

CYSTIC ECHINOCOCCOSIS IN GREECE. PAST AND PRESENT¹

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Summary:

Cystic echinococcosis is a zoonotic disease with a wide geographical distribution, Greece included, and is considered to be a serious problem for the public health and the livestock economy. Although the disease was widespread in Greece since ancient times, cystic echinococcosis was identified as a serious problem around 1970, and since then national surveillance programmes are running, based on meat inspection and stray dogs management. Ever since, there are official records of the parasite's prevalence in humans and livestock which show a continuous decline. More precisely, human hydatidosis, according to the official records, declines from an annual incidence of 14.8 per 100,000 inhabitants during 1967-1971 to 0.3 in 2008. Late surveys reveal that in Greece the prevalence of echinococcosis was 23-39.2 % for sheep, 7.6-14.7 % for goats, 0 % in cattle and 0.6 % in pigs, while further molecular analyses in Southern Greece showed the existence of the genotypes G1 and G3 in sheep and G7 in goats in that area. All data presented demonstrate that the parasite is still present in Greece. Surveillance is nowadays being performed under EU regulations but it is highly important to improve and adopt corrective and preventive measures to avoid animal and human infection.

KEY WORDS: cystic echinococcosis, *Echinococcus granulosus*, surveillance, Greece.

Résumé : L'HYDATIDOSE EN GRÈCE. PASSÉ ET PRÉSENT

L'hydatidose à *Echinococcus granulosus* est une zoonose qui a une large distribution géographique, la Grèce incluse, et qui est un important problème pour la santé publique et l'économie de l'élevage. Bien que la maladie soit connue en Grèce depuis longtemps, elle a été considérée comme étant un problème sérieux dans les années 1970 et des programmes de surveillance nationaux fonctionnent depuis, basés sur l'inspection de la viande et la gestion des chiens errants. Depuis, les données officielles montrent une baisse continue de la fréquence de la maladie chez l'homme et le bétail. Plus précisément, l'incidence annuelle des cas de kystes hydatiques humains est passée de 14,8 pour 100 000 habitants durant les années 1967-1971 à 0,3 en 2008. Les dernières enquêtes révèlent que la fréquence de l'hydatidose animale en Grèce est de 23-39,2 % chez les ovins, de 7,6-14,7 % chez les caprins, de 0 % chez les bovins et de 0,6 % chez les porcins. Des analyses menées en Grèce du sud ont montré l'existence des génotypes G1 et G3 chez les ovins et G7 chez les caprins dans ce secteur. Toutes les données démontrent que le parasite est toujours présent en Grèce. La surveillance est de nos jours en conformité avec la réglementation de l'Union européenne, mais il est très important d'améliorer les mesures de prévention de la maladie tant chez l'animal que chez l'homme.

MOTS CLÉS : hydatidose, kyste hydatique, *Echinococcus granulosus*, surveillance, Grèce.

Echinococcosis is a parasitic disease that occurs as a result of infection by taeniid cestodes belonging to the genus *Echinococcus*. Globally, six species have been recognized, of which four are of public health concern (only the first two occur in Europe), *E. granulosus* (causing cystic echinococcosis), *E. multilocularis* (causing alveolar echinococcosis), *E. vogeli* and *E. oligarthrus* (causing polycystic echinococcosis) (Moro & Schantz, 2009). The other two, which have been recently identified and their zoonotic potential is unknown, are *E. shiquicus*, found in small mammals from the Tibetan

plateau (Xiao *et al.*, 2006) and *E. felidis*, found in African lions (Hüttner *et al.*, 2008).

In Europe, *Echinococcus* is present in livestock and wildlife being pathogenic to humans and several studies have shown that it's an increasing public health concern regarded as emerging or re-emerging zoonosis. Pathology, epidemiology and geographic distribution vary significantly among the different *Echinococcus* species. As a general rule, echinococcosis in man caused by species mainly transmitted by wild animals is rare, due to limited contact between humans and wildlife. However, in Europe *E. multilocularis* is considered an emerging parasite (the annual incidence in endemic areas has increased from a mean of 0.10 per 100,000 inhabitants during 1993-2000 to a mean of 0.26 per 100,000 inhabitants during 2001-2005), principally due to the movement, relocation and increase in the fox population, mainly after the successful establishment of anti-rabies vaccination programs (Schweiger *et al.*, 2007).

