Introduction

Cystic echinococcosis or hydatidosis is an important cyclo-zoonotic parasitic disease caused by the larval stage of the tape worm *Echinococcus granulosus*. The parasite cycles in a predator or prey relationship between carnivore (definitive) hosts and herbivore (intermediate) hosts. *Echinococcus granulosus* has a worldwide geographical distribution that occurs in all continents of the world and in some areas it ranks as the leading disease of public health significance (Schantz *et al*., 1995, Eckert *et al* ., 2001). Definitive host of this parasite is carnivores and the intermediate host is wild and domestic ruminants (Andersen *et al*., 1997, Magambo *et al*., 2001. Benner *et al*., 2010). The disease is manifested as fluid-filled cysts formed in certain parts of the body (lung, liver, spleen and heart). Domestic intermediate hosts (cattle, sheep, goats, and camels) are a major source of the infection to the dogs which is caused by the adult stage of *Echinococcus granulosus*. Both man and animals acquire the infection by accidental ingestion of the eggs from the environment. Contaminated food stuffs and infected dogs carrying the tapeworm eggs in their fur are suspected to be important sources of infection (Magambo *et al*., 2001, Benner *et al*., 2010).

Pastoral communities have been reported to be highly at risk of becoming infected with *E. granulosus* due to their close

association with dogs. Between January 1998 and July 2000, 325 patients, most of them suffering from cystic echinococcosis were reported to African Medical and Research Foundation (AMREF) hydatid control centre for treatment at the Kenya-Sudan border. However, there is scanty information on the epidemiology of cystic echinococcosis in most parts of Southern Sudan (Eisa *et al*., 1962, Magambo *et al*., 1996). The disease is particularly important in developing countries where many rural inhabitants live under poor sanitary conditions and in close proximity to their domestic animals (Andersen *et al*., 1997). In the Sudan, studies on cystic echinococcosis in domesticated animals were carried out by various workers (Eisa *et al*., 1962, ElKhawad *et al*., 1979, Saad, Magzoub, 1989b, Mohammed, 1999, Mohammed, Elmalik, 2000, Elmahdi, 2003). In an attempt to establish the prevalence of the disease, a mass survey was performed in the pastoral community of southern Sudan .

The occurrence of human hydatidosis in the Sudan was reported by many workers (Eisa *et al*., 1962, Elmahdi, 2003, Tola, 1987, Magambo *et al*., 1996) Hydatid disease is an important health and socio-economic problem in Sudan (Elmahdi, 2003. Budke *et al*., 2006). The parasite's life cycle is maintained through dogs (which harbor 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 feces of infected dogs and may thus contaminate soil, grass and water. Ungulates (hoofed

animals) can become infected by grazing on pasture contaminated with dog feces (Mohammed, 2004). 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 feces of infected dogs (Daniel, *et al*., 2008, Benner, *et al*., 20**10) .**

Objectives :

1- To estimate the prevalence of hydatid cyst infection in sheep.

2- To investigate risk factors associated with the disease.

Chapter one

Literature review

1. Literature review

1.1 Classification

According to Rausch. (1994a), the systematic arrangement of *Echinococcus granulosus* was accepted as follows:

Kingdom: Animalia

Phylum : Platyhelminths

Class : Eucestoda

Order : Taeniidea

Suborder: Taeniata

Family : Taeniidae

Subfamily: Echinococcinae

Genus : *Echinococcus*

Species :*Echinococcus granulosus*

Biotypes: Northern biotype, European biotype

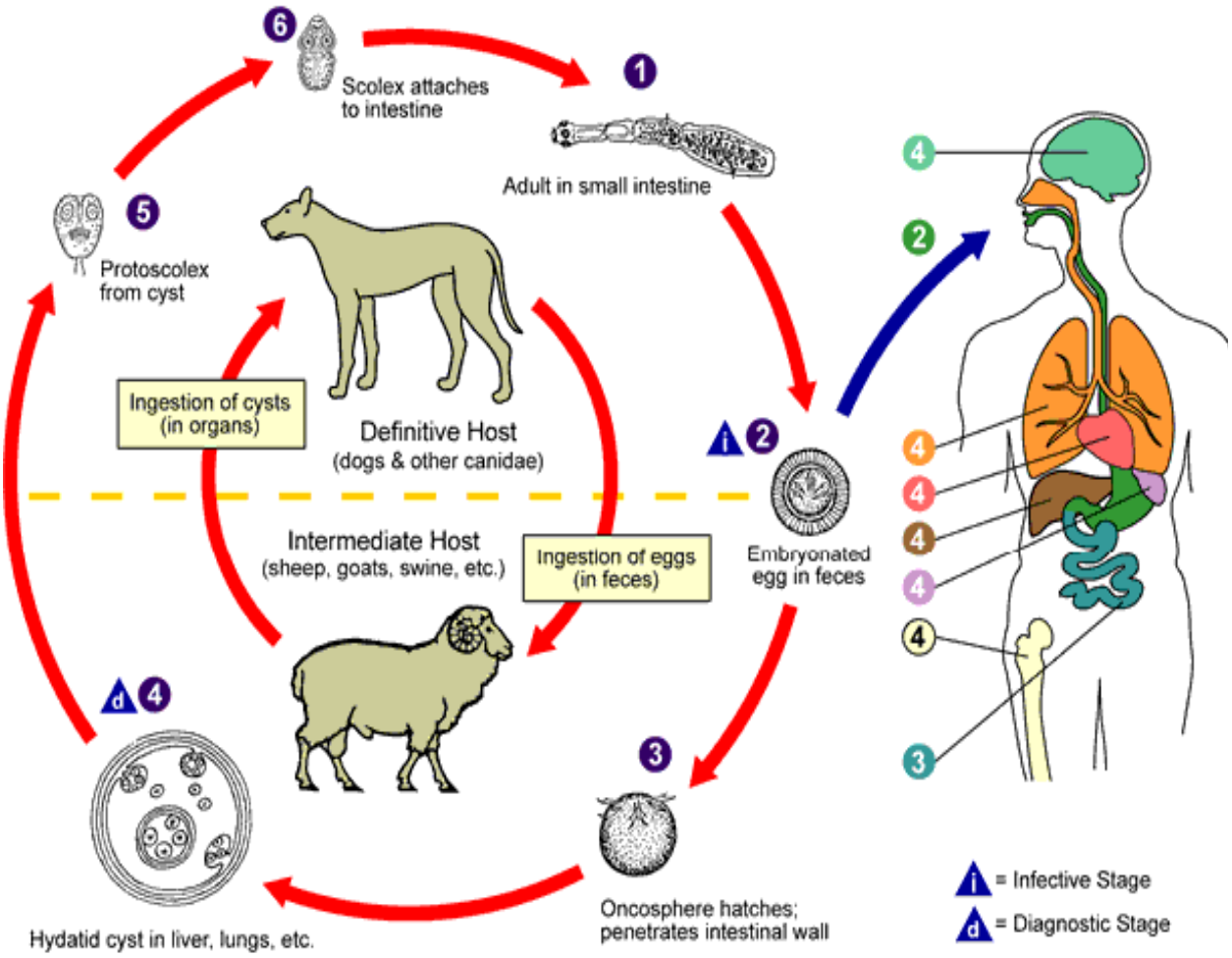
1-2 Genus: *Echinococcus*

Speciation in the genus *Echinococcus* has been discussed by (Smyth, 1977). At present, four species of the genus *Echinococcus* are recognized on the basis of the standard taxonomic criterion by which cestodes are specifically distinguished. These are *Echinococcus granulosus, Echinococcus, multilocularis*, *Echinococcus oligarthrus* and *Echinococcus vogeli*, these four species of *Echinococcus* are differentiable in the strobilar as well as the larval stages (Rausch, 1997).

