INTRODUCTION

Background:

Hydatidosis is one of the important zoonotic parasitic diseases caused by the larval stage of the genus *Echinococcus*, the tape worm of dogs. The disease is cosmopolitan in distribution. Seven species of the genus *Echinococcus* have been explored including *E. granulosus, E. multilocularis, E. vogeli, E. oligarthus* , *E. shiquicus E. equines* and *E. ortleppi* wile *E. granulosus* is the most important and widespread. Cystic hydatidosis, caused by the metacestode of *Echinococcus granulosus* is one of the most common zoonotic diseases associated with huge economic losses and public health significance worldwide (Romig *et al.* 2011). Dogs and other carnivores that harbour the adult cestode in their small intestine are the definitive hosts for the parasite, while a wide range of mammalian species including domestic ungulates and man act as intermediate hosts (Kumsa 1994). Consumption of offal containing viable hydatid cysts results in infection of definitive host carnivores including dogs that void eggs in their feces contaminating the environment. The adult tapeworm in the definitive dog host is harmless unlike the hydatid cyst in the intermediate hosts that is responsible for immense economic and health hazard in infected hosts (Azlaf and Dakkak 2006; Battelli 2009; Ibrahim 2010). Food animals such as sheep, goats, cattle, camels, buffaloes, and pigs acquire the infection by ingestion of infective eggs with contaminated grass and water. Man is infected incidentally on ingestion of infective eggs in contaminated water, vegetables, or other food or through direct contact with the dog. Upon ingestion, the oncospheres penetrate the intestinal wall and reach visceral organs such as the liver, lungs, heart, and kidneys of animals and humans to develop to hydatid cysts (Fakhar and Sadjjadi 2007). The major economic impact caused by cystic echinococcosis in food-producing animals are losses in productivity such as reduction in carcass weight, milk production, fleece and wool value, fertility, hide value, birth rate and fecundity, delayed performance and growth, condemnation of organs especially liver and lungs, costs for destruction of infected viscera, and dead animals (Sariozkan and Yalcin 2009; Ibrahim 2010; Romig et al. 2011). The prevalence, economic and public health impact of cystic hydatidosis is higher in rural communities of developing countries where there is close contact between dogs, intermediate host species, and man (Ibrahim 2010; Romig *et al.* 2011). The most common production practices that increase the prevalence and the risk of exposure of domestic animals to cystic echinococcosis are traditional systems of raising animals (extensive or semi-extensive grazing), widespread backyard slaughtering of animals, absence of rigorous meat inspection procedures, improper disposal of dead animals, keeping a large number of dogs, failure to treat dogs with anthelmintics, habit of feeding dogs with condemned offal and the subsequent contamination of pasture and grazing fields, and grazing of animals in communal fields where stray dogs have free access (Garippa *et al.* 2004; Ibrahim 2010; Romig *et al.* 2011).

History:

The presence of hydatid cysts in both humans and animals was well known in ancient times, and was described in the works of Hippocrates in the 4th century AD and Arataeus and Galen in the 1st and 2nd centuries AD, respectively. However, it was not until the 17th century that the parasitic natures of these cysts were recognized by Francisco Redi. In 1766 German Pierre Simon Pallas formulated the hypothesis that hydatid cysts were larval stages of tapeworms, and then later in 1853 Carl von Siebold demonstrated that cysts from sheep lead to adult tapeworms in dogs; however it was another decade later until Bernhard Naunyn recognized that the adult tapeworms directly develop from hydatid cysts. Full understanding of the clinical features of this disease came about in the late 1800's, which progressed to the development of immunological diagnostic tests by the early 1900's. Surgical techniques to remove cysts were first attempted in the 1600's, which has proven to be an effective treatment that has evolved with medical technology.

The life cycle:

The parasite's life cycle is almost exclusively domestic, involving dogs as definitive and ungulates (mainly sheep and cattle) as intermediate hosts (Palmer *et al.* 2011).

However, wild canids (dingoes, wolves, jackals, coyotes, red foxes, etc.) can also be involved in the transmission cycle in some areas (Jenkins and Morris, 2003; Jenkins and Macpherson et al, 2003). This transmission is responsible for the sylvatic echinococcosis cycle. The outcome of infection in livestock is hydatid cysts developing in the lung, liver or other organs (Jenkins *et al.*, 2005).

Echinococcus species have an indirect life cycle and must develop in both an intermediate and the definitive host. In many cases, the parasite cycles through the specific predators, scavengers, and its preys. The dog-sheep cycle is most likely to result in human infections. Other cycles include dog-camel, dog-horse, wolf-deer and coyote-deer. Under suitable conditions, *E. granulosus* eggs remain viable for several months in pasture and on house hold items. *E. granulosus* eggs can survive for weeks under a variety of temperature ranges but they cannot survive for a long time when exposed to direct sunlight and dry conditions. The intermediate hosts which include cattle and humans are infected by ingestion of eggs within the faeces of the definitive host. The eggs may also be found on foods such as vegetables, fruits or herbs, or in contaminated water. They can also stick to hands when a person handles an infected dog, cat, wild animals or their carcasses, wile may then be transferred to the mouth via the hands. Parasites can develop in a variety of organs in the intermediate host but are often found in the liver and lungs. The cysts grow slowly. Most cysts are discovered in humans when they are 1 to 7mm in diameter but they eventually reach 20cm in diameter. In primary echinococcosis, hydatid cysts develop in various sites from oncospheres after ingestion of *E. granulosus* eggs. In secondary echinococcosis, larval tissue spreads from the primary site and proliferates after spontaneous or trauma-induced cyst rupture or after release of viable parasite material during invasive treatment procedures (da Silva *et al,* 2010). Each cyst is filled with fluid and is surrounded by a fibrous laminated outer membrane and an inner membrane called the germinal layer. Brood capsules develop from the germinal membrane. Each brood capsule contains several invaginated heads (protoscoleces) that can develop into an adult worm if they are ingested by the definitive host. Some protoscoleces float freely and are known as "hydatid sand". The hydatid sand has the potential of developing into new cysts. Some cysts are sterile and either never produce brood capsules, or they become sterile after bacterial infection or calcification. The percentages of sterile cysts vary with the intermediate host and play a vital role in transmission of the disease. Sheep and numerous ungulates (goats, swine, and cattle) are intermediate hosts of CH, harbouring the hydatid cyst (Euzeby, 1991; Garippa *et al.*, 2004). Pigs are infected by different genotypes of *E. granulosus* (Bowles and McManus, 1993; Eckert *et al.*, 1993). Studies on the strain specificities of *E. granulosus* in Tunisia showed that the sheep strain (G1 genotype) was present in sheep, cattle, camels and humans (Lahmar *et al.*, 2004) and that the camel strain (G6 genotype) was only present in camels (M'Rad *et al.*,

2005) with fertile ovine, bovine and cameline cysts being a reservoir for dogs and other canids. These protoscoleces in the organs of intermediate hosts may remain viable for up to 36 days depending on ambient temperatures and relative humidity (Diken *et al.*, 2007). Accidentally, eggs ingested by humans and other “aberrant” hosts may not play a role in the natural cycle. Whereas the infection of carnivores with immature or mature intestinal stages does not cause morbidity, the invasion of various organs (mainly liver and lungs) of the intermediate or aberrant hosts by metacestodes can cause severe and even fatal echinococcosis (Eckert and Deplazes *et al*, 2004). An important factor influencing the persistence and spread of *E. granulosus* infection is the infection of dogs by ingestion of the viscera of infected sheep. Larval/hydatid cyst stage from the embryo released from an egg develops a hydatid cyst, which grows to about 5–10 cm within the first year and is able to survive within organs for years (Mandell *et al*, 2010). Cysts sometimes grow to be so large that by the end of several years or even decades, they can contain several litres of fluid. Once a cyst has reached a diameter of 1 cm, its wall differentiates into a thick outer, non-cellular membrane, which covers the thin germinal epithelium. From this epithelium, cells begin to grow within the cyst. These cells then become vacuolated and are known as brood capsules, which are the parts of the parasite from which protoscoleces bud. Often, daughter cysts will also form within cysts (David and Petri *et al*. 2006). *Echinococcus* adult worms develop from protoscoleces and are typically 6mm or less in length and have a scolex, neck and typically three proglottids, one of which is immature, another of which is mature and the third of which is gravid - or containing eggs (David and Petri *et al,* 2006). The adult worm only develops to maturity in the definitive host. The scolex of the adult worm contains four suckers and a rostellum that has about 25-50 hooks.

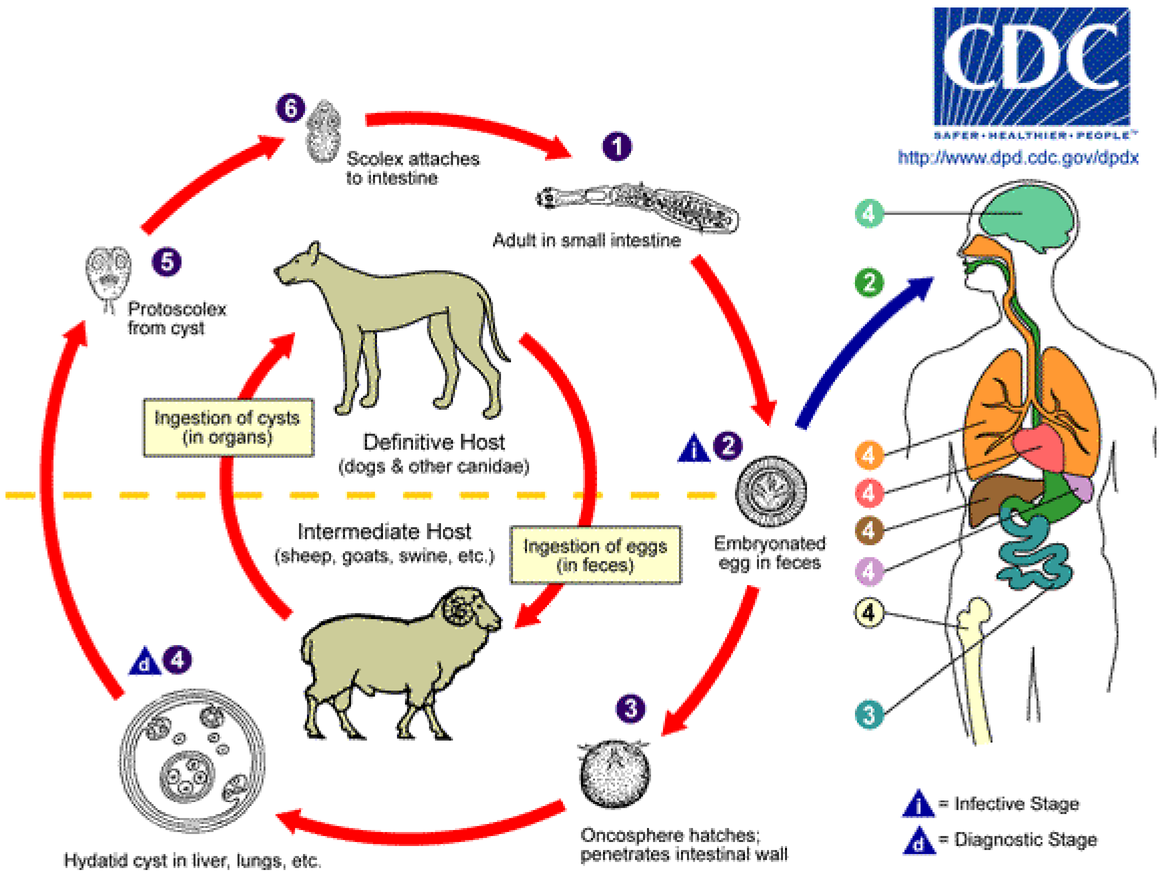

Figure 1: Life cycles of *Echinococcus granulosus*. *(Source: CDC http.www.dpd.cdc.govldpdx).*

Disease description:

The disease does not produce any clinical signs in animals and is usually only discovered during meat inspection at the slaughterhouse where the viscera (mainly liver and lungs) are condemned (Eddi *et al.*, 2004). In humans the cyst can reside and grow in the liver, lung and other visceral organs. The pathogenecity of hydatidosis depends on the extent and severity of infection and the organ on which it is situated. Occasional rupture of hydatid cysts often leads to sudden death due to anaphylaxis, haemorrhage and metastasis (Getaw *et al.*, 2010).