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South-western and Eastern Europe are considered endemic regions for the *E. granulosus* complex. *E. granulosus* is the most important species in relation to food producing animals (i.e. cattle, sheep, goat, pig, deer, boar, etc). *E. granulosus* consists of various genotypes/(sub)species recently redefined (Thompson, 2008; Nakao *et al.*, 2007). At least seven of nine *E. granulosus* genotypes are infective to humans, four of which exist in Europe. Globally, most human cases of cystic echinococcosis (CE) are caused by the sheep strain G1 of *E. granulosus* which predominantly has a dog-sheep cycle (Eckert & Deplazes, 2004).

The aim of this paper is to review the past and current situation as regards CE in Greece and to describe the national monitoring programmes and the results of their application.

BACKGROUND

In Greece, *E. granulosus* has been acknowledged as a common species since ancient times, described by Hippocrates (as “cysts full of water” in a liver of a man), and Aristotle (Sotiraki *et al.*, 2003). In modern Greece, the first recognised human infection was reported in 1839. The disease was obviously widespread but unfortunately before 1970s, it was practically not possible to collect accurate national epidemiological data. According to the National Statistical Service of Greece and the Greek Ministry of Health the incidence of human cystic echinococcosis for the years 1967-1981 was estimated at 12.9 per 100,000 inhabitants. As for the livestock species, the official prevalence from 1973 to 1977 was 53 % for cattle raised outdoors, 17.9 % for cattle raised indoors, 61 % for sheep, 7.2 % for goats and 1.9 % for pigs (Vassalos *et al.*, 1984, Tsaglas, 1985). At that time, as a result of the high prevalence of infection in animals and man, the economic losses caused by this disease in Greece had been calculated at approximately 3,671,357,000 Greek drachmas (10,774,342 Euros) (Tsaglas, 1985). In the following text we will review the programmes that were and are implemented ever since and analyse their efficiency based on published records.

ANTI-ECHINOCOCCOSIS CONTROL POLICY

As described above, CE was identified as a serious problem around 1970, and in 1978 (law nr. 829/78) a national control program was established which was elaborated in 1984 (degree-law 400/84). The main principles of this program were identification and registration of all dogs, elimination of stray dogs, routine praziquantel treatment of shepherd dogs

every 5-6 weeks, selective treatment of all other infected dog (diagnosed by examination of faecal specimens obtained by arecoline purges), abattoir control and meat inspection (Sotiraki *et al.*, 2003).

Since Greece joined the EU, surveillance is performed during official meat inspection as part of EC Regulation No 854/2004 (relevant Greek PO 79/07) of the European Parliament and of the Council of 29 April 2004, which laid down specific rules for the organisation of official control of products of animal origin intended for human consumption. Monitoring of echinococcosis / hydatidosis is covered by the Directive 2003/99/EC (EC, 2003), which forms the basis for the data on zoonoses collected throughout the member states and reported to the EU Commission on an annual basis. These data are collected and examined by the European Food Safety Authority (EFSA), the European Centre for Disease Control (ECDC) and by the Zoonoses Collaboration Centre (ZCC). *Echinococcus* is included in list A of Annex I, Directive 2003/99/EC, which determines which agents have to be monitored on a mandatory basis. According to the above, the measures in force designate that all carcasses intended for human consumption are inspected for evidence of hydatid cysts and cyst identification leads to condemnation of the part of the carcass.