1-3 Life Cycle

The adult *Echinococcus Granulosus* are found in the small intestine of carnivores (particularly dogs), while the hydatid cyst

(metacestode) are found in a wide variety of ungulates and man (Soulsby, 1982). *E. granulosus* eggs are excreted with feces of the final hosts. After ingestion by an intermediate host (usually sheep, goats, cattle, Camels, horses, and humans) , the eggs hatch in the small intestine and release oncospheres that penetrate the intestinal wall and via the circulatory system to various organs, especially the liver and Lungs. In these organs the oncosphere grows gradually to form cyst. Dogs become infected by ingesting the cyst-containing organs of infected intermediate host (Harsha *et* al., 2000).The adult stage of *Echinococcus* which occurs chiefly in dogs, is the smallest tapeworm of medical importance; it ranges from 2.5 and 9.5 mm In length, and usually possesses three segments, averaging from three to four segments. The larval stage is a fluid-filled bladder or hydatid cyst that unilocular, although communicating chambers also occur (David and Belding, 1964). Hydatid cyst of *E. granulosus* is unilocular and its growth is expansive by concentric enlargement and slowly over several months. Hydatid cyst are commonly 5 to 10 cm in diameter, a well developed cyst contains three layers: fibrous capsule of host origin, the middle one is the laminated membrane which is secreted by the thin (germinal) layer and therefore is of parasite origin. The germinal layers give rise to the broad capsule and daughter cysts.



Figure(1): Life cycle of Echinococcous species (Soulsby, 1982).

The disease state caused by *E. granulosus* is sometime known as unilocular hydatid , because only single site is initially colonized, whereas *E. multilocularis* colonizes multiple sites and therefore leads to more serious clinical disease . In human these tapeworms cause condition known as hydatid disease. Where cysts of great size may develop and cover long period post-infection (Shakespeare, 2001) .

On the other hand, sheep, goats, cattle, camel, buffaloes, pigs and donkeys have been repeatedly found infected with hydatid cyst (Oryan *et al*. ,1994, Molar, 1993, Al. Yaman et al. ,1985, and Abdel Hafez *et al*. ,1986). A previous study revealed that cysts of all infected cattle were sterile, while the cysts of the other animals were mostly fertile (Al-Khalidi, 1998). Hydatidosis is one of the parasitic diseases which causes main problem for human health . Larval stage of this parasite is located in liver and lung of cattle, sheep, goats and horses. Cystic echinococcosis (CE) is one of the most wide spread on thropozoonoses (Thompson and Lymbery, 1990) . Its wide distribution is due in part to the adaptability of the parasite to several domestic or wild intermediate hosts (Bardonnet *et al*. , 2003) . Some years ago WHO recommended that an economic evaluation of the effects of parasitic zoonoses should be integral part of any control program

(Torgerson, 2002). Cystic echinococcosis caused by *E. granulosus* is still important public health problem in the Mediterranean regions (Eckert *et al*. , 2001).

Cystic echinococcosis is endemic and is maintained in three distinct cycles, livestock/dog domestic cycle, desert cycle between dogs and camels and cylvatic cycle between wild carnivores and wild ruminants (Dalimi *et* al., 2002). Prevention of both cystic echinococcosis and alveoli echinococcosis focuses primarily on veterinary intervention to control the extent and intensity of infection in definitive host population which may indirectly be approached by controlling the prevalence in animal intermediate host (Gottstein , 2003). All species of echinococcus are infective to humans causing various forms of echinococcosis . Human cystic echinococcosis, caused by *E. granulosus* and alveolar echinococcosis, caused by *E .multilocularis* , are the most important public health threats in many parts of the world (WHO, 2001) .

1-4 Disease description:

In humans , the disease is initially without any symptoms until gradually the cyst increased in size , causing local pressure effects. In animals , the disease does not produce any clinical signs and is usually only discovered during meat inspection at

the slaughterhouse where the viscera (mainly liver and lungs) are condemned (Eddi *et al.*, 2004).

1-5 Prevalence of hydatid cyst.

The prevalence of hydatid cyst disease in animals has been studied extensively. *E. granulosus* has a worldwide distribution and occurs in all continents, *E. multilocularis* occurs in wide areas of the northern Hemisphere, *E. shiquicus* is found in the Peoples Republic of China and *E. oligarthrus* and *E.vogeli* are confined to the central and south America (WHO/OIE, 2001). All five species are infective to humans causing various forms of cystic echinococcosis. Human cystic echinococcosis , caused by *E. granulosus* and alveolar echinococcosis , caused by *E. multilocularis*, are the most important public health threats in many parts of the world and also polycystic echinococcosis caused by *E. vogeli* and *E. oligarthrus* (WHO/OIE,2001). Hydatid cyst is cyclozoonotic infection of worldwide distribution which found in various countries including: Iceland, Europe, Asia, Africa, America, and Oceania (Matossian *et al*., 1977). The prevalence of hydatid cyst in sheep in Romania, China, Italy, Greece, Iran, Turkey, and Japan has been reported to be 92.9% (Raul *et al*., 2010); 82.6% (Yusen-Hai *et al*., 2008); 91.3%, (Bortoletti, 1987), 39.2% (Sotiraki *et al*., 2010); 78.65% (Esfandiari and Yousseft, 2010); 3.50% (Meltem *et al*., 2007); 41.6% (Oku *et al*., 2004), respectively. In Iran many studies on sheep have been performed

in Ardabil province area, Mazandaran province area and central part of Iran. The results indicated an infection rate of 74.4% (Daryani *et al*., 2007); 42.6% (Daryani *et al*., 2009); 9.3% (Fakhar and Sadjjadi ,2007) respectively. Another study on sheep which has been carried out in Turkey showed an infection rate of 3.2% of lambs and 50.9% of adults (Yildiz and Gurcan , 2003). In Wales control programme failed to prevent transmission of *E. granulosus* to sentinel lambs in three areas. The lambs were examined at 15 month of age and the rate of infection was 6%, 4%, and 10% in the three infected areas I, II and III respectively (Lioyd *et al*. , 1998). Another study on sheep hydatidosis carried out in Greece showed a prevalence of 39.32% (Christodoulopoulos *et al*., 2008).

A study on the prevalence of the hydatidosis in sheep, goats and cattle was carried out in Ngorongoro district of Arusha region, Tanzania. A 4-year data from four slaughter slabs, the results showed a prevalence of 63.8%, 34.7% and 48.7% in sheep, goats and cattle respectively (Emest *et al*., 2009). In Italy, of 771 regularly slaughtered Sardinian breed sheep, 580 (75%) were found infected with *Echinococcus granulosus* hydatid cysts (Scala *et al*., 2005). In a study in Comilla and Brahman areas in Bangladesh, 460 sheep car casses were examined from February to August, 2008. The prevalence was 16.95% (Hazzaz *et al*., 2010).

The prevalence of hydatid disease in sheep from Saudi Arabia, Palestine, Jordan, Libya and Tunisia have been reported to be 12.6% (Mohamed and Ibrahim, 2009), 9.1% (Jehad, 2009), 20.3%

(Zuhair *et al*., 2001), 12.7% (Kassem, 2006), 40% (Lahmar *et al*. , 2007) . Another study in Jordan in 1992, using indigenous sheep from five region of Jordan showed an infection rate of 12.9%, the higher prevalence was (27.6%) which had been observed in sheep from Kara (Kawhawi *et al*., 1995). Also an infection rate of 8.7% with cystic echinococcosis (hydatidosis) was reported on 554 sheep in Shahat abattoir in Al-Jabal, Libya (AI-Khalidi, 1998). The prevalence of hydatid cyst in sheep in Ethiopia, Nigeria, Kenya, and Egypt have been reported to be 16.4% (Tekely *et al*., 1987), 11.4% (Dadabj, 1979), 8.1% (Calum and Macpherson, 1985), 1.33% (Rahman *et al*., 1992). An ultrasound examination of the liver and right lung was performed in 260 sheep and 320 goats from the Turkana district of Kenya. Hydatid cysts were visualized in 9.2% of the sheep and 2.5% of the goats.The animals positive on ultrasound, 87.5% received post-mortem examinations. Eighteen (6.9%) sheep and 5 (1.5%) gouts were positive for hydatid cyst on ultrasound and post-mortem examination (Abby *et al*., 1996).