Justification:

Echinococcosis is an important disease but it is a neglected public health problem in Africa, especially in rural communities. In Algeneina, hydatidosis may be one of the major infectious zoonotic diseases because in most abattoirs, animals are still slaughtered traditionally and carcass wastes are easily accessible to scavenging dogs and other wild carnivores, this occurs because they roam freely and in large groups as there are no control programs for killing stray dogs by veterinary services. This study was conducted because the problem was not investigated by previous workers in El-geniena. The investigation was undertaken to determine the magnitude and spread of hydatidosis among slaughtered animals and breed of animals infected with hydatid cyst disease. Since the animals share the same life cycle as man, the determination of the prevalence of the disease in El-geniena becomes very important in order to explore the size of the problem that will help in controling the disease.

Objectives:

The objectives of this study were:

1\ To estimate the prevalence of sheep hydatidosis in Elgeniena, West Darfur state.

2\ To investigate potential risk factors associated with the disease.

Literature review

1.1Classification:

According to Solusby (1982) *E. granulosus* was classified as follows:

Kingdom: **Animalia**

Phylum: **Platyhelminths**

Class: **Eucestoda**

Order: **Taenidea**

Family: **Taenidaea**

Genus: ***Echinococcus***

Species: ***E. granulosus***

Subspecies: ***E. gr.granulosus, E. gr.canadesis***

1.2 Etiology:

Actually, six species of *Echinococcus* have been recognized, but the most important members of the genus in respect of their public health importance and their geographical distribution are E. *granulosus* which causes cystic echinococcosis and *Echinococcus multilocularis* which causes alveolar echinococcosis. Infection with *E. granulosus* results in the development of one or several unilocular hydatid cysts that in humans develop mainly in the liver (70%), but also lungs (20%) and 10% of cysts can occur almost anywhere in the body (e.g., brain, body musculature, wall of the heart, kidneys, orbit of the eye, marrow cavity of bones). *E.*

multilocularis metacestodes develop as a series of small, interconnected cysts, growing as a metastasising lesion almost exclusively in the liver (98%-100%), but in the later phase of infection distant metastases in other organs may occur.

1.3 Morphology of cyst:

Morphologically adult *Echinococcus* is only a few millimeters long (rarely more than 10 mm) and usually has no more than six segments (Soulsby *et al.*, 1982). Anteriorly, an adult echinococcus possesses a specialized attachment organ. The scolex that has four muscular suckers and two rows of hooks, one large and one small; on the rostellum, the body or strobila is segmented and consists of reproductive units (proglotids), which may vary in number from two to six (Terefe *et al.*, 2012).

(A) **(B)**

Figure 2: Hydatid cysts in lung (A) and liver (B)

(El-Ibrahim, 2009).

1.4 Diagnosis:

1.4.1. Parasitological methods

In cattle, diagnosis of cystic echinococcosis is mainly through post-mortem findings during meat inspection. The most reliable method for diagnosis of *Echinococcus* spp. in definitive hosts is by necropsy, because worm burdens can be accurately estimated and parasites collected for identification (Eckert *et al*., 1997). However, necropsy usually results in a biased sample, in that only unwanted dogs can be necropsied.

Faecal examination does not differentiate *E. granulosus* from other taenid species and thus cannot be used to differentiate *E. granulosus* in dogs and other definitive hosts. The morphology of taenid eggs is similar and therefore it is very difficult to differentiate on the basis of presence of eggs in faeces of dogs and other intermediate hosts.

1.4.2. Immunodiagnostic techniques

In 1980s an immunological method for detecting circulating antibodies against *E. granulosus* in serum was devised (Jenkins and Rickard *et al*., 1986). Specific circulating antibodies against *E. granulosus* were readily detectable in dogs raised worm-free and mono-specifically infected with *E. granulosus* in Australia, but in populations of rural dogs in Kenya with natural infections of *E. granulosus* and other cestodes, detection of antibodies was unreliable (Jenkins *et al*., 2005). The presence of antibodies in serum did not mean that the dog was infected at the time of testing because the antibodies against taenid cestodes remain detectable for weeks or months after worms have been lost (Jenkins and Rickard *et al*., 1985). In the early 1990s, an immunological method of detecting (coproantigens) released in the faeces of tape-worms infected definitive hosts was reported independently in England and Switzerland (Allan and Craig, 1989; Deplazes *et al*., 1990). This method was adapted to detect Coproantigen of taenid cestodes including *E. granulosus* (Deplazes *et al*., 1990; 1992).

1.4.2.1. Coproantigen detection ELISA diagnostic test

In dogs, diagnosis of *Echinococcus* species using coproantigen-detection ELISA method has a number of advantages over the use of Arecoline purgation as a diagnostic test. Among the advantages is that the coproantigen-detection by ELISA it has easier sample collection, faster to do, and requires less personnel. These factors make it suitable for surveillance of large dog populations (Abbasi *et al*., 2003). Faecal samples for coproantigen testing can be collected in the field for some dogs hence eliminating the need of transporting the dogs to specific locations, unlike Arecoline purgation which requires taking dogs to specific purge sites and concentration of dogs in specific locations (Lopera *et al.*, 2003). The other advantage of coproantigens test is that it enables early detection in the course of infection (Jenkins *et al.*, 2000; Lopera *et al*., 2003). The important advantage of coproantigen test over the antibody detection is that those coproantigen-positive dogs are infected at the time of the testing, Coproantigen become undetectable a few days after removal of *E. granulosus* (Jenkins *et al.,* 2000) and the test can be carried out at room temperature. The coproantigen test can be used to test *E. granulosus* in wild carnivores which are not easy to capture. The detection of coproantigen of *E. multilocularis* has been performed in wild fox populations in Japan (Sakai *et al.*, 1998).. An interesting approach was described by Nonaka *et al*. (1996), who developed a sandwich ELISA based on a polyclonal capture antibody against excretory/secretory antigens of intestinal stages of *E. multilocularis* and a monoclonal detecting antibody (Kohno *et al*., 1995) directed to a homologous antigen. This assay can detect coproantigen in material from heat treated (70°C for 12 h) or formalin-fixed (1%) fecal samples. However, variable results have been obtained in various laboratories with formalin-fixed material. Crude cystic fluid which has been used as antigen for serological diagnosis in cattle (Golassa *et al.*, 2011) , this was not as sensitive as the post-mortem method due to the fact that CE may not in some cases elicit an immune response in the host and thus some infections could be missed.

1.4.3. DNA technology (PCR)

Great potential for diagnosis of canine echinococcosis has been shown by DNA amplification through the development of stool based polymerase chain reaction (PCR) (copro-PCR) tests for both species-specific and strain-specific pre-patent and patent detection of adult *E. granulosus* infections (Naidich *et al.*, 2006; Zhang *et al.*, 2003). Mitochondrial DNA-based detection of *Echinococcus* species has been shown to be an excellent tool for analysis of strain/genotypic variation in the genus, determining phylogenic relationship and informing taxonomic species questions (Thompson and McManus *et al*., 2002).

1.4.4. Ultrasound imaging technology (US)

Ultrasound imaging has been used in small ruminants like sheep in some studies and followed up with post-mortem examination.

1.5 Treatment:

Hydatid cyst is difficult to treat and, even more so, to cure for a number of reasons. The disease is complex and dynamic with an evolving phase and quietly growing cysts. Clinical management of hepatic cysts includes albendazole or mebendazole therapy in combination with either surgical resection or the PAIR procedure. Larger cysts (diameter >10 cm) preferably undergo surgical resection (Bek\cci *et al*., 2012). During 1984–1986, the World Health Organization took an early initiative and established two multicenter studies in Europe to directly compare albendazole and mebendazole, using a single standard protocol. Mebendazole and albendazole are the two most commonly used drugs to treat infection with hydatid cysts. Multiple studies have shown albendazole to be superior to mebendazole in efficacy. A small prospective study has shown that combining albendazole with percutaneous drainage results in better outcomes (Bek\cci *et a*l., 2012).

In animal experiments, it has been shown A efficacy of mebendazole against *Echinococcus* metacestodes was positively correlated with drug concentration in the serum and duration of treatment, Albendazole was given orally to sheep with naturally occurring live pulmonary and hepatic cysts. The viability of pulmonary cysts was established before treatment by thoracotomy and needle puncture. Both 10 and 20 mg/kg bwt/day doses were found effective in that no viable protoscoleces were found after six weeks' treatment in either group while untreated controls still had viable cysts. In addition, treated animals showed macroscopic and electron microscopic changes. However, bone marrow toxicity had probably occurred in two sheep (Morris *e*t *al.*, 1985)

1.6 Control:

At present, conventional control measures consist of: 1) educating the rural population about hydatidosis and its control; 2) centralizing the slaughtering of animals for food in units with veterinary control; 3) ensuring sanitary conditions for slaughtering done on ranches and preventing dogs' access to raw viscera; 4) reducing the number of dogs on the ranches and treating them for *Echinococcus* on a regular basis. A fifth measure has recently been added: looking for human hydatidosis during primary health care visits. This has made it possible to diagnose many unsuspected cases and interest the population in the control campaign. Recently, joint and coordinated implementation of these health measures, both medical and veterinary, has resulted in noteworthy improvement in the results of the control campaigns .Observations in Bulgaria also indicate that, even if complete eradication is achieved, control activities should continue to ensure that the infection does not recur. The annual incidence of human hydatidosis in Bulgaria in 1950–1962 was 6.5 per 1,000 inhabitants; that provided the impetus for a control campaign from 1971 to 1982, which decreased the figure to 2 per 100,000. Administrative and economic problems between 1983 and 1995 necessitated suspension of the control measures, and the incidence returned to the previous levels (Todorov and Boeva, 1999). In Peru, suspension of the control programs in a hyperendemic area was associated with a five-fold increase in the incidence of the human infection (Moro *et al*., 1997).