In addition, and to support meat inspection, there is a national legal basis in force for stray dogs (Law 3170/2003), based on the animal welfare principles and the European Convention for the Protection of Pet Animals, and in respect to animal and public health. The current framework succeeded a previous one (Law 829/78), which was actually the legal basis for the control program for echinococcosis, rabies and leishmaniosis implemented from 1983 to 1994. This legislation basically encompasses the registration of all dogs (owned and stray), and the collection and clinical examination of stray dogs, followed by spaying of bitches, adoption/return to the existing owners or release, under certain conditions, of the animals into the environment.

HUMAN HYDATIDOSIS

According to the Greek Ministry of Health, the incidence of human cystic echinococcosis for the years 1967-1971, 1972-1976 and 1977-1981 was, respectively, 14.8, 12.9, and 10.9 per 100,000 inhabitants. A retrospective study to estimate the incidence of hydatidosis among Greeks between 1969 and 1975 (Karpathios *et al.*, 1985) showed that during this period a total of 4202 adult patients were diagnosed with hydatidosis, indicating an incidence of 9.77 per 100,000 inhabitants. Of these, 3397 (80.8 %) patients underwent surgery (485 per year or 7.9 surgical cases per 100,000 inhabitants). For the

period 1981-83, Papadopoulos (1985) reported an incidence of 12.7 per 100,000 inhabitants (range 11.6-13.35).

Official data from the Ministry of Public Health indicate 54 cases reported in 1998, 51 in 1999, 29 in 2000, 41 in 2001, 23 in 2002, 16 in 2003, 26 in 2004, 11 in 2005, 5 in 2006, 49 in 2007, while in 2008, 8 cases were reported until May. According to the EFSA Journal (2010), and on a case report basis, a total of 25 cases were reported in 2004, while in 2005, 2006, 2007 there were 10, 5, and 10 confirmed cases, respectively, and in 2008 there were 31 total cases, of which 28 were confirmed (0.3/100,000 inhabitants).

As regards recent published records, they are not available on a national basis, but there is a number of scientific reports from single clinics / hospitals from throughout the country. More precisely, records from Athens include 85 surgically treated patients between 1986 and 1996 in Evangelismos General Hospital (Athanasidi *et al.*, 1998) and 194 patients between 1996 and 2006 in Hippocrateion Hospital. In the latter, there were also three gluteus muscle cysts reported during the last 10 years and one liver cyst in 2007 (Manouras *et al.*, 2007; Manouras *et al.*, 2009). In Asclepeion Voulas Hospital, during a 20 years period, 35 patients (34 % male, 66 % female) were treated surgically for liver cysts (Avgerinos *et al.*, 2006), while in the Red Cross Hospital one case each of liver cysts (Anthi *et al.*, 2004) and of hydatid disease of the tarsal bones (Papanikolaou *et al.*, 2005) were reported. Finally, the University of Athens School of Medicine reported 50 cases of liver hydatid cysts between 1993 and 1997 (Voros *et al.*, 1999), and one cyst of the subcutaneous tissue (Safiolas *et al.*, 2007).

In Thessaloniki, in AHEPA Hospital, a total of 615 patients were operated for hydatid disease between 1967 and 1998, 220 of them having cysts in more than one organ (Prousalidis *et al.*, 2004) while 75 cases of calcified liver hydatidosis were reported between 1964 and 1996, (Prousalidis *et al.*, 1999). Furthermore, in Hippocrateion Hospital, Papathanasiou *et al.* (2006) reported a hydatid cyst in the seminal vesicle.

In Medical School of Patras, 67 patients with hepatic hydatidosis were operated between 1985 and 1990 (Vagianos *et al.*, 1995) and in the State Hospital of Corfu Island seven patients (three female, four male) were operated for hepatic cysts during the last 14 years (<http://www.ixek.gr>; 2009). Finally, cases were also reported in Larissa (Tepetes *et al.*, 2007), Crete Island (Petrakis *et al.*, 2009), and Lesbos Island (Kouskos *et al.*, 2007).

In addition, there are a few reports of *E. multilocularis* infection in humans (Tzamouranis, 1969; Theodoropoulos *et al.*, 1978), but there are doubts as to the reliability of this diagnosis.

