Prevalence of hydatidosis and fertility of hydatid cysts in food animals in Northern Greece

Anastasia Founta[1], Spyridon Chliounakis[1], Konstantina Antoniadou-Sotiriadou[2], Maria Koidou[1] & Vasileios A. Bampidis[1]

[1] *Laboratory of Parasitology, Department of Animal Production, Faculty of Agricultural Technology, Food Technology and Nutrition, Alexander Technological Educational Institute (ATEITHE), 57400 Thessaloniki, Greece.*
[2] *Laboratory of Parasitology and Parasitic Diseases, Faculty of Veterinary Medicine, Aristotle University (AUTH), 54124 Thessaloniki, Greece.*

** Corresponding author at: Department of Animal Production, Faculty of Agricultural Technology, Food Technology and Nutrition, Alexander Technological Educational Institute (ATEITHE), 57400 Thessaloniki, Greece. Tel.: +302310013313, e-mail: bampidis@ap.teithe.gr.*

Veterinaria Italiana 2016, **52** (2), 123-127. doi: 10.12834/VetIt.123.347.2
Accepted: 11.09.2015 | Available on line: 30.06.2016

Keywords
Cattle,
Goat,
Hydatid cyst,
Hydatidosis,
Pig,
Sheep.

Summary
This study was conducted in order to determine the prevalence of hydatidosis due to *Echinococcus granulosus sensu lato* and the fertility rate of hydatid cysts in sheep, goats, cattle, and pigs slaughtered at the abattoir of Lagkada, in the Prefecture of Thessaloniki, Northern Greece. Lungs and livers from a total of 294 sheep (31.3% infected), 126 goats (8.7% infected), 372 cattle (4.8% infected), and 641 pigs (1.7% infected) were examined. The number of hydatid cysts found in infected sheep was 657 (58.3% fertile, 12.8% sterile, and 28.9% calcified cysts), in goats 54 (14.8% fertile, 38.9% sterile, and 46.3% calcified cysts), in cattle 108 (24.1% fertile, 50.0% sterile, and 25.9% calcified cysts) and in pigs 47 (10.6% fertile, 55.4% sterile, and 34.0% calcified cysts). Lung infection with hydatid cysts was higher ($p < 0.05$) in sheep, goats, and cattle than in pigs (56.5%, 77.8% and 62.0% vs. 17.0%, respectively); while liver infection was lower ($p < 0.05$) in sheep, goats, and cattle than in pigs (43.5%, 22.2% and 38.0% vs. 83.0%, respectively). Among the 4 species slaughtered for human consumption, sheep exhibited the highest frequency of hydatidosis and the highest proportion of fertile cysts.

Prevalenza di idatidosi e tasso di fertilità di cisti idatidee in animali destinati al consumo umano nel nord della Grecia

Parole chiave
Bovino,
Capra,
Cisti idatidea,
Idatidosi,
Pecora,
Suini.

Riassunto
Lo studio è stato condotto al fine di determinare la prevalenza di idatidosi da *Echinococcus granulosus sensu lato* e il tasso di fertilità delle cisti idatidee in ovini, caprini, bovini e suini macellati a Lagkada (Prefettura di Salonicco, Grecia settentrionale). Sono stati esaminati campioni di polmone e fegato di 294 pecore (31,3% infetti), 126 capre (8,7% infetti), 372 bovini (4,8% infetti) e 641 suini (1,7% infetti). Le cisti idatidee rinvenute nelle pecore infette sono risultate pari a 657 (58,3% fertili, 12,8% sterili e 28,9% calcificate), nelle capre 54 (14,8% fertili, 38,9% sterili e 46,3% calcificate), nei bovini 108 (24,1% fertili, 50,0% sterili e 25,9% calcificate) e nei suini 47 (10,6% fertili, 55,4% sterili e 34,0% calcificate). Nelle pecore, capre e bovini è stata riscontrata la prevalenza di infezioni polmonari è risultata più elevata ($p < 0,05$) rispetto ai suini (rispettivamente 56,5%, 77,8% e 62,0% vs 17,0%); al contrario nel suino si è osservato una prevalenza di infezioni epatiche maggiore ($p < 0,05$) rispetto alle pecore, capre e bovini (rispettivamente 83,0% vs 43,5%, 22,2% e 38,0%). Tra gli animali esaminati, destinati al consumo umano, le pecore sono risultate esposte ad una più alta frequenza di idatidosi e hanno mostrato la più alta percentuale di cisti fertili.