1.7 Geographical distribution:

Echinococcus granulosus has a world-wide geographic range and occurs in all continents including circumpolar, temperate, subtropical and tropical zones (Craig *et al.*, 1996; Schantz *et al.*, 1995). The highest prevalence of the parasite is found in parts of Eurasia, Africa, Australia and South America. Within the endemic zones, the prevalence of the parasite varies from sporadic to high, but only a few countries can be regarded as being free of *E. granulosus.* The worldwide distribution of the disease is partly due to the easy adaptability of the parasite to several domestic and wild Intermediate hosts (Bhatia *et al*., 1997). Actually, this wide spectrum of intermediate hosts seems to correspond to genetic variability among *Echinococcus granulosus* strains which can be assessed using nuclear and/or mitochondrial genotypic methods (Raether and Hanel, 2003; Eckert and Deplazes *et al*., 2004). *E. granulosus* is present virtually worldwide since there are very few countries that are considered to be completely free of *E. granulosus.* An important fact to keep in mind is that the areas of the world where there is a high incidence of infection by *E. granulosus* often coincide with rural, grazing areas where dogs are able to ingest organs from infected animals.

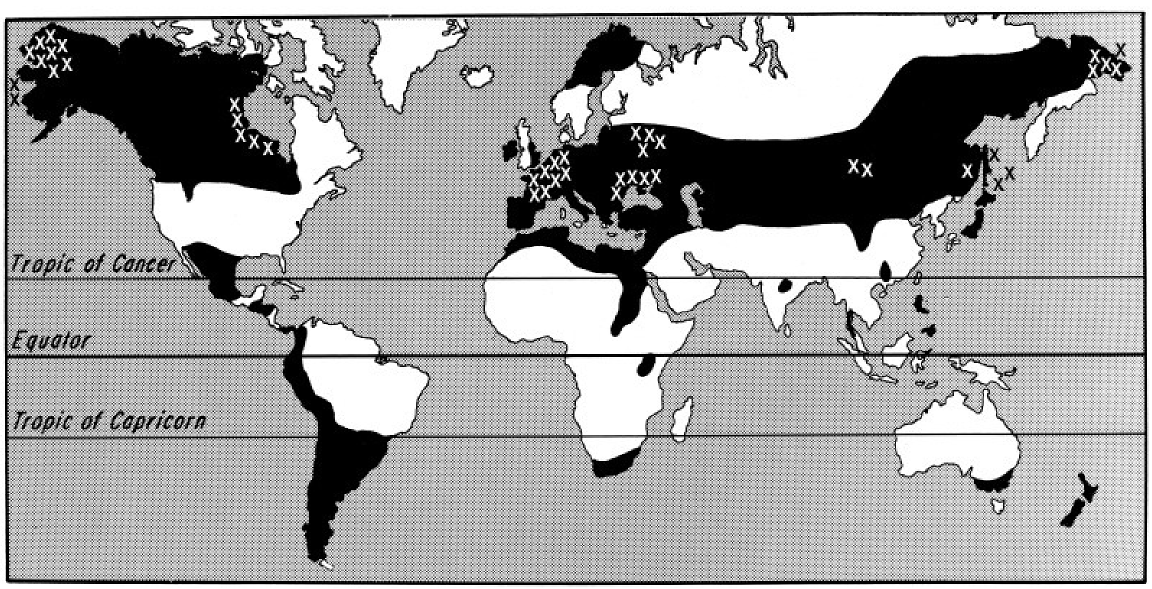

Figure 3: Global distribution of *E. granulosus* (black) and *E. multilocularis* (x).

Source:TMCRhttp://tmcr.usuhs.mil/tmcr/chapter3/geographic .htm)

1.8. Zoonotic importance and risk factors

Cystic echinococcosis is a public health problem in different geographical areas of the world, particularly in Asia, South America, Central America and Africa (McManus and Smyth *et al*. 1986). Spain and other Mediterranean countries are considered as hyper endemic areas (McManus and Thompson *et al*., 2003). *E. granulosus* of carnivores and its metacestode in herbivores and man have been recognized as the most important helminth zoonosis and of great economic and public-health significance in developing countries (Eckert *et al*., 1981). Echinococcosis due to *E. granulosus* which occurs at high prevalence in both dogs and livestock and also accounts for the highest number of condemned lungs in slaughterhouses is of major public health concern in Zambia (Pandey and Sharma, 1987). Dogs are the most successful canids adapted to human habitation world-wide (Robertson *et al.*, 2000; Dohoo *et al.*, 1998; Ugbomoiko *et al.*, 2008). They have contributed to physical, social and emotional well-being of their owners, particularly children who are often at greatest risk of exposure. However, despite the beneficial effects, close bonds of dogs and humans (in combination with inappropriate human practices and behaviour) remain a major threat to public health, with dogs harbouring a bewildering number of infective stages of parasites (including *Echinococcus*) transmissible to man and other domestic animals (Molyneux *et al*. , 2004; Ugbomoiko *et al.*, 2008). Certain deep-rooted traditional activities have been described as factors associated with the spread and high prevalence of the disease in some areas. These factors include; the wide spread backyard slaughter of animals, the corresponding absence of rigorous meat inspection procedures, the long standing habit of feeding domesticated dogs with condemned offal and the subsequent contamination of pasture and grazing fields (Getaw *et al.*, 2010). This can facilitate the maintenance of the life cycle of *Echinococcus granulosus* which is the causative agent of cystic hydatidosis and consequently the high rate of infection of susceptible hosts (Biffa *et al.*, 2006). Risk factors for human hydatidosis include: a pastoral occupation, a history of dog ownership, poor education background, eating habits, age, sex and drinking water source (McManus *et al.*, 2003).

1.9. Economic importance

Echinococcosis in humans and animals is both an economic and public health problem in many parts of the world (Budke *et al.*, 2005; Moro and Schantz *et al*, 2006). For example, in the North African countries, the cost to human health treatment and animal losses was estimated at US$ 60 million per year (Budke *et al.*, 2006; Moro and Schantz, 2006). In Jordan alone, a more recent estimate was reported at an equivalent of twenty one million US$ dollars (Conteh *et al.*, 2010). Hydatidosis in animals is equally an economic problem and results in growth delays; the qualitative and quantitative production loss of meat, milk, wool; the fall in fertility as well as the seizures of viscera (offal) during meat inspection (Torgerson and Budke, 2003; Torgerson *et al.*, 2000). In Uruguay, the annual losses were estimated at US$ 6.2 million from the organs seizure and the loss of livestock productions (Torgerson *et al.*, 2000). In Queensland Australia, hydatid disease was thought to cost the meat industry, conservatively about U$2.7 million annually through loss offal sale (McManus and Thompson *et al*, 2003). The economic importance of echinococcosis in livestock is due to the condemnation of the whole edible carcasses and offal such as liver, lung and heart (Torgerson *et al.*, 2000). In severe infection, the parasite may cause retarded performance and growth and reduced quality and yield of meat and milk (Getaw *et al.*, 2010). For instance, in Yugoslavia, a 10% reduction in milk yield and 5% in carcass weight due to hydatidosis has been described (Torgerson, 2003; SarIözkan and YalçIn *et al*, 2009).

1.10 Epidemiology:

A study was conducted to estimate the infection rate of hydatidosis caused by *E. granulosus* in cattle and sheep as intermediate hosts in slaughterhouses of Khartoum State (Mohamadin and Abdelgadir *et al*., 2011). An abattoir survey was carried out in 849 cattle and 3850 sheep slaughtered in the study area. The highest infection rate (2.8%), was found in cattle followed by sheep (1.4%). The most affected organs in cattle were the lung and liver (37.5% for each). In sheep, the liver was the most infected organ (65.2%), followed by mesentery (21.7%). The records of abattoirs in Khartoum state indicated that hydatidosis was one of the most frequently encountered parasites during the last six months in Khartoum State (Mohamadin and Abdelgadir *et al*., 2011).

A study was conducted in Alkadarow abattoir (Adam *et al*., 2013) to determine the prevalence of hydatid cysts in Alkadarow abattoir to identify the frequency of cystic ecchinococcos (CE) among slaughtered animals. A total of 500 sheep from Kordufan, Butana, and White Nile were clinically examined and inspected for the evidence of presence of CE, and macroscopic and microscopic investigations were done. CE was not detected in the study population and was highly suggestive that the efforts of Animal Health authorities had eventually succeeded in the elimination of the parasite especially among animals for export resulting in a significant decrease in the prevalence of CE down to zero per cent as found in this study (Adam *et al*., 2013).

Another study was performed to determine the prevalence of CE in livestock in Sinnar area, Blue Nile state, Sudan (Ibrahim, Romig, Peter, and Omer 2011). The location, parasitological status and fertility conditions were determined. One hundred and twenty hydatid cysts (30 from camels, 62 from cattle and 28 from sheep) were examined by polymerase chain reaction (PCR) and mitochondrial gene sequencing for the genetic allocation of *Echinococcus* strains or species. The prevalence of CE was 29.7% (30/101) in camels, 2.7% (62/2310) in cattle and 0.6% (26/4378) in sheep. It was shown that infection rates increased with age in camels, cattle and sheep. In camels, 67% (20/30); the infected animals were 2–5 years old; whereas 58% (36/62) of the infected cattle were >5 years. In sheep, the prevalence rate was distributed equally between animals ranging from 2–5 years to >5 years. Even though multiple cysts were found in some animals, the average number of cysts per animal was close to 1 in all examined species. The lungs were found to be the predilection sites for the parasite in both camels and cattle, while most of the cysts found in sheep were located in the liver. About 63.4% of cysts encountered in camels were considered large (5–7 cm), whereas those in cattle and sheep were medium (2–4 cm) and small in size (<2 cm), respectively. The highest fertility rate was found in camel with 85.4% (35/41) followed by cattle (50.0%, 32/64) and sheep (39.0%, 11/28). All examined cysts belonged to *Echinococcus canadensis* G6, which was confirmed to be the overwhelmingly predominant species in that area. It was concluded that the epidemiological situation in Sinnar area, Blue Nile state is characterized by intense transmission of *Echinococcus canadensis* G6, thereby closely resembling the situation in most other regions of Sudan.