ECHINOCOCCOSIS IN LIVESTOCK SPECIES AND IN DEFINITIVE HOSTS

Concerning the intermediate hosts, the prevalence of hydatidosis in different animal species has varied significantly over the last forty years. From 1975 to 1977, according to official meat inspection data, the prevalence of infected animals was 53 % for cattle raised outdoors, 17.9 % for cattle raised indoors, 61 % for sheep, 7.2 % for goats and 1.9 % for pigs (Vassalos *et al.*, 1984; Tsaglas, 1985). At the initiation of the National control program in 1984, official prevalence estimates were 82 % in cattle, 80 % in sheep, 24 % in goats and 5 % in pigs (Sotiraki *et al.*, 2003).

According to a study by Himonas *et al.* (1987), cyst fertility in 601 cysts from 103 sheep, 194 cysts from 77 goats, 528 cysts from 107 cattle and 102 cysts from 60 pigs, was respectively 64.2 % (73.8 % of the infected animals carrying fertile cysts), 54.6 % (57.1 % of the infected animals carrying fertile cysts), 16.1 % (30.8 % of the infected animals carrying fertile cysts), 6.9 % (8.3 % of the infected animals carrying fertile cysts). The fertility rate was higher in cysts in lungs than in those in liver in sheep and goats and vice versa in cattle and pigs. In a later study conducted in the same area, involving a total of 200 sheep, the percentage of infected animals was 100 % with a mean of 1.1 (29.8 % of total cysts) fertile cysts per animal. Moreover, in the same survey in 106 cattle, 203 pigs and 52 goats examined, the percentage of infected animals was 56.6 %, 9.3 % and 15.4%, and the mean rate of fertile cysts per animal of 0.1 (6.6 % of total cysts), 0.02 (9.5 % of total cysts), and 0.1 (12.5 % of total cysts) respectively. The fertility rate was higher among the cysts in lungs than in those in liver in sheep, pigs and goats and vice versa in cattle (Himonas *et al.*, 1994).

The official data of the infected animals from 1999 to 2008 are shown in Table I (a, b).

In a survey conducted from 1998 to 2002 in Northern Greece (Sotiraki *et al.*, 2003), the prevalence of infection was 31.3 % in sheep (0.7 % in animals < 1 year old, 2.2 % in those 1-2 years old, 70.7 % in animals > 2 years old), 10.3 % in goats (0 % in animals < 1 year old, 13.6 % in animals > 2 years old), 0.6 % in pigs, and 0 % in cattle. Of the cysts examined, above 8 % of the sheep ones were fertile, none of the infected goats, and all cysts recovered from pigs were calcified. During the year 2005, in a survey carried out in Peloponnese, Southern Greece, the prevalence recorded was 30.4 % for sheep and 14.7 % for goats. A total of 1,045 and 152 hydatid cysts were found, respectively, in infected sheep and goats, with a respective abundance of 5.0 and 0.8. Fertile cysts were found in 16.2 % of sheep and 7.4 % of goats, with fertility rates of 39.8 % for sheep and 22.4 % for goats. Further analyses revealed G1

(common sheep strain) and G3 (buffalo) genotypes in sheep, and G7 (pig) in goats (Varcasia *et al.*, 2007). In another survey carried out between 2002 and 2006 in Thessaly, Central Greece, the prevalence in sheep was 39.3 % in 700 hoggets and 1,500 adult sheep. The proportion of fertile hydatid cysts was significantly higher in hoggets (95.65 % for liver and 90 % for lungs) than in adult sheep (78.79 % for liver and 73.42 % for lungs) (Christodouloupoulos *et al.*, 2008). More recently, in an ongoing survey in various slaughterhouses in Northern Greece, among 949 animals (567 sheep and 382 goats) 160 were found to be infected by *E. granulosus* (16.9 %). The prevalence among slaughtered sheep and goats was 23 % and 7.6 % respectively (Chaligiannis *et al.*, unpublished data). Infection in other animals has not been reported except for a recent survey in horses, in which a seroprevalence of 0.1 % was recorded (Kouam *et al.*, 2010).