Introduction

Cystic echinococcosis (CE) / hydatidosis caused by the larval stage of *Echinococcus granulosus sensu lato* is a major parasitic disease of veterinary and public health importance throughout the world (Soulsby 1982). The disease has great economic and zoonotic importance because it affects almost all the domestic animals and human (Soulsby 1982). In food animals, hydatidosis has an adverse effect on production causing decreased production of meat, milk, wool, and reduction in growth rate alongside to predisposition to other diseases (Soulsby 1982, Abiyot *et al.* 2011).

Cystic echinococcosis has a worldwide distribution and the incidence of infection differs by country and region. As far as Europe is concerned, Italy is considered a medium to high risk country for CE with the prevalence rate being 5-92.8% in sheep, 72.0% in goats, 7.3-67.1% in cattle, and 0.8-11.1% in pigs (Garippa *et al.* 2004, Gianneto *et al.* 2004, Garippa 2006, Grosso *et al.* 2012). In Spain, CE is an endemic disease in the North-Eastern, Central, and Western parts of the country, with prevalence rate up to 23% in sheep and cattle (Jimenez *et al.* 2002). Moreover, in Cyprus disease rates decreased from 23.6% in cattle examined in 1998-1999 to 6.6% in cattle tested in 2002-2003, from 5.3% to 1.5% in sheep, while, in goats, rates were consistently below 0.5% and remained at 0.1% (Christofi *et al.* 2002). In Greece, in the early 1980s, the prevalence of echinococcosis among food animals was 80% in sheep, 24% in goats, 82% in cattle, and 5% in pigs (Sotiraki *et al.* 2001). In Northern Greece, surveillance in livestock species since 1998 has documented a prevalence of 31.3% in sheep, 10.3% in goats, 0.6% in pigs, and 0% in cattle (Sotiraki *et al.* 2003); while another survey conducted on sheep in Central Greece from 2002 to 2006 revealed an incidence rate of 39.3% (Christodoulopoulos *et al.* 2008). Finally, a survey conducted on sheep and goats in Peloponnesus, Southern Greece, during the 2005, revealed an incidence rate of 30.4% in sheep and 14.7% in goats (Varcasia *et al.* 2007). The aim of the present study was to determine the current prevalence of hydatidosis and the fertility rate of hydatid cysts in sheep, goats, cattle, and pigs slaughtered at the abattoir of Lagkada, in the Prefecture of Thessaloniki, Northern Greece.

Materials and methods

The lungs and the liver of 1.433 carcasses comprised of sheep (294), goats (126), cattle (372), and pigs (641) were examined for the presence of hydatid cysts of *E. granulosus sensu lato*. All animals were slaughtered at the abattoir of Lagkada, in the Prefecture of Thessaloniki, Northern Greece, from April 2006 to June 2009. Liver and lungs of slaughtered animals were examined for hydatid cysts by visual inspection, palpation, and serial cuts of the organs. When cysts were found, the infected organs were collected, put in plastic bags separately, labelled and sent to the Laboratory of Parasitology and Parasitic Diseases, Faculty of Veterinary Medicine, Aristotle University of Thessaloniki, for further examination. A detailed record was kept including the origin of the host, number, and location of the cysts. The age of animals varied between 1 to 6 years in sheep and goats, 2 to 8 years in cattle, and 1 to 4 years in pigs. Cysts were classified morphologically as fertile, sterile or calcified. Individual cysts were carefully incised and examined for protoscolices. Fertility was defined by the microscopic detection (×40), without staining, of protoscolices. In fertile cysts, the larvae had good conformation and look like white dots. Sterile hydatid cysts were characterized by their smooth inner lining usually with a slight turbidity of the contained fluid, typical calcified cysts produced a gritty sound feeling upon incision (Soulsby 1982, Parija *et al.* 2004). Descriptive statistics were used and, in certain cases, data were analysed by ANOVA (SPSS 2008). The level of significance was set at $p < 0.05$.