An abattoir survey was conducted on 248 sheep slaughtered at El-obied abattoir in North Kordofan state, Sudan (Elderdiri *et al*., 2014). The objective of the study was to estimate the prevalence of hydatid cysts in sheep and to investigate risk factors associated with the disease. Routine meat inspection procedures were employed to detect the presence of hydatid cyst in visceral organs (liver, lung, heart and peritoneum). The selected sheep originated from six localities: Omsimima, Elnihood, Bara, Elkhwoie, Shikan, and Gibash. The overall prevalence was 1.6%. The prevalence of hydatid cysts infection according to age of sheep was 3.2% in animals more than one years and 0.6% in animals less or one year old. The distribution of the hydatid cysts according to the source of sheep was (2.08%) in Omsimima, (2.6%) in Elnihood, 0% in Bara, 0% in Elkhowei, 0% in Gibash and 0% in Shikan. As for body condition the prevalence was 1.9% in good body condition sheep and 0.0% in poor body condition. Regarding distribution by sex, the prevalence of hydatid cysts was 1.5 % in males and 1.6% in females. The prevalence of hydatidosis according to breed was 2.6% in Kabashi breed, 0.7% in Hamary breed, 2.9% in Garag and 3.2% in Shorany breed. The results of. Using multivariate analysis to determine possible significant association between hydatidosis and potential risk factors, the result showed there was no significant association with any of the investigated risk factors. The liver was the most infected organ (3 cyst), while one cyst was found in the thigh. No cyst was found in the lung, heart or peritonieum. Microscopic examination of the 4 cysts (found in 4 affected animals) revealed that, one cyst was sterile, three cysts were fertile (Elderdiri *et al*., 2014).

An abattoir survey was conducted on 244 cattle slaughtered at Elobied abattoir in North Kordofan State, Sudan (Omer *et al*., 2013). The objective was to estimate the prevalence of hydatid cysts in cattle and to investigate risk factors associated with the disease. Routine meat inspection procedures were employed to detect the presence of hydatid cyst in visceral organs (liver, lung, heart, and peritoneum). The selected cattle originated from Darfur, Kordofan and White Nile State. The over all prevalence was 2.5%. The prevalence of hydatid cyst infection according to age of cattle was 4.4% in animal more than 5 years and 1.2% in animals less or equal to 5 years. The distribution of the hydatid cyst in cattle according to the area (State) was 3.4% in Darfur, 1.3% in Kordofan and 0.0% in the White Nile. As for body condition the prevalence was 2.5% in good body condtion and 0.0% in poor body condition. Regarding distribution by sex, the prevalence of hydatid cyst was 3% in males and 1.2% in females. Also, prevalence of hydatid cyst in the presence of dogs was 2.8% and 1.4 % in the absence of dogs. The prevalence of hydatid cyst according to breed of animals was 8.3% in fuga, 2.5% in Bggara and 0.0% in Kenana. The study showed that the lung was the most infected organ (83.3%) while (16.7%) were in the liver. No cyst was found in the heart or peritoneum. Microscopic examination of the 13 cysts (found in 6 affected animals) revealed that 12 cysts (85.7%) were sterile, one cyst (14.3%) was calcified. No fertile cysts were observed. Regarding sex and location of the cysts; the cysts in males were localized in the lung, but in females they were localized in the liver (Omer *et al*., 2013).

A total of 1000 indigenous sheep carcasses were selected from the municipalities' abattoirs and slaughterhouses of Nablus, Jenin and Tubas districts in Palestine (Elibrahim, 2009). Each animal carcass was inspected carefully; cysts of each organ (liver, lung) were counted, measured and examined microscopically to determine the fertility. The total prevalence of hydatid cyst was 9 %, distributed according to age of sheep as: 0.6% in hoggets (≤ 1 year), 10 % in 1-2 years, 24% in 2-3 years and 27% in >3 years age. The liver was the most infected organ, 51% of cysts infected both liver and lung (mixed infection), 31% were in the liver alone, while involvement of lung alone was observed in only 13 % of the cases. The lower number was in the spleen 3%

and viscera 1%. Microscopic examination of infected cysts revealed that 17% of organs had fertile cysts. 61% of cysts were <4 cm in size, while 38 % were >4 cm (Elibrahim *et al*., 2009).

The prevalence and public health importance of hydatidosis in sheep was investigated in Bahir Dar municipal and Azewa hotel abattoirs, Ethiopia (Belina, *et al*., 2012). Among 400 sheep examined during meat inspection, 60 sheep (15%) were harboring hydatid cysts. The cysts were encountered in 60.87 %, 37.68 %, 0.25 % and 0 %, liver, lung, kidney and spleen, respectively. The rate of cyst calcification was higher in liver than in other visceral organs. There was a significant difference in the harboring of hydatid cyst between age groups and body condition scores. Significantly higher prevalence of hydatidosis was recorded in sheep more than 3 years old (p=0.032) and sheep of poor body condition score (p=0.004). However, there was no significant difference between sexes (p=o.05). Hospital and clinic case-book survey (2007 to 2010) was also performed in Felegehiwot hospital, Gambi clinic and Kidanemeheret clinic to investigate the retrospective prevalence of human hydatidosis. The records showed that among 68,179 patients admitted for ultra sound examination, 30 (0.044%) hydatid cases were registered (Belina, *at al*, 2012).

Tasawar, Naz and Lashari (2014) investigated the prevalence of hydatosis in 1908 sheep and 262 buffaloes in Army abattoir in Multan, Pakistan. They found that the overall prevalence of hydatid cyst of *E. granulosus* in sheep was 7% and 10% for buffaloes. They reported that sheep and buffaloes serve as an important intermediate host in the region and help in maintaining its cycle as the people in Pakistan have high dependency on sheep and buffalo meat.

A cross-sectional survey was carried out on 421camels in Ayssaita district, Ethipoia to estimate the prevalence and identify the potential risk factors to infection of camels with hydatidosis when slaughtered in backyard in pastoral area (Gebremichael *et al*., 2013). The overall prevalence of camel hydatidosis was found to be 34.20% (95% CI: 29.65, 38.75). Based on the potential risk factors, the likelihood of acquiring camel hydatidosis was higher in female than male (, in old than young, in lean than good body condition. Sources of water and feeding habits of camels was also found to be statistically significant (P<0.05). Of the 144 camels positive for hydatidosis, 47.90% had cysts in the lungs only, 20.80% in the liver only, 29.90% in both liver and lung and 1.40% in the spleen alone with a total of 187 organs infected. Regarding fertility of the cysts; 62.35% and 42.35% were fertile cysts in the lung and liver, respectively. With regards to viability of the fertile cysts; 67.92% and 66.67% of the fertile cysts were viable in lung and liver, respectively. The questionnaire survey to investigate on public awareness of hydatidosis and its risk factors on pastoralists revealed that only 4.29% of pastoralists were aware of the disease, but none of them was knowledgeable on its sources and transmission. Therefore, it was concluded that it is highly imperative to impart public health education to build up public awareness about the sources of infection and its control in the pastoral area(Gebremichael, Feleke, Terefe and Lakew, 2013)

Hydatidosis/echinococcosis (*E. granulosus*, Batsch *et al*, 1786) considered to be a serious problem for both public health and the livestock economy in Ethiopia. A review paper summarized available data on the disease (Formsa and Jobre *et al*., 2011). An abattoir survey data collected over a period of 15 years (1985-1999) were analyzed to assess the infection prevalence of hydatidosis in domestic animals in three different agroecological zones of Ethiopia. Accordingly, (35.15%) cattle, (11.78%) sheep, (4.9%) goats, (16.79%) camels and (0%) pigs slaughtered in 21 different abattoirs located in various parts of the country were found harbouring hydatid cysts. A statistical discernible significant difference was observed in the overall hydatidosis infection prevalence between the different species of animals, and in infection prevalence of bovine hydatidosis in the three agroecological zones where the slaughtered cattle were believed to originate from. Similarly, a statistically significant difference ($p<0.01$), in the prevalence of ovine hydatidosis was observed between mid-altitude and lowland agroecologies. Conversely, there was no significant difference ($p>0.20$) in the infection prevalence of caprine hydatidosis between mid-altitude and lowlands. The present study reconfirmed that hydatid disease is widespread and highly prevalent in ruminant livestock in Ethiopia and warrants institution of a nation-wide control measures. Considerations on experiences of other countries with respect to the economic benefits that hydatid disease control programs may bring to livestock producers and combining such efforts with other zoonosis control schemes in view of the ‘one health’ initiative is worthy for animal health planners and policy decision-makers. The study also served as a quick reference source on hydatidosis in the country and basis for future studies (Formsa and Jobre *et al*., 2011).

The status of hydatidosis in small ruminants at Lahore was conducted by Iqbal, (2012). A total of 4800 animals comprising 2400 sheep (784 hoggets and 1616 adults) and 2400 goats (561 young, 1839 adults) of both sexes were examined at Lahore abattoir during. In sheep, 14 (1.79 %) hoggets including 12 (1.78%) males and 2 (1.80 %) females and 184 (11.38%) adult sheep including 139 (11.12%) males and 45 (12.30%) females were infected. Six (1.06%) goats comprising 4 (0.87%) males and 2 (1.94%) females under one year of age and 143 (7.77 %) above one year of age among which, 99 (7.58%) males and 44 (8.25%) females were found infected with hydatidosis. The overall prevalence of hydatidosis in sheep was 8.85% and 6.21% was in goats. During postmortem, the lungs, liver, heart, spleen, abdomen and thoracic cavity were examined. In both sexes of sheep, the mean percentage of organ distribution of hydatid cyst was recorded as [45.19 % lungs], [33.91 % liver], [19.55 % lungs and liver in situs], [2.06 % heart], [2.39 % spleen], and [6.9 % abdomen and thoracic cavity]. The mean of organ distribution of hydatid cyst in goats was 34.38 % in lungs, 40.56 % in liver, 16.95 %

lungs and liver in situs, 0.49 % in spleen and 7.63 % in abdomen and thoracic cavity. In sheep, highest infection was observed in the lungs whereas the liver was the most infected organ in goats. No seasonal variation was observed in the prevalence of hydatidosis in sheep and goats throughout the year. Fertility of hydatid cysts removed from liver and lungs of sheep and goats were studied and it was found that apparently hepatic cysts were more fertile as compared to pulmonary cysts in both the species but the difference was not significant (P = 0.87).