The relationship between age of sheep and infection with *E. granulosus* was investigated in many studies. In Turkey 742 sheep slaughtered at twelve abattoirs in Thrace were investigated for hydatid cysts, the cysts were found in 2.64% of 720 lambs (< 1year old) and in 31.8% of 22 sheep (between 1-6 years old) (Meltum *et al*., 2007). Also a study of 1081 sheep slaughtered in central Kyrgyzstan, an area endemic for echinococcosis the results demonstrated approximately 64% of sheep were infected

with the prevalence increasing markedly with age (Torgerson *et al*., 2009). In a study to investigate risk factor of hydatidosis in sheep slaughtered at Addis Ababa abattoir, the relation between age and hydatid infection rate was 16% in < 1 year, 18.8% in 1-2 years, 37.5% in 2-3years, 39.2% in > 3 years (Kebebe *et al*. , 2009). In another study in Italy, the age of sheep was positively associated with the probability of infection that increases 1.15 times for each further year of age (Scala *et al*., 2004).

Location of cysts in sheep has been also investigated. The liver was the predilection site of infection. These finding were reported from the studies in Saudi Arabia (Ibrahim, 2010), Egypt (Rahman *et al*., 1992) and (Abu-Elwafa *et al* ., 2009), Jordan (Kawhowi *et al*., 1995), Kenya (Abby *et al*. , 1996). In Libya 87.2% of the infection in sheep was in the liver, 33.4% was in the lungs, 6.3% was in the peritoneal cavity and 2.4% was in the spleen (AL-Khalidi, 1998). In Turkey, cysts were encountered in the livers of 96.2%, 26.9% in the lungs, and 3.85% in the spleen (Meltem *et al*. , 2007). In Iran the infection was 26.4% in liver, 22.5% was in the lungs, 51.1% was in liver and lung and 1% was in the spleen (Fakhar and Sadjjadi, 2007). But lungs are the most location site in Oromia study in Ethiopia. Hydatid cysts were recovered from 55% of the lungs, 40% of the livers and 5% of the spleens (Getaw *et al*., 2010).

Fertility of cysts was reported in many studies to be: in Saudi Arabia (47.67%) (Ibrahim, 2010), Jordan (38.1%) (Kawhowi *et al*., 1995), Libya (79.2%) (AL-Khalidi, 1998), Kenya (70.5%)

(Calum, 1985). In Iran the fertility rates of hepatic cyst of sheep and cattle were 47.1% and 1.4%, respectively and the fertility rates of pulmonary cyst of sheep and cattle were 39.4% and 8.1% respectively. In the sheep, the fertility of cysts in the liver was higher than that in lungs, but in the cattle the fertility of cysts in lungs was higher than liver. The viability of protoscoleces of fertile cysts for sheep and cattle were about 76.9% and 82.5%, respectively (Daryani *et al*., 2009). In another study in Urugusy the prevalence of ovine hydatidosis was 41.6 and 8.5% in 1991–1992 and 1999, the prevalence of fertile cysts in sheep more than 4 years old was 7.3% and 2.3% in 1991–1992 and 1999, respectively (Fakhar and Sadjjadi, 2007).

1-6 Diagnosis of Echinococcus

A study for diagnosis of hydatid cyst in humans used Ultrasonograghy and an indirect hem agglutination test to detect the hydatid cyst and antibodies (Yu Sen *et al*., 2008). In other intermediate hosts (livestock) detection of the larval cyst is carried out in the abattoirs by meat inspection in addition to ultrasonogrophy and hem agglution tests (Hazzaz *et al*., 2010). In dogs or other carnivores, detection of the adult cestodes was by necropsy and fecal samples were obtained after arcoline purgation examined microscopically (Oku *et al*., 2004).

1-7 Hydatid cyst in the Sudan:

In Sudan several surveys have been conducted on hydatid disease. Various epidemiological parameters of hydatid cyst in the Sudan were investigated, high prevalence were found in camels (43.9%) and less in cattle (3.89%), sheep (12.9%) and goats (4.4%) (Mohamed, 1985).The livestock data were collected in abattoir-based survey in the towns of Omdurman, Tamboul and Wad Madani between 1998 to 2001, the prevalence was 6.9% in sheep (Elmahdi *et al*., 2004).Recently survey of sheep hydatidiosis in khartoum state from October to November 2010 were present in 10.7% (Elnour, 2011)

1-8 Epidemiology:

The adaptability of *E. granulosus* to a wide variety of host species and the repeated introduction of domestic animals from some parts of the world to others has resulted in the present broad cosmopolitan distribution of the parasite in all major climates. Its life cycle is complex involving two hosts and a free-living egg stage. The dynamics of transmission of the parasite are determined by the interaction of factors associated with these two hosts, the external environment and socio-ecological factors.

Intraspecific variations, with differences in infectivity to both definitive and intermediate hosts and differences in other biological properties of the parasite are of fundamental importance in determining the epidemiology of the parasite (Gemmell *et al*., 2001). It is customary to consider the epidemiology as being based on two cycles, pastoral and sylvatic. In the pastoral cycle, the dog is always involved, being infected

by feeding on ruminants' offals containing hydatid cysts. The domestic intermediate host will vary according to the local husbandry. This cycle is the primary source of human hydatidosis, the infection being by accidental ingestion of oncospheres from coats of dogs or from food or water contaminated by dog faeces. The sylvatic cycle occurs in wild canids and wild ungulates and is based on predation or carrion feeding. This cycle is less important as a source of human infection, except in hunting communities where the infection may be introduced to domestic dogs by the feeding of infected viscera of wild ruminants (Schantz and Schwabe, 1969). At any time the parasite population consists of 3 sub-populations: adult in the definitive host, larvae in the intermediate host, and eggs in the environment.

1-9 The larva in the intermediate host:

The intensity, infectivity and availability of the eggs in the environment, local circumstances of livestock husbandry, feeding behaviour of the intermediate host, and the slaughter policy together determine the number of infective organism entering the host (Gemmell, 1976). However, the number of these eggs that become established was strictly controlled by the host natural and acquired resistance to infection. they reported that hydatid cyst may only produce a low level of antigenic stimulation, perhaps insufficient to induce a host response adverse to cyst survival, but strong immunity was induced following parentral (intramuscular) injection of lambs with artificially activated

embryos of the parasite and a significant reduction in the total cyst counts and absence of viable cysts from the challenge infection was observed.

This immunity can be maintained throughout the life of the host by continuous ingestion of eggs but may wane within 6 – 12 months in the absence of reinfection (Gemmell and Johnstone, 1981). *E. granulosus*, has become adapted to a large variety of both wild and domestic intermediate host species distributed all over the world (Macpherson and Wachira, 1997).

1-10 Domestic intermediate hosts:

In many parts of the world, *E. granulosus*, is perpetuated predominantly by a domestic cycle involving an array of livestock species which include cattle, camels, sheep, goats, pigs, donkeys and horses. Regional foci of infection seem to be defined by lifestyle rather than livestock distribution (Macpherson *et al*., 1989).