Results

From a total of 1,433 slaughtered animals (294 sheep, 126 goats, 372 cattle, and 641 pigs), 132 (9.2%) food animals were found infected with hydatid cysts of *E. granulosus sensu lato*. Specifically, hydatid cysts were detected in lungs and livers of 92 (31.3%) sheep, 11 (8.7%) goats, 18 (4.8%) cattle, and 11 (1.7%) pigs (Table I). The number of hydatid cysts found in infected sheep was 657 (58.3% fertile, 12.8% sterile, and 28.9% calcified cysts), in goats 54 (14.8% fertile, 38.9% sterile, and 46.3% calcified cysts), in cattle 108 (24.1% fertile, 50.0% sterile, and 25.9% calcified cysts) and in pigs 47 (10.6% fertile, 55.4% sterile, and 34.0% calcified cysts). Lung infection with hydatid cysts was higher ($p < 0.05$) in sheep, goats, and cattle than in pigs (56.5%, 77.8% and 62.0% vs. 17.0%, respectively); whereas liver infection was lower ($p < 0.05$) in sheep, goats, and cattle than pigs (43.5%, 22.2% and 38.0% vs. 83.0%, respectively). The number of cysts found in lungs per infected animal was higher ($p < 0.05$) in sheep, goats, and cattle than in pigs (4.0, 3.8 and 3.7 vs. 0.7, respectively); while the number of cysts found in liver per infected animal was lower ($p < 0.05$) in goats than in sheep and pigs (1.1 vs. 3.1 and 3.5, respectively).

Discussion

The prevalence of CE recorded in the present study in cattle and pigs is higher than that previously

Table I. *Prevalence of hydatidosis (*Echinococcus granulosus sensu lato*), number and type of hydatid cysts, infected organs, and number of cysts per infected animal in food animals.*

	Sheep (n = 294)	Goats (n = 126)	Cattle (n = 372)	Pigs (n = 641)	Total (n = 1433)
Infected animals (%)	92 (31.3%)	11 (8.7%)	18 (4.8%)	11 (1.7%)	132 (9.2%)
Number of hydatid cysts	657	54	108	47	866
Type of hydatid cysts					
Fertile (%)	383 (58.3%)	8 (14.8%)	26 (24.1%)	5 (10.6%)	422 (48.7%)
Sterile (%)	84 (12.8%)	21 (38.9%)	54 (50.0%)	26 (55.4%)	185 (21.4%)
Calcified (%)	190 (28.9%)	25 (46.3%)	28 (25.9%)	16 (34.0%)	259 (29.9%)
Infected organs					
Lungs (%)	371 (56.5%)	42 (77.8%)	67 (62.0%)	8 (17.0%)	488 (56.4%)
Liver (%)	286 (43.5%)	12 (22.2%)	41 (38.0%)	39 (83.0%)	378 (43.6%)
Number of cysts / infected animal					
Lungs (range)	4.0±1.32 (2-7)	3.8±1.24 (2-6)	3.7±0.91 (2-5)	0.7±0.52 (0-2)	3.7±1.55 (0-7)
Liver (range)	3.1±1.07 (2-5)	1.1±0.69 (0-3)	2.3±0.74 (1-4)	3.5±1.20 (2-6)	2.9±1.17 (0-6)

