE prevalence rates in sheep and goats are co-reported in Spain.