Countries with known hyperendemic infections in Sub-Saharan Africa include Kenya, Nigeria, Somalia, Sudan, Swaziland and Uganda (FAO, 1993). Both susceptibility to infection and cyst fertility rates are essential factors in determining the importance of different intermediate hosts to local maintenance of *E. granulosus*. The susceptibility of cattle to infection is variable (Eisa, *et al*., 1962, Macpherson, 1985). Where camels are kept, more than half their population is infected and levels of infection

in camels are much higher in relation to other domestic intermediate hosts (Macpherson and Wachira, 1997).

Hydatid cysts in camels, goats and sheep are usually fertile and the three hosts appear to be the most important intermediate hosts of *E. granulosus*, in Sub-Saharan Africa (Macpherson, 1985). However, Saad and Magzoub, (1989b) reported that most cysts encountered in sheep and goats were calcified or semi-calcified. Donkeys and probably all equines are poorly susceptible to infection with *E. granulosus* in Africa (Dada *et al*.,1981).

1-11 Domestic-Wildlife interactions:

The introduction of commercial game ranching of wild herbivores in many African countries, mainly to satisfy the appetite of tourists for exotic meats and for the sport of hunting have provided opportunities for dogs to be exposed to hydatid cysts from intermediate hosts (Schantz and Schwabe,1969). Dogs infected with the domestic strains of *E. granulosus* may contaminate the grasslands and range lands that livestock and wildlife share, particularly in East Africa.

In this region transhumance pastoralits live in close proximity to wild animals that share the same habitat with domestic ones, thereby facilitating the transmission of a large number of diseases including echinococcosis (Macpherson, 1994). More than six species of carnivores have been found infected with

E. granulosus (Macpherson, 1986). It is believed that the source of infection to wild carnivores is from predation or the scavenged carcasses of infected domestic livestock (Macpherson *et al*., 1984).

1-12 The eggs in the environment:

The crowding of animals during grazing on contaminated soil and the extent to which soil is contaminated by dogs faeces are important environmental factors (FAO/UNEP/WHO, 1981). Local meteorological factors affect the survival of eggs as well as the activity of the agents concerned in egg dispersal and availability (Wachira *et al*., 1991). Desiccation is lethal (Laws, 1968) and the end points of temperature are of the order of +4°C to –70°C (Gemmell, 1990). The eggs of *E. granulosus* survived for more than 200 days at 7°C, 50 days at 21°C, but less than a week at 40°C (Gemmell, 1977). Agents responsible for egg dispersion into the environment have not yet been fully identified but suggested agents include wind, birds, rainfall, arthropods, and earthworms, as well as animal feet (Gemmell, 1997).

1-13 Dynamics of transmission:

The perpetuation of echinococcosis depends upon the common presence of the parasite and the definitive and intermediate hosts. The continued existence of host and parasite populations

depends upon the fine balance of various interacting regulatory forces (Anderson and May, 1978). Studies on dynamics of host, parasite systems had indicated that such characteristics as over dispersion of parasite numbers within the host population and the development of host immunity act as important stabilizing factors (Anderson and May, 1978). Factors contributing to the dynamics of transmission include intrinsic, extrinsic and socio-ecological factors (Roberts *et al*., 1986).

1-14 Treatment-

1-14-1 Treatment of final hosts:

Arecoline hydrobromide given orally was found to be effective in the treatment of *E. granulosus* infection dogs (Lloyd *et al*.,1991). Praziquantel was found to be extremely effective against both immature and adult stages in dogs (Thakur *et al*., 1978). Total clearance of worms only occurred in dogs given the highest dose (Arru *et al*. , 1990).

1-14-2 Treatment of intermediate hosts:

Ivermectin injected directly into the cysts resulted in cysts collapse and death of protoscolices with ultrastructural changes on the germinal layers. However, this effect was restricted to the ivermectin-treated cysts (Ochieng-Mitula and Burt, 1996, Casado

et al., 2002) .The efficacy of ivermectin and albendazole in combination is much better than either drug when used alone.

Surgery is the treatment that has the potential to remove cystic echinococcosis in human and leads to complete cure (WHO, 1996). However, surgery may be impractical in patients with multiple cysts localized in several organs. It is also a hazardous procedure because spillage of the cyst fluid may cause anaphylactic shock or dissemination of protescolices resulting in secondary hydatidosis (WHO, 1996). Chemotherapy and PAIR (Puncture – Aspiration – Injection - Reaspiration) offer an alternative treatment, especially in inoperable patients and for cases with high surgical risk (WHO, 1996). In PAIR, puncture should be done with precaution under ultrasonic guidance then aspiration of substantial amount of cyst fluid, followed by injection of a protoscolicidal substance and reaspiration of the cyst fluid after 15 – 20 minutes. Chemotheraphy with benzimidazoles (albendazole and mebendazole) for human cystic and alveolar echinococcosis has become more frequently used with significant success. Albendazole was used for multiple cysts, for those not amenable to surgery and also pre-surgically to reduce the risk of recurrence and after surgery (Morris and Taylor, 1988). The response to combined long-term treatment with albendazole and praziquantel was better and much quicker compared to either agent (Morris *et al*., 1990).

1-15 Control of *Echinococcus granulosus*:

A good knowledge of the local epidemiology of echinococcosis is essential to the success of a control programme. It assists in determining the best control polices to pursue (Gemmell, 1997), therefore, any approach to the control of echinococcosis should recognize the multiplicity of interacting extrinsic and intrinsic factors as well as the impact of socioecological factors on the dynamics of transmission.

Options for control include horizontal and vertical approaches. The former emphasizes long-term primary healthcare (education, sanitation and upgrading of meat inspection) with the aim to reduce disease transmission. The vertical approach is targeted to the reduction of the parasite biomass by reducing the tapeworm population (dog-dosing) or reducing the dog population. The vertical approach can be divided into four phases: planning, attack, consolidation and maintenance of eradication (Gemmell *et al*., 2001).

1-15-1 The control in dogs:

The reduction of the total parasite biomass through 6 weekly mass dog dosing with Praziquantel, eradication of unwanted and stray dogs, immunization of dogs against *E. granulosus*, and the regular programme to spay bitches will reduce the infection pressure to humans and livestock. Macpherson and Wachira, (1997), Herd *et al*., (1975) had shown a significant suppression of

egg production in dogs immunized,the infection with secretory antigens derived from adult *E. granulosus* grown *in vitro*.

1-15-2 Safe meat hygiene practices:

Slaughtering of meat animals at abattoirs and destruction of infected organs play a major role in interrupting the transmission cycle. The effective supervision of disposal of condemned offals by burning, boiling or deep burial, forms an important part of echinococcosis control. Dogs should be prevented from entering abattoirs. Illegal slaughtering must be prosecuted and special precautions must be taken when home slaughtering is carried out for social ceremonies (Gemmell *et al*. , 2001).

1-15-3 Health education:

Health education is a basic component of any programme for control of *Echinococcus granulosus* and cystic echinococcosis. It requires the motivation and participation of various population groups and has to take into consideration the beliefs, perceptions, behaviours, expectations, traditional habits, cultural and religious traditions, customs and needs of the people. The educational material should address local problems in order to be effective and have the needed impact on governmental officials, political decision-makers, managers, farmers health professionals, butchers, abattoir workers, dog owners, school-age and other educationally deprived children, field and laboratory workers and every one involved directly or indirectly in a control programme of echinococcosis. The full socio-economic impact which may be considerable in endemic areas has to be brought out clearly in

order to alert the community on the need for control. The educational materials include audio-visual aids (Video films, television programmes), Mass Media, posters, pamphlets, pictures, brochures, colouring books and preserved adult *E. granulosus* and hydatid cysts (Macpherson and Wachira, 1997, Gemmell *et al*., 2001).