reported by Sotiraki and colleagues in Northern Greece (Sotiraki *et al.* 2003), while goats showed a slow, but progressive decreasing infection rate, and sheep had similar infection rate. Our results in sheep confirm those of a report in which the prevalence of CE in the region of Peloponnesus was 30.4% (Varcasia *et al.* 2007). In contrast, our results regarding the prevalence of infection in goats (8.7%) are in disagreement with those (14.7%) reported by Varcasia and colleagues (Varcasia *et al.* 2007). The variations of the infection rates could be due to the various species/genotypes of *E. granulosus sensu lato* (Cardona and Carmena 2013), the variations in the temperature, the environmental conditions, and the nature of the pasture, as well as the way of raising and grazing of these animals (Soulsby 1982). In agreement with our results, Marshet and colleagues found sheep to be more susceptible to infection than goats (13.9% vs. 3.1%, respectively) (Marshet *et al.* 2011). This may be attributed to the browsing nature of goats, thereby being fed on less contaminated vegetation than sheep, which are grazers (Dalimi *et al.* 2002).

The present study revealed that sheep carried not only more hydatid cysts, but also more fertile cysts (58.3%) than goats (14.8%), cattle (24.1%), and pigs (10.6%). Similar findings have been reported in various studies in sheep (Abiyot *et al.* 2011, Marshet *et al.* 2011, Fikire *et al.* 2012), which detected a fertility rate of 78.6%, 54.0% and 59.1%, respectively. In addition, a fertility rate of 33.3% in goats (Marshet *et al.* 2011) and 19.3% in cattle (Fikire *et al.* 2012) was reported. Data on the prevalence and fertility of cysts in various domestic animals provide reliable indicators of the importance of each type of animals as a potential source of infection to dogs (Daryani *et al.* 2006). In light of this fact, it can be deduced that sheep play a critical role in the occurrence of hydatidosis.

In addition, the severity of CE infection in livestock species (susceptibility to infection, fertility and location of cysts) may vary depending on the *E. granulosus sensu lato* species/genotype involved. *Echinococcus granulosus sensu lato* is considered to be a species complex, comprising at least 10 genotypes (G_1-G_{10}) (Cardona and Carmena, 2013). In Peloponnesus, Southern Greece, sheep were found to be infected with the common sheep genotype G_1 (90%) and buffalo genotype G_3 (10%), while goats were infected with pig genotype G_7 (100%) (Varcasia *et al.* 2007).

A remarkable feature of *E. granulosus sensu lato*, particularly of the G_1 genotype, is its extraordinary ability to adapt to and infect effectively a wide range of definitive and intermediate host species under very different environmental and ecological conditions. The G_1 genotype is considered the most widespread genotype worldwide and the most important genotype in Europe and in the Mediterranean. Moreover, G_1 is the etiologic agent of the vast majority of human infections (Varcasia *et al.* 2007, Cardona and Carmena 2013). The G_7 genotype, which was found in goats in Peloponnesus, differs morphologically, developmentally, epidemiologically and genetically from other genotypes of *E. granulosus sensu lato*, particularly from the G_1-G_3 group (*E. granulosus sensu stricto*) (Nakao *et al.* 2007). The presence of the pig genotype in Peloponnesus goats has considerable implications for the implementation of hydatid control programs that include regular drug treatment of dogs because of the shorter maturation time in dogs of G_7 compared with the common sheep G_1 genotype (Thompson and McManus 2002, Varcasia *et al.* 2007). This information should also be valuable for the design and implementation of more efficient control strategies against CE. Elucidation of the role of G_1,

G_3, and G_7 genotypes in the epidemiology of CE in Peloponnesus requires specific future investigations in other regions of Greece.