A study was conducted in cattle in Kombolcha El-fora abattoir (Abunna, 2012) to determine the prevalence of bovine hydatidosis. A total of 400 cattle randomly sampled and examined after slaughter for the presence of hydatid cysts in the organs and viscera of the animals using the standard meat inspection procedures. Positive or suspected samples were submitted to the parasitology laboratory at the Kombolcha regional laboratory and cyst identification, fertility and viability tests were performed. The statistical analysis showed that there was no significant difference ($P > 0.05$) between the prevalence of bovine hydatidosis and sex of animals or origin of the animals studied $P > 0.05$. Of 191 cysts examined, 154(80.63%) were calcified, 1(0.51%) sterile, and 36 (18.85%) fertile cysts. Among the fertile cysts, 24(72.22%) were found to be viable. Of 108 cysts recorded in the lung, 74(68.52%) were calcified, 1(0.93%) sterile, 21(19.44%) were viable and 12 (11.11%) were non-viable. Furthermore, of 70 cysts recorded in the liver, 67 (95.71%) were found to be calcified and 3(4.29%) viable. The results of this study showed that hydatidosis pose significant economic problems by causing condemnation of considerable numbers of organs, rendering them unfit for the market. There- fore, initiation and implementation of control measures were suggested to alleviate the economic impact of hydatidosis and the zoonotic risks to the human**.**

In Tonisa (Lahmar, 2012) examined 10,818 domestic ruminants (3913 cattle, 2722 sheep, 3779 goats, 404 dromedaries) slaughtered in various abattoirs in Tunisia for echinococcosis. They reported that the prevalence of cystic echinococcosis (CE) was 16.42% in sheep, 8.56% in cattle, 5.94% in dromedaries and 2.88% in goats. CE prevalence increased with age according to an asymptotic model and there was evidence of variation in infection pressure depending on the region of Tunisia where the animals were slaughtered. Cattle appeared to have the highest infection pressure of the species examined. The mean intensity of hepatic cysts was higher than that of pulmonary cysts in all species. The highest mean intensity of infection with E. granulosus larvae was observed in cattle (18.14) followed by sheep (9.58), goats (2.31) and dromedaries (2.12). The abundance of infection increased in a linear fashion with age in all animal species. Cyst abundance varied with species of animal and district of Tunisia. Cysts from dromedaries were more fertile (44.44%) than those from sheep (30.25%), goats (30.32%) and cattle (0.95%). The viability of the protoscoleces from fertile cysts from cattle (78.45%) was higher than those from sheep (70.71%) and camels (69.57%). The lowest protoscolex viability was recorded for hydatid cysts from goats (20.21%). This epidemiological study confirmed the importance of CE in all domestic ruminant species, particularly sheep, throughout Tunisia and emphasized the need to interrupt parasite transmission by preventive integrated approaches in a CE control programme (Lahmar, 2012).

E. granulosus lesions in the liver was found in 156 of 9,515 persons in the Department of Florida, Uruguay. The sensitivity of ELISA and latex agglutination serology compared with ultrasound was 47.6% and 28.1%, respectively, and specificity was 85%. There was a significant positive association between positive sonography and a personal history of previous but treated *Echinococcus* infection, while those that were seropositive but ultrasound-negative were significantly more likely to have a personal history of infection or a history of infection in their family. Prevalence of infection increased significantly with age. There was no correlation between echinococcosis and dog ownership or home slaughter of sheep but offal disposal was important, with an increased prevalence of infection of 3.2%, 2.8%, and 3.1%, respectively, in persons feeding offal to dogs or burying or burning it compared with a prevalence of 0.8–1.5% in those using other methods of disposal. Almost half the population, when questioned, seemed to have sound knowledge about *E. granulosus* and described correct treatment of *E. granulosus* in dogs but this did not affect prevalence. There was a significant positive association between infection and the presence of a fenced fruit/vegetable garden and use of rural waters, particularly the cachimba (a small dam) and the aljibe (a cistern or tank) that collect rainwater from the ground surface and roofs, respectively Carmona*, et al1*998)

An infection rate of 8.4% with cystic echinococcosis was recovered from 1,050 sheep, goats, cattle and camels in Shanat abattoir in Al-Jabal, Libya (Al-Khalidi *et al*., 1998). He reported that among 338 goats, 18 (5.4%) were infected; among 124 cattle, 8 (6.4%) were infected and among 40 camels 14 (35.0%) were infected. The animals were of both sexes and of various ages. As for infection of cattle, 75.0% of the infection was in the liver, 37.5% in lungs and 12.5% in the spleen, The cysts of all infected cattle (87.5%), but one cow (12.5%), were sterile.

A previous study was conducted to determine Genotypic characteristics of hydatid cysts isolated from humans in East Azerbaijan Province (Vahedi, *et al*, 2011-2013). In this cross-sectional study 55 paraffin blocks of identified hydatid cysts have undergone genotyping using polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) technique. About 29 (52.72%), 16 (29.1%), 3 (5.45%), 3 (5.45%), 1 (1.81%), 1 (1.81%), 1 (1.81%) and 1 (1.81%) out of 55 hydatid cysts were located in lung, liver, spleen, kidney, heart, pancreas, brain, and femur, respectively. The frequency of hydatidosis observed was higher in patients from rural areas (P = 0.013; odds ratio = 0.599; 95% confidence interval: 0.28, 1.27). Based on RFLP results, the entire studied hydatid cysts were identified as sheep strain (G1). According to the results obtained it was concluded that the majority of cases of human hydatidosis in East Azerbaijan Province are caused by sheep strain (G1) of *E. granulosus*, which indicated sheep-dog cycle in the studied area. (Vahedi, Mahdavi, Ghazanchaei and Shokouhi.2011-2013).

Chapter Two

Materials and Methods

2.1.1 Study area:

Western Darfur State is located in western Sudan. It has got national borders with central Darfur State to the south east and

North Darfur State to the north; it also shares international borders with Chad republic to the west. It has an area of 75,000 km2 and a total human population of 757,000 mostly engaged in agriculture and livestock rearing. Elgeniena is the capital town of the state 13º27"0"N 22º27"0"E .The climate varies in Western Darfur State, the difference between the mean daily maximum temperature 40-38 ºC in May and the mean daily minimum temperature 12-16 ºC in February is about 25.2 ºC. The rainy season occurs between June and October, but the peak of rainfall in the desert is 800 mm in the southern parts where the lowland is covered with broad leaves wooded savanna trees and grass. In Summer (March to June) the climate is dry and hot, while in Autumn (July-October) it is wet and warm. During Winter (November –February), the climate is cool and dry.

Table 2.1: Number of animals in western Darfur state.

Animal Species	Total Number
Sheep	5,240,450
Total animals	18,028,814

Source: Ministry of Agriculture And Animal resource (Elgeniena).

2.2 Study design:

The study design is a cross sectional study which intended to information on occurrence of a disease (Martin *et al.,* 1987). This was conducted at Alriad abattoir and Aljamarek abattoir in Elgeniena town on three days in each abattoir per week.

2.3 *Sample* Size:

The expected prevalence of ovine hydatidosis for calculation of sample size was taken from the study in Addis Ababa, Ethiopia in which the prevalence of hydatidosis in sheep was 13.9% (Ermias *et al.,* 2011).

Sample size was calculated according to the formula by Martin (1987).

$$n= \frac{(1.96)^2 \ P^{\wedge}Q^{\wedge}}{L^2}$$

Where:

n ≡ Required sample size

$P^{\wedge}$ ≡ Expected prevalence =0. 139

$Q^{\wedge}$ ≡ 1- P = 0.861

L ≡ Allowable error

n= 4 x(0.139)x (0.861)/0.0025 ≅ 191.5=192 animal samples

The number of sheep examined was 192 animal**.**

2.4 Ante –mortem examination:

Regular visits were made on three successive days/week for each of Aljamarek and Alriad slaughter houses, to conduct ante-mortem and post-mortem examination of slaughtered animals. A total of 192 sheep were examined in the Aljamarek and Alriad abattoirs during the survey period which extended from September to December 2014. During ante-mortem inspection; the sexes, age, breed, body condition, name of abattoir and sources of animals were determined. The age of animals was determined by dentition. The body condition was assessed and recorded depending on their body score, as poor, medium or good body condition. The source of the animal was also recorded by determining the localities from which the animals came.

2.5 Post -mortem examination:

During post-mortem examination, visual inspection, palpation and systematic incision of each visceral organ was performed particularly the liver, lungs, kidneys, heart and spleen. In parallel, the following data were recorded: Serial number, date, and infection, presence of other diseases, infected organ and size of cyst. Infected organs were collected in polyethene bags and taken to Elgeniena veterinary hospital laboratory for examination.

2.6 Laboratory examination:

2.6.1 Examination of cysts:

Infected organs were transported to the laboratory of Elgeniena veterinary hospital and further analysis to determine the state of the cysts was performed.

The fertility of cysts were verified microscopically. Each cyst was cut opened with scissor and the content of the cyst was poured into a clean petri dish. A drop of cyst fluid with protoscolices was put on a clean slide to which a drop of 0.1 % aqueous eosin solution was added for clear vision and to study the viability of the protosclices. The preparation was examined under the microscope using (40×) magnification. The principle of the test was that viable protosclices should completely or partially exclude the dye while the dead ones take it up (Ibrahim, 2010).

The viability of protoscolices was also determined by flame cell motility. The cyst which contained no protoscolices; being suppurative, caseaous, shrunk evacuated, degenerated or fluid filled cysts with no protoscolices by direct microscopic examination were considered as sterile cysts (Omer *et al*., 2013). Solid sand containing cysts were considered as calcified cysts (Omer *et al*., 2013).

2.6.2 Size measurement (Volume):

Hydatid fluid was aspired from the cysts using a syringe and the volume of cysts was estimated by measuring this fluid **(Omer *et al*, 2013).**

2.7 Statistical analysis:

The results obtained were analyzed using statistical package of social science (SPSS). Descriptive statistical analysis was displayed in frequency distribution and cross tabulation tables. Univariate analysis was performed using the chi-square for qualitative data. P-value of 0.25 was considered as significant association and the risk factor was then selected to enter the multivariate analysis.

Multivariate analysis: Forward or backward stepwise logistic regression was used to analyze the data and to investigate association between a potential risk factor and the prevalence of hydatidosis. A p-value of 0.05 indicated significant association between hydatidosis and the risk factor.

Chapter Three

Results

Among the total of 192 sheep inspected, 17 (8.9%) animals were positive, and the rest were negative for hydatidosis (table 3.1.1).

Table 3.1.1: Distribution of hydatidosis infection among 192 sheep examined in Aljamarek and Alriad abattoirs in Elgeniena:

Validity	Frequency	Percent	Validity %	Cumulative %
Negative	175	91.1	91.1	91.1
Positive	17	8.9	8.9	100.0

Total	**192**	**100.0**	**100.0**	

3.2 Survey of hydatid cyst in Aljamarek and Alriad:

A total of 192 sheep in both Aljamarek and Alriad abattoir were examined in this study. The distribution of 192 sheep according to abattoir was 100 (52.1 %) in Alriad abattoir, and 92 (47.9 %) in Aljamarek abattoir (Table 3). Among 100 animals examined in Alriad abattoir, 10 were infected and the rate of infection was (10%) and among 92 animals examined in Aljamarek abattoir 7 were infected and the rate of infection was (7.6%). The Chi square test revealed no assocation between hydatidosis and slaughterhouse (p=0.561).

3.3 Age of animals:

192 sheep of various ages were examined in this study. The presence of cyst in various organs was investigated.

The distribution of the 192 sheep according to age was 94 (49%) in young animals and 98 (51%) in old animals (table3). Among the 94 animals of young examined, 4 were infected, the rate of infection was (4.25%), while in the 98 animals in old age examined 13 were infected, the rate of infection was (13.8 %) and the Chi square test revealed positive association (p= 0.02) between hydatidosis and age of examined sheep.