1-16. **Vaccination**:

A vaccine, based on a single polypeptide antigen derived from oncospheres and produced in *Escherichia coli* using recombinant DNA technology has been successfully developed for using against *T. ovis* in sheep. This technology has now been successfully applied to *E. granulosus* (Lightowlers *et al*., 2004).

Trials using the recombinant oncosphere antigen vaccine EG95 gave 96–98% protection against experimental challenge of sheep with *E. granulosus.* Protection may last up to 12 months and can be transferred to lambs via colostrum.Trials with natural challenge of vaccinated lambs resulted in similar levels of protection. EG95 vaccine for *E. granulosus* can now be mass produced and has the potential to significantly reduce the time for the attack phase of hydatid control programmes (WHO /OIE, 2001). While considerable research has been undertaken with crude antigens to protect dogs from echincoccosis , no success has been demonstrated so far. Basic research on canine mucosal immunology and *Echinococcus* infection is required for progress (Carlos *et al*., 2006).

Chapter two

Materials and methods

2. Materials and methods

2-1. Study area:

The study was conducted at ElKadaro abattoir in Khartoum state. Khartoum is the capital city of Sudan. Animals come from all or most states of the Sudan in Khartoum to marketing for exports and local consumption. The government owns ElKadaro abattoir which is located at Khartoum Bahari on the Eastern Bank of the Nile. The abattoir provides slaughtering and chilling services for exporters and local meat traders.

The animals examined in this study came from three states in the Sudan. These states are Khartoum, Blue Nile, and Elgedarif. These states are considered one of the most sheep raising areas in Sudan. The population of animals in these states are: 5,274,322 in Khartoum, 1,348,378 in Elgedarif and 832,112 in Blue Nile (PDASS, 2008). The number of sheep estimated in these states about, 2,103,444 in Elgedarif, 3,918,180 in Blue Nile and 438,218 in Khartoum (ELPS, 2009).

Khartoum state is located between the longitude 34.45^{o} to 31.5^{o} *E* and latitude 16.45^{o} to 15. 8^{o} *N.* Its area is about 22,736 Km^{2} approximately. The dominant climate is semi – desert, the mean annual rainfall is 150 ml, the annual minimum and maximum temperature is 22.7^{o}C - 41.1^{o}C respectively. Elgedarif is located between longitude 33.30^{o} to 36.30^{o} *E* and latitude 12.40^{o} to 14.40^{o} *N.* Its area is about 3,362,171 Km^{2}, annual rainfall at area of Northern and North western between 100 to 500 ml and area of eastern and southern between 500 to 900 ml. The climate ranges from poor savanna in the southern to rich savanna

in the eastern. Blue Nile is located between longitude 33º to 35º E and latitude 10º to 12º N. Its area is about 38000 Km² (MMGR).

2-2. Study design and data collection:

The study design was a cross-sectional epidemiological study conducted at the Elkadaro abattoir on four randomly selected days of the seven slaughter days of a week. The days selected are Friday, Monday Wednesday and Thursday. During each of the selected day animals were selected by simple random sampling method. Animals in each group were numbered by ink and then this numbers were recorded in pieces of papers, put in a hat and the recorded number animals were selected.

A total of 192 sheep were examined in the abattoir during the survey period which extended from March to April 2015. During the ante mortem inspection, the age, sex, origin, and body score of each individual animal was assessed and recorded. Animals, depending on their body score, were ranked as poor and good. Animal origin was also recorded as state. Animals were identified on the basis of enumerated marks on their body surface using ink and this marking was transferred to all visceral organs after slaughtering. During the post-mortem examination, a thorough visual inspection, palpation and systematic incision of each visceral organs particularly the liver, lung, kidney, heart and spleen was carried out (Berhe, 2009). Infected organs were taken to the laboratory and all hydatid cysts found in the organs were

collected to conduct cyst count, cystic size measurement, cyst fertility test and viability of protoscoleces.

2-3. Examination of cyst fertility and viability of protoscoleces:

After each hydatid cyst was collected from different internal organs, the cystic wall was penetrated by a needle and opened with scalpel-blade and the contents were transferred into a sterile test tube. The cyst volume was arbitrarily classified into three categories: small: less than 2ml, medium: between 2 and 3 ml and large: more than 3 ml. Based on the presence or absence of broad capsule containing protoscoleces in hydatid fluid, cysts were identified and classified as fertile and infertile. The infertile cysts were further classified as sterile (fluid filled cyst without protoscoleces). To determine viability of protoscoleces, a drop of the sediment consisting of the protoscoleces was placed on a microscopic glass slide and 22×22mm cover slip was applied and observed for the amoeboid-like peristaltic movement (flame-cell activity) with an objective of x 40 (Berhe, 2009).

2-4. Sample size determination

The expected prevalence of hydatidosis in sheep for the calculation of the sample size was taken from the study in Addis Ababa (Ermias *et al*., 2011 .vol.3) according to the study on

prevalence of ovine hydatidosis in sheep the prevalence was estimated about 13.9 %

The following formula was used to calculate the sample size (Martin et al., 1987)

Formula: n = $\frac{4P \times Q}{L^2} \frac{4P \times Q}{L^2}$

Where:

P is the prevalence in sheep = 0.139

Q is 1 – P = 0.861

L is the allowable error = 5% = 0.05

L² = 0.0025

4 × 0.139 × 0.861 ÷ 0.0025 = 191.5 sheep

So number of sheep which will be examined is 192 sheep

2-5. Data analyses:

Results of the study were analyzed using statistical package of social sciences (SPSS). Chi – Square test was used for qualitative data. The significance level was calculated .

Figure (2) **Instruments used for cysts examination**

Figure (3) Dentition and collection of ante mortem data.

Figure (4) Examination of the organs to detect cysts

Figure (5) Examination of slaughtered animals

Figure (6) Hydatid cyst in peritoneum.

Figure (7) Hyadatid cyst in muscle

Figure(8) Hydatid cyst n liver

Chapter three

Results

3. Results

A total of 192 sheep of various ages were examined in this study. The presence of hydatid cysts in various organs was investigated.

The result showed that the overall prevalence is 6 (3.1%)

3-1 Age of animals:

Table (1) showed the age distribution of sheep, 103 sheep were young (age of sheep were less than two year), 89 sheep were old (equals or mor than 2years)

Table (1): Distribution and prevalence of 192 sheep infection by age

Infection	Young (%)	Old (%)	Total (%)
yes	0 (0%)	6 (6.7%)	6 (3.1%)
No	103 (100%)	83 (93.3%)	186 (96.9%)
total	103 (53.6%)	89 (46.4%)	192 (100%)

The result of the study showed that the prevalence of hydatid cyst infection significantly lower in young (less than two year old), compared to adult sheep(equals or more than two years) It was found that of 103 carcasses less than two year ,there is no infection. Of 89 animals old group 6 carcasses were infected (6.7%)

The chi-square test showed significant association between infection and age of animals which is highly significant (p-value 0.007) (table 2)

Table (2) : Association between hydatid cyst infection and ages of animals.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.168	1	.007
Continuity Correction(a)	5.114	1	.024
Likelihood Ratio	9.451	1	.002
Fisher's Exact Test			
Linear-by-Linear Association	7.130	1	.008
N of Valid	192		

Cases			

3.2- Area (state) or origin:

Animals came from three states in the Sudan figure (9) showed distribution of animals by states