Finally, information concerning dogs is scarce. The infection prevalence in approximately 550,000 dogs at the initiation of the first programme was 50.4 % for shepherd dogs, 26.9 % for watch dogs, 19.2 % for hunting dogs, 9.3 % for stray dogs and 0.1 % for companion dogs (Himonas, 1968; Vasalos, 1978; Tsiglas, 1985). Later on, from 1985 to 1987, a mass diagnostic examination by the arecoline dosing technique performed by the National Veterinary Services showed *E. granulosus* infection in purged stools of 3.3 % of 110,093 dogs (Papadopoulou, 1989). The same species was also reported in wolves (Papadopoulou, 1989). According to the EFSA Journal (2007), infection among owned dogs has almost disappeared due to the systematic preventive treatment of animals with antiparasitic drugs. The infection of stray dogs is decreasing overtime. *E. multilocularis* has not been documented in Greece.

a – from 1999 to 2001 (source: Hellenic Ministry of Rural Development and Food)

Year of examination	% infected during meat inspection				
	1997	1998	1999	2000	2001
Cattle	0.95	1.7	2.26	3.39	1.86
Sheep	5.3	2.6	3.23	2.78	3.21
Goats	1.5	0.39	0.69	0.8	0.8

b – from 2004 to 2008 (source: EFSA Journal)

Year of examination	% infected during meat inspection				
	2004	2005	2006	2007	2008
Cattle	1.18	0.93	0.97	1.44	1.09
Sheep	1.89	1.64	2.03	3.91	1.5
Goats	0.31	0.35	0.41	1.94	0.52
Pigs	0	0.008	0.02	0.004	0.001

Table I. – Prevalence of *Echinococcus* in slaughtered animals.

CONCLUSIVE REMARKS

The data reviewed above are obviously controversial especially when official records are compared with research data. National surveillance programmes are usually based on meat inspection records but the sensitivity of meat inspection is rather low (Aalten *et al.*, 2008). Therefore low infection levels will not be detected especially when meat inspection is carried out fast and/or is not adequately supported by a sufficient number of official veterinarians. In addition, cases that lead to total condemnation are being notified to central authorities whereas those with only partial viscera condemned due to the presence of hydatid cysts remain unregistered.

Attempts to synthesize the diverse data sources may misjudge the real situation. The numbers of human cases, even when only based on national reports, cannot be disregarded. The numbers of annual cases may seem small but yet they stand among the top in Europe, making CE a very important public health threat in Greece. It is also important to consider that most clinical figures given refer to surgical indexes (patients that had an operation). This leads to only a few cases officially being reported in comparison to the total numbers diagnosed, which can guide to underestimating the real situation. On the other hand, published data are often drawn from partial, occasional or targeted surveys concerning human and animal case studies (Ecca *et al.*, 2001). Such case studies were often limited to specific specialized branches of surgery, to specific or unusual localizations of the parasite and to retrospective studies in single hospitals or clinics. Though these data are only estimates and of little epidemiological significance, they are indicative of the presence of the parasite in a specific area and often provide significant clinical information.

Overall, all data presented confirm that the parasite is still circulating among livestock and humans in Greece. Due to diagnostic difficulties in the definitive host and the asymptomatic character of the disease in the intermediate hosts in the case of *E. granulosus*, the monitoring of the disease must be performed at the slaughterhouse level. Therefore, it is important to improve the level of identification and notification of hydatid cysts findings by improved slaughterhouse registration and meat inspection practices. Furthermore, there is an urgent need to improve and adopt corrective and preventive measures to avoid animal and human infection, such as anthelmintic treatment of owned dogs, strict stray dog policy, strong veterinary control to avoid home slaughtering of sheep, goats and other livestock, and supervision of slaughtering facilities, i.e. destruction of infected offal. Moreover, additional measures such as the education of farmers and general public are a key action in the control of this infection in animals and humans.

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