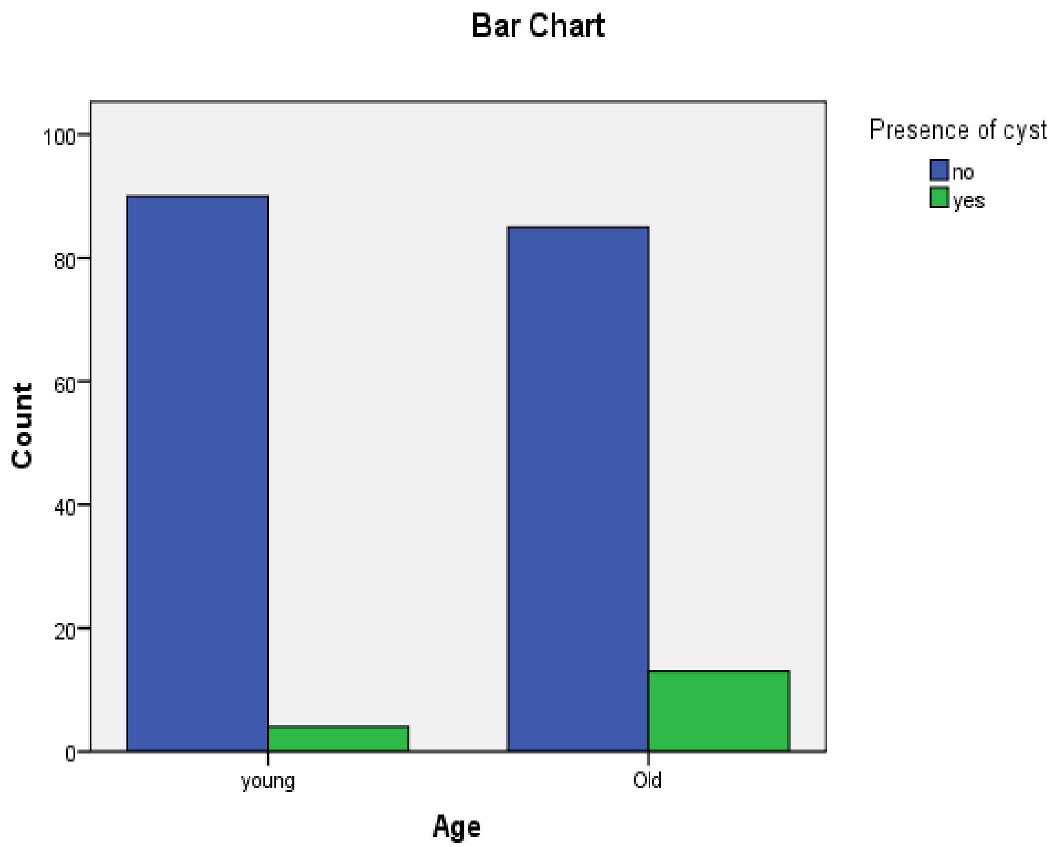

Figure 4 Proportion of ovine hydatidosis by age recorded at Aljamarek and Alriad abattoir, Elgeniena.

3.4 Sex of animals:

Table 3.1.2 shows the distribution of 192 sheep examined for hydatidosis according to sex. The total number of male sheep examined was 149 (77.6%), while the total number of females examined was 43 (22.4%). Among total number of males, 13 animals were found infected. The rate of infection within males was (8.7%), while among the total number of females examined, 4 animals were found infected. As shown in table 3.1.3, the rate of infection within females was (9.3%).

As shown in table 3.1.4 the Chi-square test showed no significant association between hydatidosis infection and sex of animal (p-value =0.90).

3.5 Breed:

The distribution of hydatidosis infection in Aljamarek and Alriad slaughterhouse in Elgeneina according to breed was as follows:

All sheep examined were local breeds 160 (83.3%) Sahrawi, 32 (16.7%), Hamary, 13 Sahrawi animals were positive, and 4 animals were positive from Hamary breed (table 3.12). The rate of infection (table 3.13) was (8.1%) % in Sahrawi breed and 4 (12.5%) in Hamary breed.

As shown in table 3.1.4 the Chi-square test showed no significant association between hydatidosis and breed (p-value =0.42).

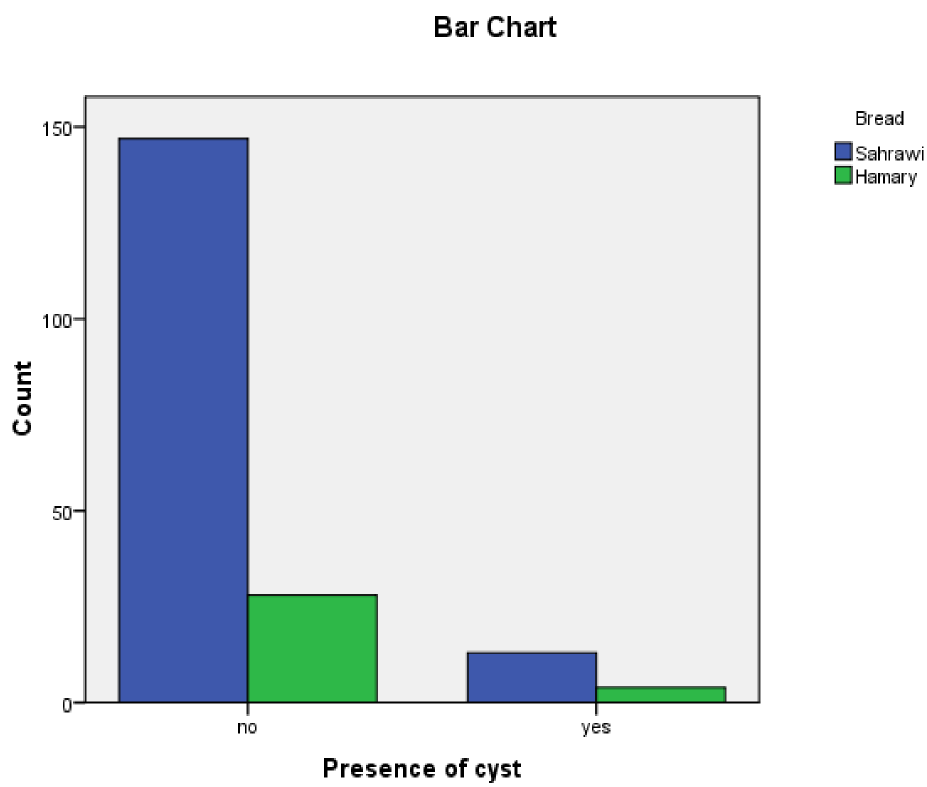

Figure 5: Proportion of ovine Hydatidosis by breed recorded at Aljamarek and Alriad abattoir. Elgeniena.

3.6 Body condition:

The distribution of hydatidosis infection in Aljamarek and Alriad slaughterhouse in Elgeneina according to body condition was investigated.

154 (80.2%) sheep were in good body condition, and 38 sheep (19.8%) were in poor condition (table 3.1.2). Among the 154 sheep in good body condition 16 were infected. The rate of infection within animals in good body condition was (10.4 %).

Only one animal was found infected among sheep with poor body condition and the rate of infection was (2.7%). (table 3.1.3).

As shown in table 3.1.4 the Chi-square test showed a significant association between hydatdosis and body condition no significant (p-value =0.08).

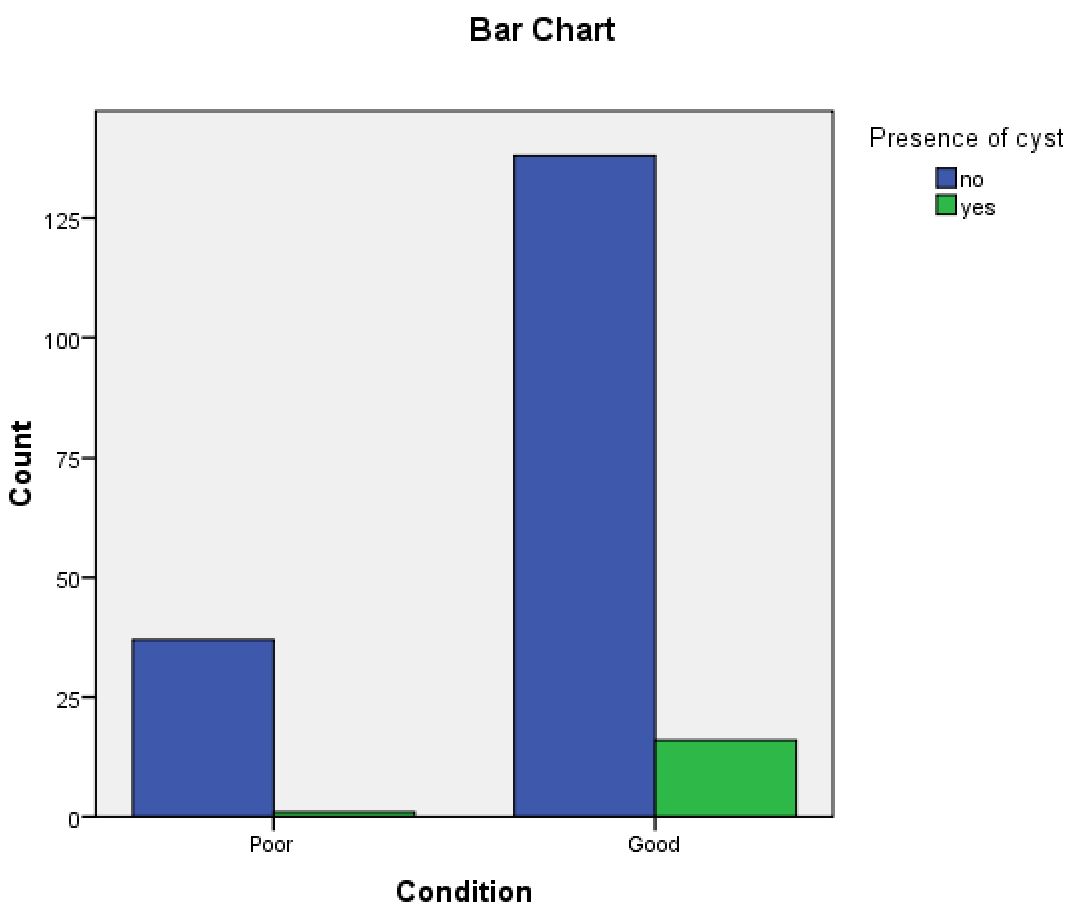

Figure 6: Proportion of ovine Hydatidosis by body condition recorded at Aljamarek and Alriad abattoir. Elgeniena.