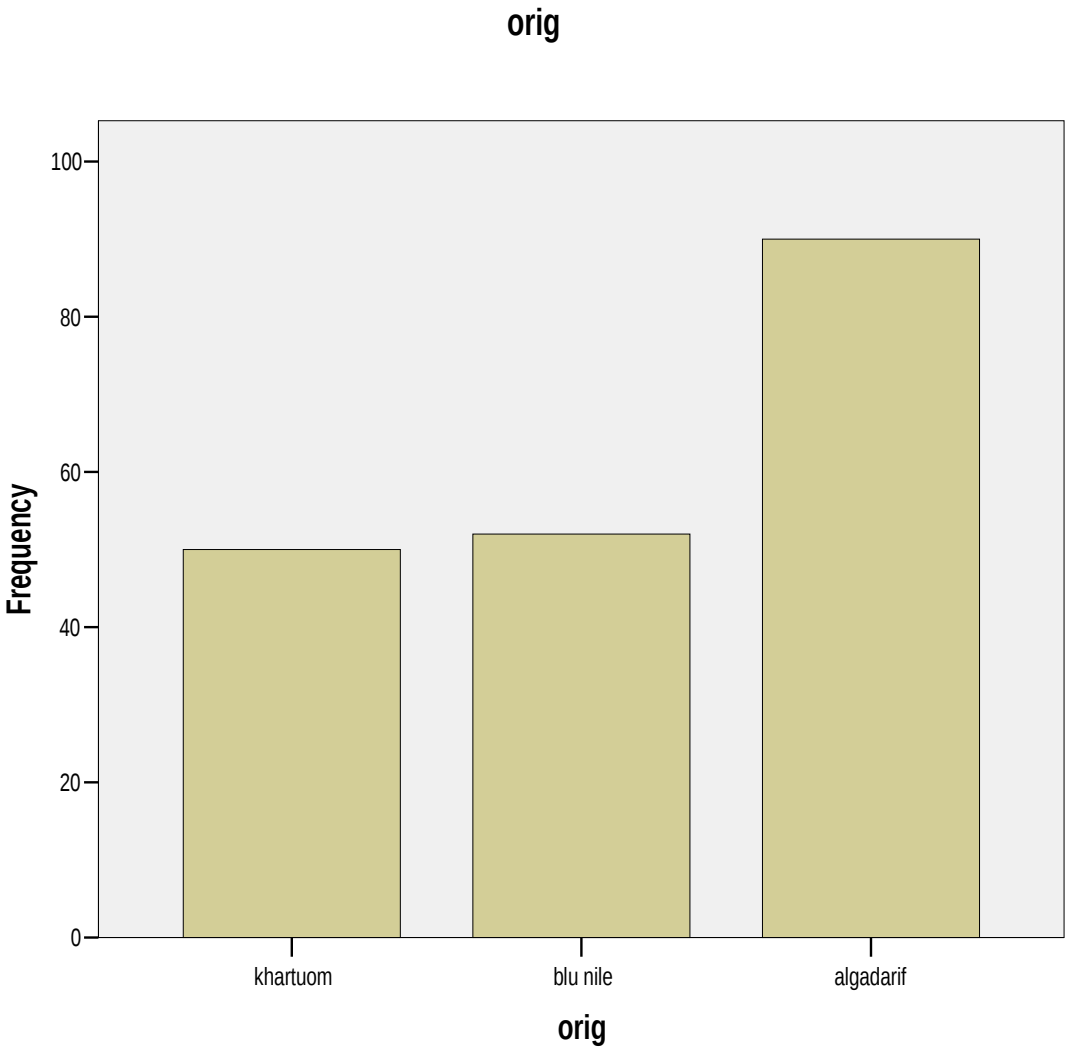


Figure (9) distribution of sheep by states

Table (3) summarizes the number of infected animals with hydatidosis in various states. The highest rate of infection was in Blue Nile state (83.3%), Elgadarif state had an infection rate of

(16.7%) and Khartoum state which showed no positive cases from 50 sheep.

Table (3) : Prevalence and distribution of hydatid cyst infection by origin (state).

Infection		Khartoum	Blue Nile	Elgedarif	percent
Yes		0	5	1	6
percentage		0%	9.6%	1.1%	3.1%
no		50 (100%)	47 (90.4%)	89 (98.9%)	186 (96.9%)
Total		50 (100%)	52 (100%)	90 (100%)	192 (100%)

The result of the study showed that there is highly significant association between hydatid cyst infection and origin of animals (p – value = 0.007) (Table 4).

Table (4): Association between hydatid cyst infection and origin (state) of animal

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.054	2	.007
Likelihood Ratio	9.490	2	.009
Linear-by-Linear Association	.016	1	.901

N of Valid Cases	192		

3 -3 Body score

The body score of animals and the presence of hydatid cysts has been investigated figure (10)

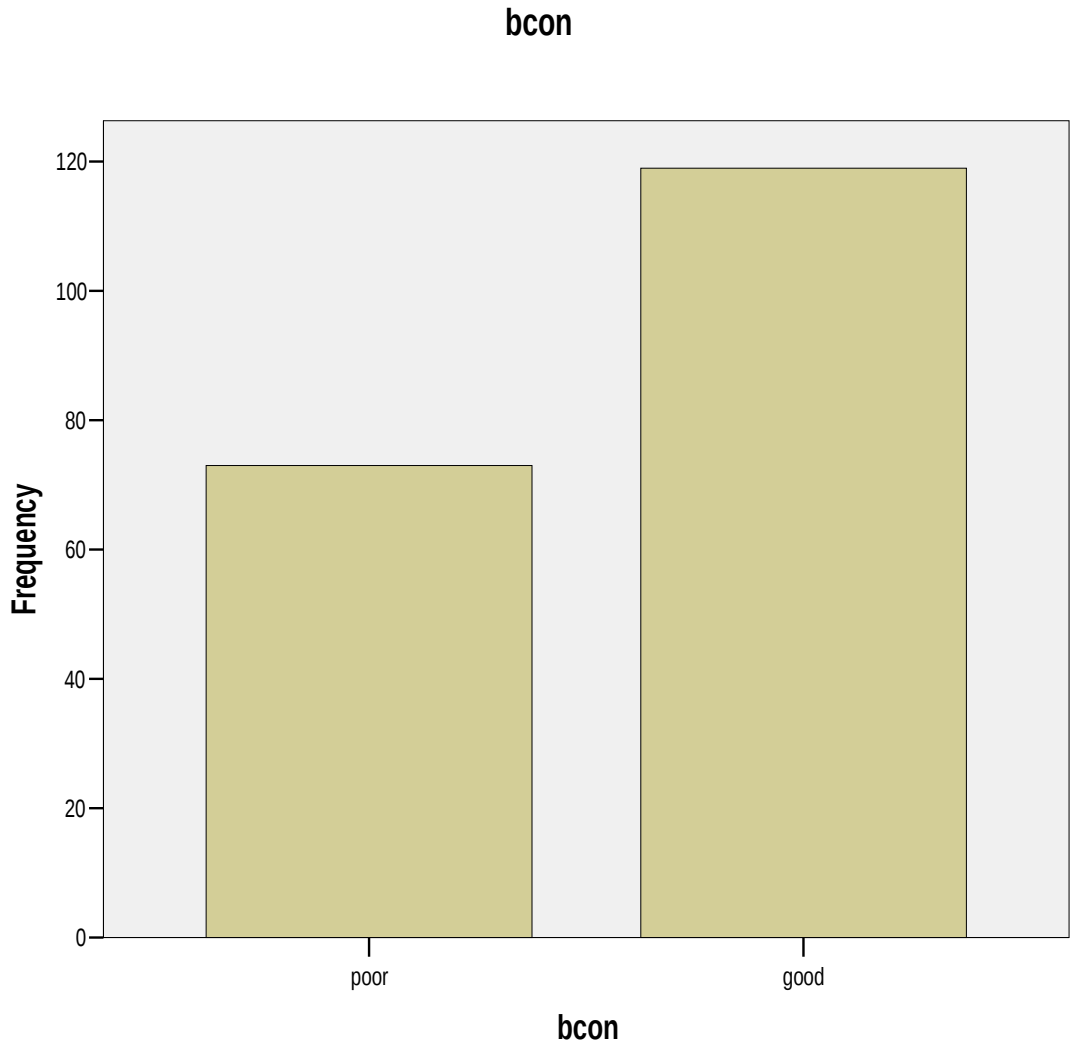


Figure (10).Distribution of sheep according to body score

Hundred and nineteen of sheep were found to be in good condition 62%, and seventy three were found to be in poor condition 38% (Table 5).