Regarding cysts' distribution in sheep, goats, and cattle, in this study higher infection was recorded in lungs (56.5%, 77.8%, and 62.0%, respectively), followed by liver. This may be due to the relatively softer consistency of lung tissue that allows easy growth of cysts (Himonas *et al.* 1987, Marshet *et al.* 2011). Similar findings were obtained by Abiyot and colleagues, who observed that lungs were more affected with hydatid cysts, 78.6% in sheep and 53.6% in goats, than liver (Abiyot *et al.* 2011). The present study is also in accordance with a previous study conducted in Greece by Himonas and colleagues, who found that lungs were the most commonly affected organ in sheep (66.2%), goats (62.5%), and cattle (61.7%) (Himonas *et al.* 1994). In contrast to our results, where the preponderant site of cysts in pigs was the liver (83.0%), Himonas and colleagues reported that in pigs, lungs were more frequently affected with hydatid cysts (54.8%) than liver (35.7%) (Himonas *et al.* 1994).

All 4 species of animals slaughtered for human consumption and included in this study, were infected with cysts. Because of the higher frequency and intensity of the infection and the higher proportion of fertile cysts, of the 4 species, sheep probably act as the main reservoir of infection (most important intermediate host) in maintaining and perpetuating the domestic life cycle of *E. granulosus sensu lato* in the region of Thessaloniki, Greece. The fertility of hydatid cysts is one of the most important factors in the epidemiology and control of echinicoccosis/hydatidosis (Abdul-Salam and Farah 1988, Bortoletti *et al.* 1989, Irshadullah *et al.* 1989, Bortoletti *et al.* 1990, Saeed *et al.* 2000). The results of the present study provide a base line data on hydatidosis in sheep, goats, cattle, and pigs, which will help in controlling of this disease.

References

Abdul-Salam J.M. & Farah M.A. 1988. Hydatidosis in camels in Kuwait. *Parasitol Res*, **74**, 267-270.

Abiyot J., Beyene D. & Abunna F. 2011. Prevalence of hydatidosis in small ruminants and its economic significance in Modjo Modern Export Abattoir, Ethiopia. *J Public Health Epidemiol*, **3**, 454-461.

Bortoletti G., Capra S., Palmas C. & Gabriele F. 1989. Distribution of ovine hydatidosis in Sardinia, 1987-1988. *Parassitologia*, **31**, 251-257.

Bortoletti G., Gabriele F., Seu V. & Palmas C. 1990. Epidemiology of hydatid disease in Sardinia: a study of fertility of cysts in sheep. *J Helminthol*, **64**, 212-216.

Cardona G.A. & Carmena D. 2013. A review of the global prevalence, molecular epidemiology and economics of cystic echinococcosis in production animals. *Vet Parasitol*, **192**, 10-32.

Christodoulopoulos G., Theodoropoulos G. & Petrakos G. 2008. Epidemiological survey of cestode-larva disease in Greek sheep flocks. *Vet Parasitol*, **153**, 368-373.

Christofi G., Deplazes P., Christofi N., Tanner I., Economides P. & Eckert J. 2002. Screening of dogs for *Echinococcus granulosus* coproantigen in a low endemic situation in Cyprus. *Vet Parasitol*, **104**, 299-306.

Dalimi A., Motamedi G., Hosseini M., Mohammadian B., Malaki H., Ghamari Z. & Gaffari F. 2002. Echinococcosis/hydatidosis in Western Iraq. *Vet Parasitol*, **105**, 161-171.

Daryani A., Ziaei H., Sharif M., Dehghan M.H., Alaei R. & Arab R. 2006. Prevalence of hydatid cyst in slaughtered animals in Northwest Iraq. *J Anim Vet Adv*, **5**, 330-334.

Fikire Z., Tolosa T., Nigussie Z., Macias C. & Kebede N. 2012. Prevalence and characterization of hydatidosis in animals slaughtered at Addis Ababa abattoir, Ethiopia. *J Parasitol Vector Biol*, **4**, 1-6.