3.7 Source of animals:

Among the 192 local sheep breeds inspected, 20 (10.4%) animals were from Elgeniena locality, 47(24.5%) animals from Kereinik locality, 36(18.8%) animals from serba, 9 (4.7%) animals form Jabal moon, 43(22.4%) from Baida and 37 (19.3%) animals from Foro Baranga (table 3.1.2). Three sheep out of the 20 animals examined in Elgeneina were infected, four animals out of the 47 sheep examined from Kereinik were infected, one sheep among the 36 animals examined from Serba was infected, four animals among the 43 sheep examined from Baida were infected and five sheep among the 37 animals examined from Foro Baranga. None of the animals was infected among the nine sheep from Jabal moon.
The rate of infection was (15 %) in Elgeniena, (8.5%) in Kereinik, (2.8%) in serba, (9.3%) in baida, (13.5%) in Foro Baranga and (0.0%) in Jabal Moon.

The Chi-square test showed (table 3.1.4) no significant association between infection and source of the animal (p-value =0.48).

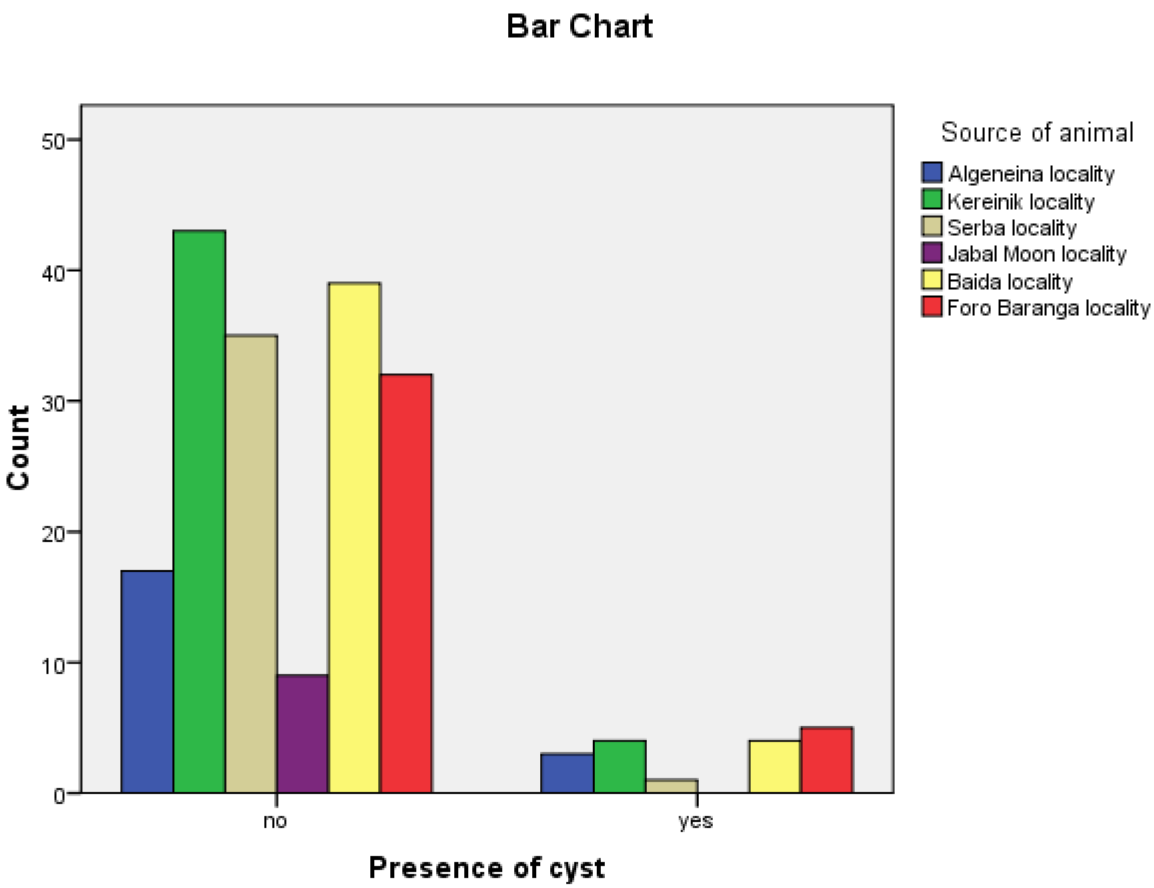

Figure 7: Proportion of ovine Hydatidosis by Source of animal recorded at Aljamarek and Alriad abattoir, Elgeniena.

3.8: Concurrent diseases:

All sheep were thoroughly examined at post-mortem for concurrent diseases. Investigations regarding distribution of concurrent diseases among the 192 sheep examined showed that 172 (89.6 %) sheep had no abnormalities', 3animals (1.6 %) had anemia and 17 (8.8 %) sheep had hemorrhage (table 3). Among the 172 sheep that were free of concurrent diseases, 14 were infected, the rate of infection was (8.1%), among the three animals that had anemia, one sheep was infected, the rate of infection within anemic animals was (33.3%), and among the 17 sheep that had hemorrhage, two were infected, the rate of infection among animals showing hemorrhage was (11.8%).

The Chi-square test showed (Table 3.1.) a significant association between hydatidosis and concurrent diseases (p-value = 0.28).

3.9 Location of cysts:

The location of cysts in different organs was investigated. The results obtained showed that the liver was the most infected organ with hydatidosis. In fifteen sheep (88.2%) hydatid cysts were found only in the liver only, and in two sheep the cysts (11.8%) were found in the liver and lung but in one sheep the cysts (5.9%) were found only in the lung (Table 3.1.3). Hydatid cysts infection were not found in organs other than the liver and lungs.

Chi- square test showed a significant association (Table 3.1.4) between hydatidosis and location of cyst (p-value=.000).

3.10 Size of cysts (volume):

The distribution of cysts of <5ml, 5- 10 ml, and more than10 ml volume in the different organs are tabulated (Table 3.1.2). More than 10 ml volume of cyst fluid was recorded in one case (5.9%), 5-10 ml cysts were recorded in 4 (23.5%) cases, while < 5ml cysts were recorded in13 (70.6%) cases (table 3.1.3).

Chi- square test showed a significant association (Table 3.1.4) between hydatidosis and size of cyst (p-value=.000).

3.11 Fertility of cysts:

Macroscopic examination of the cysts revealed that among the total of 17(8.9%) cysts, 5 (29.4%) cysts were fertile and viable, 9 (52.9%) cysts were sterile, and 3(17.6%) cysts were calcified (Table 3.1.3).

Chi-square test showed a significant association (Table 3.1.4) between the hydatidosis and fertility of cyst (p-value=.000).

Table 3.1.2: Summary of frequency tables for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses.

Risk Factors	Frequency	Relative Frequency %	Cumulative Frequency %
Abattoir:			
Alraid	100	52.1	52.1
Aljamarek	92	47.9	100
Total	192	100	
Age:			
Young	94	49	49
Old	98	51	100
Total	192	100	
Sex			
Male	149	77.6	77.6
Female	43	22.4	100
Total	192	100	
Breed:			
Sahrawi	160	83.3	83.3
Hamary	32	16.7	100
Total	192	100	

Table 3.1.2: Summary of frequency tables for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses. **(Continued):**

Risk Factors	**Frequency**	**Relative Frequency %**	**Cumulative Frequency %**
Body condition:			
Good	154	80.2	80.2
Poor	38	19.8	100
Total	192	100	
Source:			
Algeneina	20	10.4	10.4
Kereinik	47	24.5	34.9
Serba	36	18.8	53.6
Jabal Moon	9	4.7	58.3
Baida	43	22.4	80.7
Foro Baranga	37	19.3	100
Total	192	100	

Table 3.1.2: Summary of frequency tables for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses. **(Continued):**

Risk Factors	**Frequency**	**Relative Frequency %**	**Cumulative Frequency %**
Other Abnormaliy			
Anemia	3	1.6	1.6
Haemorrhage	17	8.9	10.4
No Abnormality	172	89.6	100
Total	192	100	
Location of cyst:			
Liver	15	7.8	7.8
Lung	1	0.5	8.3
Liver and lung	2	1	9.3
No cyst	174	90.6	100
Total	192	100	

Table 3.1.2: Summary of frequency tables for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses. **(Continued):**

Risk Factors	Frequency	Relative Frequency %	Cumulative Frequency %
Volume of cyst fluid:			
< 5 ml	13	6.8	6.8
5-10 ml	4	2.1	8.9
>10 ml	1	0.5	9.4
No cyst	174	90.6	100
Total	192	100	
Fertility:			
Fertile and viable	5	2.6	2.6
Sterile	9	5.2	7.8
Calcified	3	1.6	9.4
No cyst	174	90.6	100
Total	192	100	

Table 3.1.3: Summary of cross tabulation for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses.

Risk Factors	Number Inspected	Number Affected (%)

Abattoirs	Alriad	100	10(58.8%)
	Aljamarek	92	7(41.2%)
Age	Young	94	4(23.5 %)
	Old	98	13(76.5 %)
Sex	Males	149	13(76.5 %)
	Females	43	4(23.5 %)
Breed	Sahrawi	160	13(76 %)
	Hamary	32	4(23 %)
Body condition	Good	154	16(94.1 %)
	Poor	38	1(5.9%)
Source	El-Geneina	20	3(17.7 %)
	Kereinik	47	4(23.5%)
	Serba	36	1(5.9 %)
	Jabal Moon	9	0(%)
	Baida	43	4(23.5 %)
	Foro Baranga	37	5(29.4 %)

Table 3.1.3: Summary of cross tabulation for potential risk factors of hydatidosis in 192 sheep examined at El-Geniena slaughterhouses. **(Continued):**

Risk Factors		**Number Inspected**	**Number Affected (%)**
Other Abnormalites	Anemia	3	1(5.9 %)
	Hemorrhage	17	2(11.7 %)
	No Abnormality	172	14(82.4%)

Table 3.1.4: Summary of univariate analysis for potential risk factors of hydatidosis in 192 sheep examined at Alriad and Aljamarek slaughterhouse using the Chi- square test.

Risk factors		**Number Inspected**	**Number Affected (%)**	**d.f**	**Chi-square value**	**p-value**
Abattoir	Alriad	100	10(10%)	1	0.34	0.56
	Aljamarek	92	7(7.6%)			
Age	Young	94	4(4.25 %)	1	4.8	0.024
	Old	98	13(12.1 %)			
Sex	Male	149	13(13.3 %)	1	0.14	0.90
	Femle	43	4(9.3 %)			
Breed	Sahrawi	160	13(8.1 %)	1	0.63	0.42

	Hamary	32	4(12.5%)			
Body condition	Good	154	16(10.4 %)	1	2.2	0.11
	Poor	38	1(2.6 %)			

Table 3.1.4: Summary of univariate analysis for potential risk factors of hydatidosis in 192 sheep examined at Alriad and Aljamarek slaughterhouse using the Chi- square test **(Continued):-**

Risk factors		**Number Inspected**	**Number Affected (%)**	**d.f**	**Chi-square value**	**p-value**
Source	El-Geneina	20	3(15 %)	5	4.47	0.48
	Kereinik	47	4(8.5%)			
	Serba	36	1(2.8 %)			
	Jabal Moon	9	0(0.0%)			
	Baida	43	4(9.3 %)			
	Foro Baranga	37	5(13.5 %)			
Other Abnormalities	No Abnormalities	172	14(8.1%)	2	2.51	0.28
	Anemia	3	1(33.3 %)			
	Hemorrage	17	2(11.8 %)			

Table 3.1.5: Multivariate analysis of hydatidosis and potential risk factors in 192 sheep examined at Alriad and Aljamarek slaughterhouses using logistic regression.