Table (5): Prevalence and distribution of 192 sheep examined for hydatid cysts in Elkadaro slaughter house by body score.

infection		Good (%)	Poor (%)	total %
	yes	2 (1.7%)	4 (5.5%)	6 (3.1%)
	no	117 (98.3%)	69 (94.5)	186 (96.9%)
total		119 (100%)	73 (100%	192 (100%)

The Chi-square test showed no significant association between hydatid cysts infection and the body score of animals (p- value is 0.142) (Table 6).

Table (6): Association between hydatid cyst infection and body score

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.157	1	.142
Continuity Correction(a)	1.084	1	.298
Likelihood Ratio	2.079	1	.149
Fisher's Exact Test			
Linear-by-Linear Association	2.145	1	.143
N of Valid Cases	192		

3-4 Sex of sheep:

Of 192 sheep total number of female examined was 163 animals and male was 29 animals,among female 4 animals were found infected (2.45%) and males, 2 animals were found infected (6.9%) (Table7).

Table (7): Distribution of 192 sheep examined for hydatid cysts in Elkadaro slaughter house by sex.

Infection	Male (%)	Female (%)	Total (%)
yes	2 (6.9%)	4 (2.45%)	6 (3.1%)
No	27 (93.1%)	159 (97.55%)	186 (96.9%)
total	29 (100%)	163 (100%)	192 (100%)

Analyzed by the Chi-square test, there's no significant association between hydatid cyst infection and sex of animals, (p – value 0.205) (table 8). However a higher rate of infection was observed in female animals.

Table (8) : Association between hydatid cysts infection and sex of animals.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-	1.605	1	.205

Square			
Continuity Correction(a)	.473	1	.492
Likelihood Ratio	1.283	1	.257
Fisher's Exact Test			
Linear-by-Linear Association	1.597	1	.206
N of Valid Cases	192		

3-5 Cyst location:

The location of cysts in different organs has been investigated. The liver was the most infected organ with hydatid cyst where five cases (45.5%) were found infected. Lung was the second infected organ where three cases (27.3%) were be found infected. muscle had the lowest number where one case (9%) was found be infected. Table 9 summarizes the distribution of hydatid cyst in organs:

Table (9) : Distribution of hydatid cysts infection in sheep by organ.

		Frequency	**Percent**	**Cumulative Percent**
Valid	Liver	5	45.5%	45.5%
	Lungs	3	27.3%	72.8%
	Muscle	1	9%%	81.8%

	liver/lungs	2	18.2%	100.0%
	Total	11	100.0%	

Table 10 shows association between hydatid cyst infection and location in organs. The analysis of cyst location in 11 hydatid cyst cases showed significant association between hydatid cyst infection and location (p-value 0.044)

Table (10): Association between hydatid cyst infection and location of cyst.

	Value	**df**	**Asymp. Sig. (2-**

			sided)
Pearson Chi-Square	8.119	3	.044
Likelihood Ratio	10.602	3	.014
Linear-by-Linear Association	6.857	1	.009
N of Valid Cases	11		

3-6 Number and size of cyst :

Distribution of single and multiple cysts in organs was listed in (table 11). Single cyst have been found in two cases (33.3%). While multiple cyst have been found in four cases (66.6%).

Table (11) : Distribution of hydatid cyst in organs of sheep by number of cyst

	Frequency	Percent	Cumulatine percent
Valid one cyst	2	33.3%	33.3%
Tow cyst	3	50%	63.3%
Three cyst	1	16.7%	100%
Total	6	100%	

3-7 Fertility:

Microscopic examination of cysts revealed a total of 11 cysts, 8 (72.7%) of them were fertile cysts, 2 (18.3%) of them were sterile cysts, and 1 (9%) of them were calcified. Table 12 shows the distribution of 11 hydatid cysts by naturally.

Table (12): Distribution of 11 cysts according to fertility :

Nature of cyst	Number	Percent
Fertile and viable	6	54.5%
Fertile and not viable	2	18.2%
Sterile	2	18.2
Calcified	1	9.1%
Total	11	100%

Table (13): Summary analysis for risk factors of hydatidosis in sheep slaughtered at Elkodaro slaughter house for ante-mortem and psot-mortem investigation using the Ch-square test.

Risk factors	**No .inspected**	**No affected (%)**	**Df**	**X^2**	**p-value**
Origin Khartoum Blu Nile Algadarif	 50 52 90	 0 (0) 5 (9.6) 1 (1.1)	2	10.054	0.007
Age <2 years ≥2 years	 103 89	 0 (0) 6 (6.7)	1	7.168	.007
Body score Poor good	 69 117	 4 (5.8) 2 (1.7)	1	2.157	0.142

Table (13) continued

Risk factors	No .inspected	No affected (%)	Df	X^2	p-value
Location of cyst			3	8.119	.044
liver	192	5 (2.6)			
long	192	3 (1.6)			
long/liver	192	2 (1)			
muscle	192	1 (.5)			
sex			1	1.605	.205
male	29	2 (6.9)			
female	163	4 (2.5)			

Chapter four

Discussion

4-1. Discussion

Echinococcosis is one of the most geographically widespread Zoonotic diseases that occur in all inhabited continents, including sub-artic ,artic, Temperate, subtropical and Tropical zones especially in undeveloped countries and developed countries . The disease is endemic to hyper endemic in agricultural countries of Europe , Northern ,Eastern and Southern African ,Sothern and Northern American middle East and Asia (Matossia *et al*., 1977,Budke *et al*., 2006,2010). Despite all the studies, The real magnitude of the disease in domestic animals, wild animals and man in the Sudan is still need of further investigation . Slaughtered animals may pass through several owners on their way to the slaughterhouse, these create the difficulty to trace infected animals slaughter and poor meat hygiene practices are suggested to be behind the occurrence of hydatidosis observed in this study.

In our study the prevalence of disease in sheep (3.1%) slaughtered in Alkadro slaughterhouse, Khartoum state Sudan.

The prevalance higher than another study carried out in Khartoum state Sudan . The rate of infection in sheep was 1.4% (Sahar and Abdelgadir , 2011).

The prevalence of hydatid cyst infection in this study is, however, similar to the results of other studies in other regions . For example, Algeria: 3.8% (Koudri ***et al***., **2012**), Turkey: 3.15% (Meltem and Erkut, 2007)

.The results are lower than another study carried out in Khartoum state. Sudan from where the rate of infection in sheep was 10.7% (Elnour, 2011). Also in second study carried out in central region of Sudan the rate of infection was 6.9% (Elmahdi. *et al*., 2004).

The prevalence of presence study is lower than the results of other studies in other regions: 9.2% in Kenya (Abby *et al*., 1996), 11.4% in Nigeria (Dada, 1980), 12.9% Jordan (Kamhawi *et al*., 1996), 12.7% Libya (Kassem, 2006), 12.6% Saudi Arabia (Ibrahim, 2010), 9.1% in Palestine (Jehad, 2009). 16.4% in Ethiopia (Tekelye *et al*., 1987), 20% Jordan (Anwar, 2005), 19.9% Addis Ababa (Kebabe, 2010), 17.1% Tanzania (Mellau *et al*., 2010), 29.3% Oromia, Ethiopia (Getaw *et al*., 2010) 74% Iran (Daryani *et al*., 2007), and 75% in Italy (Scala *et al*., 2005).