Garippa G. 2006. Updates on cystic echinococcosis (CE) in Italy. *Parassitologia*, **48**, 57-59.

Garippa G., Varcasia A. & Scala A. 2004. Cystic echinococcosis in Italy from the 1950s to present. *Parassitologia*, **46**, 387-391.

Giannetto S., Poglayen G., Brianti E., Sorgi C., Gaglio G., Canu S. & Virga A. 2004. An epidemiological updating on cystic echinococcosis in cattle and sheep in Sicily, Italy. *Parassitologia*, **46**, 423-424.

Grosso G., Gruttadauria S., Biondi A., Marventano S. & Mistretta A. 2012. Worldwide epidemiology of liver hydatidosis including the Mediterranean area. *World J Gastroenterol*, **18**, 1425-1437.

Himonas C., Antoniadou-Sotiriadou K. & Papadopoulos E. 1994. Hydatidosis of food animals in Greece: prevalence of cysts containing viable protoscoleces. *J Helminthol*, **68**, 311-313.

Himonas C., Frydas S. & Antoniadou-Sotiriadou K. 1987. The fertility of hydatid cysts in food animals in Greece. *In* Helminth zoonoses (S. Geerts, V. Kumar & J. Brandt, eds). Dordrecht, Martinus Nijhoff, 12-21.

Irshadullah M., Nizami W.A. & Macpherson C.N. 1989. Observations on the suitability and importance of the domestic intermediate hosts of *Echinococcus granulosus* in Uttah Pradesh, India. *J Helminthol*, **63**, 39-45.

Jimenez S., Perez A., Gil H., Schantz P., Ramalle E. & Juste R. 2002. Progress in control of cystic echinococcosis in LaRioja, Spain: decline infection prevalences in human

and animal hosts and economic costs and benefits. *Acta Trop*, **83**, 213-221.

Marshet E., Asamre K., Bekele J., Anteneh T., Abera M., Aragaw K. & Abebe R. 2011. The status of cystic echinococcosis (hydatidosis) in small ruminants slaughtered at Addis Ababa municipal abattoir. *J Anim Vet Adv*, **10**, 1445-1449.

Nakao M., McManus D.P., Schantz P.M., Crain P.S. & Ito A. 2007. A molecular phylogeny of the genus *Echinococcus* inferred from complete mitochondrial genomes. *Parasitology*, **134**, 713-722.

Parija S.C. 2004. Textbook of medical parasitology: protozoology and helminthology, 2nd Ed., Publishers and Distributors, New Delhi, India.

Saeed I., Kapel C., Saida L.A., Willingham L. & Nansen P. 2000. Epidemiology of *Echinococcus granulosus* in Arbil province. Northern Iraq, 1990-1998. *J Helminthol*, **74**, 83-88.

Sotiraki S., Himonas C. & Korkoliakou P. 2003. Hydatidosis - echinococcosis in Greece. *Acta Trop*, **85**, 197-201.

Sotiraki S., Papadopoulos E., Himonas C. & Korkoliakou P. 2001. Hydatidosis - echinococcosis in Greece. *In* Proc. XXth International Congress of Hydatidology, Kusadasi, Turkey, 4-8 June 2001, Book of Abstracts, 71.

Soulsby E.J.L. 1982. Helminths, arthropods and protozoa of domesticated animals, 7th Ed. Bailliere, Tindall and Cassell, London, UK.

Statistical Package for the Social Sciences. 2008. Release 17.0. SPSS Inc., Chicago, IL, USA.

Thompson R.C.A. & McManus D.P. 2002. Towards a taxonomic revision of the genus *Echinococcus*. *Trends Parasitol*, **18**, 452-457.

Varcasia A., Canu S., Kogkos A., Pipia A. P., Scala A., Garippa G. & Seimenis A. 2007. Molecular characterization of *Echinococcus granulosus* in sheep and goats of Peloponnesus, Greece. *Parasitol Res*, **101**, 1135-1139.