Risk factors	**Animals examined**	**Positive (%)**	**Df**	**Exp (B)**	**Sig**	**95 % C.I. for Exp (B)**	
						Lower	**Upper**
Age:			1				
Young	94	4(4.25)		ref			
Old	98	13(13.3)		4	0.02	1.16	14.1
Breed:			1				
Hamary	32	4(12.5%)		ref			
Sahrawi	160	13(8.1%)		1.4	0.51	0.43	5.1
Body condition:			1				
Poor	38	1(2.6%)		ref			
Good	154	16(10.4%)		5	0.1	0.68	44

Table 3.1.5: Multivariate analysis of hydatidosis and potential risk factors in 192 sheep examined at Alriad and Aljamarek slaughterhouses using logistic regression.

Risk factors	Animals examined	Positive (%)	Df	Exp (B)	Sig	95 % C.I. for Exp (B)	
						Lower	Upper
Other Abnormality			2				
No Abnormality	172	14(8.1 %)	1	ref			
Anemia	3	1(3.33 %)		2	0.45	0.14	6
Hemorrhage	17	2(11.8 %)		3	0.24	0.13	3

CHAPTER FOUR

DISCUSSION

The real magnitude of hydatidosis in domestic and wild animals and man in the Sudan still needs further investigation. Animals for meat production may pass through several owners on their way to the slaughterhouse. This may create difficulty in tracing infected animals. In the present study the prevalence of hydatidosis in sheep slaughtered in Alriad and Aljamarek slaughterhouses, Western Darfur State, Sudan was 8.9%. This result is in agreement with the results of another study (Alkhalida, *et al*., 1998) carried out in Libya in which the rate of infection was (8.7%). The results obtained in this study were also similar to previous studies conducted in the Sudan and other countries in which, the rate of infection in sheep was: 9.2% in Kenya (Abby *et al* , 1996), and 9.1% in Palestine (Jehad *et al.* , 2009).

In comparison to other regions, it was clear that prevalence of hydrated cyst recorded in this study had higher rate. For example, the prevalence of hydatidosis recorded in the current study was higher than the prevalence reported from: Kenya: 3.61% (Njoroge *et al.,* 2002), China: 8% (Ya Sen 2008), Egypt: 0.66% (Abo-Elwafa *et al*, 2009), Northwest Iran: 2.7% (Tappe *et al*., 2008), Ethiopia: 4.9% (Formsa and Jobre *et al*., 2011), Sinnar: 0.6% (Ibrahim, 2011), Khartoum: 1.4% (Mohamadin and Abdelgadir *et* *al*., 2011), Khartoum: 0% (Eldoom *et al*., 2013), Alobied: 1.6% (Alderdery *et al*., 2014). The reason for the high prevalence of the disease recorded in this study was probably due to geographic location, outdoor rearing in open grazing areas, and large number of sheep and dog populations coupled with a high number of back-yard slaughters which in most cases are not inspected by the Veterinary Department Staff. In general, the difference in prevalence of hydatidosis in different districts and camps could have resulted from differences in animal husbandry practices, unsupervised slaughter of animals, improper disposal of infected carcasses and sheep offal which dogs could easily scavenge. However, the prevalence of hydatid cyst infection recorded in this study was lower than the prevalence of hydatidosis reported in other studies from: Sudan: 12.9, 11 % and 10.7% by Mohamed (2013), Omer *et al.*(2010) and Abdalraswol (2011), respectively, Iran: 11.1% (Dalimi *et al.*, 2002) and 45.5 % (Khanjari *et al.*, 2012) Iraq: 11.1% (Saida and Nouraddin *et al*., 2011), Saudi Arabia: 12.6% (Ibrahim *et al*., 2010), Libya:12.7% (Kassem *et al*., 2006), Jordan: 20 % (Anwar *et al*., 2005) and 12.9% (Kamhawi *et al.*,1996), Ethiopia: 16.4% (Tekelye *et al*., 1987) and 13.47% (Fikire *et al.*, 2012), Tanzania:17.1% (Mellau *et al*. , 2010), Addis Ababa: 19.9% (Kebabe *et al*., 2009). Variations of the prevalence of hydatidosis exists even within the same country and this might be due to the variation in environmental conditions because; the eggs of the cestode survives for only short periods of time if they are exposed to direct sunlight and dry conditions (OIE, 2005), and under ideal conditions, *E. granulosus* eggs remain viable for several months in pastures or gardens and on household fomites. The eggs survive best under moist conditions and in moderate temperatures. Viable eggs have been found in water and damp sand for 3 weeks at 30°C, 225 days at 6°C and 32 days at 10-21°C (OIE, 2005). In addition, the difference in hydatidosis prevalence rate between countries could be associated with different factors like control measures applied in place, the level of community awareness created about the disease, education and economic status of the population, variation in the temperature, environmental conditions, nature of the pasture, the way of raising animals and levels of exposure and maturity and viability of eggs (Njoroge *et al.*, 2002). In the current study the prevalence of hydatidosis was only 8.9 % less than values recorded by other workers. This proved the environmental conditions in West Darfur State is not conducive for egg survival for a long period of time. However, prevalences lower than that recorded in the present investigation were similarly recorded by other workers (Haridy *et al.*, 2000; Ibrahim *et al.*, 2011; Abdullahi *et al.*, 2011).

The prevalence of hydatid cyst infection according to source (origin) of examined animals showed that there was no significant association between the hydatidosis and origin of the animals (p value = 0.48). This result agree with Formsa and Jobre (2011) in Ethipia.

Female sheep had slightly higher rate of infection than male sheep. The rate of infection in female animals was 9.3%, while in male animals was 8.7%. There was no significant association between hydatidosis and sex of animals (p-value = 0.90). This could probably be explained by the fact that female sheep are usually kept for a longer period of time for breeding purposes, thus they become more exposed to infection and will allow enough time for the cysts to develop. Although female animals are more affected with hydatid cyst compared to male animals, but 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 sheep graze together on the same pasture. This result agrees Daryani *et al.*, (2007) and Abdalraswal, (2011) in Northwest Iran **and in S*udan, respectively.***

The rate of hydatid cyst infection recorded in this study showed that the prevalence of hydatidosis was 4.25% in youn animals and 12.1 % in old animals. The results obtained showed a significant association between hydatid cyst infection and age of animals examined (p-value = 0.02). These results were consistent with previous studies who regarded that young animals have low rate of infection than adult ones (Meltem, 2007; Kebebe *et al.*, 2010). The difference in infection rate could be attributed mainly to the fact that adult animals have longer exposure time to *E. granulosus*. This finding supports the finding of Khanjari *et al.*, (2012) who also attributed more prevalence of infection in adult animals to longer exposure to *E. granulosus*. This could probably be attributed to the fact that hydatid cyst infection is a chronic disease, and older animals become exposed to infection for a longer period of time, the chances of detecting cysts at meat inspection are higher due to the bigger size of cysts and *Echinococcus* eggs require 6-12 months before the hydatid cyst stage grows sufficiently to produce protoscolices capable of infecting the carnivore host. These findings agree with some workers (Kamhawi *et al.*, 1995; Daryani *et al.*, 2009; Ibrahim *et al.*, 2011; Omer, 2013).

The ***prevalence of hydatid cysts as related to body condition showed was*** 10.4 %, in good body conditions, and 2.6 % in poor body conditions. There was a significant association between hydatid cyst infection and body condition of animals (p-value = 0.11). Hydatid cyst infection is a mild disease which does not affect the general health of the affected animals, but lack of variability in relation to body condition might be due to the little tendency of excluding emaciated animals form being slaughtered.

This finding agrees with Abdalraswal (2011) who reported similar findings.

The prevalence of hydatid cyst infection as related to the breed of animals was 8.1% in Sahraw and, 12.5 % in in Hamary. There was no significant association between breed and hydatid cyst infection (p-value = 0.19). This could be due to the fact that both breeds are local breeds and are probably of equal susceptibility.

The occurrence of hydatid cyst infection in relation to the location of cyst in animals was high in the liver than in other organs. There was a significant association between hydatid cyst infection and location of cysts (p-value =0.00). This finding is consistent with the observations reported by many workers in different countries (Ibrahem and Craig, 1998; Njoroge *et al*., 2002; Ibrahim , 2010; Tappe *et al*., 2010; Abdullahi *et al*., 2011; Mohamadin and Abdelgadir, 2011; Salem *et al.*, 2011; Khanjari *et al*., 2012; Fikire *et al*., 2012). The higher prevalence of hydatid cysts in the liver could be attributed to the fact that the liver is the first organ the blood flows through after leaving the intestine and is filtered in it with more chances of infection and only the ova that are not trapped in the liver pass to the lungs and then to other organs (Soulsby, 1982).

The fertility of the cyst is an important factor that can affect the stability of *E. granulosus* cycle depending on the geographical conditions, infected host and size of cyst. In the current study there was significant association between hydatidosis and fertility of cyst (p-value=0.00). Most cysts in this study were fertile, viable in three cases and only in one case the cyst was sterile. This result agree with a study conducted in Jordan ***Kamhawi et al., (1995) in Jordan and Daryani et al., (2009)*** in Northern Iran.

More than 10 ml size cysts were found in one case and less or equal to 10 ml cysts have been found in two cases, while a caseated cyst was found in one case. This result is compatible with studies conducted in Ethiopia (Kebede *et al.*, 2009) and Sinnar area, Blue Nile State, Sudan (Ibrahim *et al .,* 2011).

CONCLUSIONS

- The output of this study indicates that the overall prevalence of hydatid cyst was 8.9% .
- The distribution of prevalence of hydatid cysts infection by age showed that the prevalence in old animals is higher than in young animals.
- Significant association was observed between hydatid cyst infection and age of animal(p-value=0.001).
- For the location of hydatid cyst in carcas organs, the liver was found to be the most affected organ (82%).
- Microscopic examination of hydatid cyst showed that one cyst was sterile 9 (52.9%) , 5 cysts were fertile (29.4%) and 3(17.6 %)were calcified.

RECOMMENDATIONS

More elaborate studies on *Echinococus granulosus* cyst are encouraged to elucidate on:

- Prevalence of the disease in other states in the different species of farm animals.
- Prevention of the disease in the intermediate host by finding a suitable drug to destroy or render the hydatid cyst sterile, proper methods for destroying stray dogs and wild carnivores and conduct extensive research programs on the best drug to be used for deworming pet dogs.
- Enhancement of awareness of people about the economic and public health importance of the disease.
- Conduct extensive research programs to elucidate on the public health significance and economic losses resulting from the disease.

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