This difference in the prevalence of hydatid cyst infection could be attributed to the variability of the following: origin of animals, mode of grazing, presence of the definitive host (carnivore), degree of contamination with parasite and other environmental factors such as periodical destruction of dogs and other carnivores, improved standards of meat inspection, overall improvement in socio-economic condition, hygienic status of sheep herds, variation in the temperature, environmental conditions, the nature of the pasture and the way of raising of these animals.

The prevalence of hydatid cyst infection by origin (states) has been investigated in this study. The rate of infection in Blue Nile

state was 9.6 %, in Elgadarif state was 1.1%, and Khartoum state was 0.% . There is significant association between the hydatid cyst infection and origin (state) of the animals (p-value = 0.007). The higher rate of infection was in Blue Nile (9.6%) fallowed by Elgadarif state (1.1%). The reason behind this could be of geographic reasons, outdoor rearing in open grazing areas, dense dog population (sheep dogs and wild carnivores), no central abattoirs and there is no hygienic elimination of sheep's offal which leads to environmental parasite contamination. In Elgadarif state the rate of infection was 1.1%, the situation is similar to the Blue Nile state but most of the animals investigated from the Blue Nile state were young sheep (less than one 2year). Khartoum state had no infection found in examined sheep (0%), this could be attributed to the official hygienic slaughtering, more knowledge about anthelmentic dosage, hygienic condemnation of infected organs and indoor rearing of animals.

Age of animals is another factor investigated in this study. Our study showed that the rate of hydatid cysts infection was 0% in age of less than 2year, and 6% in age of equals or more than 2years old. Our study showed significant association between hydatid cysts infection and age of the animals examined (p-value = 0.007) which is highly significant. These results are consistent with other studies regarding young animal low rate of infection than adult animals. In Addis Ababa, the rate of infection in age groups was: 0% in the age group of less than one year, 18.8% in age of 1 – 2 years old, 37.5% in age of >2 – 3 years old and

39.3% in age of > 3 years old (Kebebe *et al*., 2010), in Turkey, the prevalence was 2.64% in age group < 1 year and 31.8% in > 1 – 6 years old (Meltem *et al*., 2007). This finding is not surprising due to the fact that hydatid cysts infection is a chronic disease, the higher age reflects a much longer period of exposure to infection. The chances of detecting cysts at meat inspection are higher in aged animals due to the bigger size of the cysts. Also the older animal cysts have more time to enlarge and transport cysts to the other organs. In our survey 6 of sheep mor than 2 years of age were found positive, with infection rate of 6%. An Echinococcus egg, in general, requires at least 6 – 12 months before the hydatid cyst stage grows sufficiently to produce protoscolices capable of infecting the carnivore host (Urquhart et al. 1996). Although our results are still consistent with the previous study (Urquhart *et al*., 1996).

Our study showed that male sheep have higher rate of infection than females sheep, the rate of infection in males animals was 6.9%, while in female animals was 2.45%. However, there was no significant association between hydatid cyst infection and sex of animals (p-value = 0.205). This is not similar to the reported results in Turkey which is 4.50% in female and 1.82% in male sheep (Meltem *et al*., 2007), in Iran which is 76.1% in female and 24.8% in male sheep (Daryani *et al*., 2007). There is no significant association was observed between sex and hydatid cyst infection in this study. This could be attributed to the fact that both male and female animals graze together on the same pasture.

The results of our study showed that the prevalence of hydatid cyst infection within different body score of the animals was: 1.7% in good body score, 5.5% in poor body score. However, there was no significant association between hydatid cyst infection and body condition of animals (p-value = 0.142) this could be attributed to the fact that hydatid cysts infection is a mild disease which may not affect the general health of the affected animal.

The prevalence of hydatid cyst infection relation to the location of cyst in animals was 45.5% in liver, 27.3% lung , 9% in muscle and 18.2% in both liver and lung while theirs significant association between hydatid cyst infection and location of cysts (p-value = 0.044). The liver in our study was the most affected organs. These finding were similar to the observations reported in Iran (Fakhar and Sadjjadi, 2007),Turkey (Meltem *et al*., 2007), and Libya (AL-Khalidi, 1998), but did not coincide with other carried out in Iran (Daryani *et al*., 2007), and (Esfandiari and youssefi, 2010), and Uruguay (Oku *et al*., 2004), where lungs were the most predominant affected organs. The liver was the most common site of infection in sheep, and lungs came in the second place in the present study. This is could be mainly due to the fact that the liver is the first organ supply with blood after leaving the intestine. Therefore most of the oncospheres hatched in the intestine are filtered in it,and also passed to the lungs then to other organs (Soulsby, 1982).

Fertility of the cyst is an important factor that can affect stability of *E. granulosus* cycle depending on geographical situation, kind of infected host, site and size of cyst. In this study the fertility was 72.7%, which is lower compared to that has been observed in Iran (76%) (Daryani *et al*., 2009), Libya (79.2%) (AL-Khalidi, 1998), but higher compared to that observed in Iran (68.5%) (Daryani *et al*., 2007), Kenya (70.5%) (calum, 1985), Nigeria (59.7%) (Dada, 1980), Jordan (38.1%) (Kamhawi *et al*., 1996), Tanzania (48.8%) (Emest *et al*., 2009), Saudi Arabia (47.6%) (Ibrahim, 2010), Uruguay (7.3%) (Oku *et al*., 2004), and in Turkey (4.05%) (Meltem and Erkut, 2007). The high rate of fertile cysts and small-sized cysts in our study could be due to the high contamination of pasture by the eggs of *E. grranulosus* and low use of antiparasitic and anthelmentic drugs, Such as Ivermectine, Albendazole, Febendazole, and other drugs used for long period before slaughtering to increase sheep weight. In our survey the majority of slaughtered animals were reared outdoors on open pastures and there is a strong practical relationship between animal offal and scavenging dogs.

4-2. Conclusions:

The output of this study indicates that the overall prevalence of hydatid cysts was 3.1%. This prevalence is in agreement to the results study carried out in Turkey 3.15% (Meltem and Erkut, 2007) and Algeria 3.8% (Koudri *et al*., 2012) .

The distribution of the prevalence of hydatid cysts infection by age showed that the prevalence in old animal is higher than in young animals, (6.7% in old animals (≥ 2) and 0% in yang animal (< 2 year).

For body score, the prevalence is high in animals in poor body score (5.5%) and low in animals in good body score (1.7%). The prevalence of hydatid cyst infection was 2.45% in females and 6.9% in males .The infection was higher in Blue Nile state (9.6%) and no infection in Khartoum state. The liver was found to be the most affected organ, with prevalence of 45.5% and the least affected was the muscle (9%). Using the Chi-square, analysis showed a highly significant difference regarding the location of the hydatid cysts.

The Microscopic examination of the hydatid cysts, showed that 72.7% of cysts were fertile, 18.3% of cysts were sterile and 9% of cysts were calcified. The viable cysts from fertile cysts was 75%. Regarding the volume of cysts 5 (45.5%) of cysts were 2 – 3 ml, 4 (.36.3%) were < 2 ml and 2 (18.2%) were > 3 ml.

4-3 Recommendations:

Further determination of ovine hydatidosis and the existence of *E. granulosus* in the area and molecular characterization of cycling strains are necessary.

2. Further investigation of risk factors associated withovine hydatidosis.

3. Initiation of control campaign in the area and concentration on mass educational programs and treatment of animals with anti-parasite medicines.

4. Regular monitoring programs that lead to disease control strategy which required reducing the economic impact and public health consequences of hydatidosis.

5. Preventing illegal slaughtering and preventing rambling dogs access to the field of slaughter houses.

6. Public health education through media, and teaching livestock holders and people who at risk about periodic epidemiologic investigations.

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