Introduction

Background:

Hyadatidosis (*Echinococcosis*) is a cyclozoonotic infection of cosmopolitan distribution . It is one of the main forms of parasitic diseases in farm animals caused by the larval stage of *Echinococcu*s tape worms which utilize canines as definitive host and various herbivores or rodent as intermediate host . Species under genus *Echinococcus* are small tapeworms of carnivores with larval (metacestode) stages known as hydatids proliferating asexually in various mammals including humans. There are five morphologically distinct species in this genus ; *E. granulosus, E.multilocularis, E. oligarthus, E.Vogeli* and *E. shiquicus* (El-Ibrahim., 2009).

The adult worm of *E. granulosus* consist of 3 to 4 segments and exhibits two hosts in its life cycle , a carnivore as a definitive host and one species of various domestic herbivorous animals as an intermediate host. Human can be infected with the larval stage if he ingests the eggs of the parasite with either his food or drink (El-Ibrahim., 2009). Human cystic echinococcosis is the most common presentation and probably accounts for more than 95% of the estimated 2–3 million global cases, with human alveolar echinococcosis causing around 0.3–0.5 million cases (all in the northern hemisphere), fewer than 150 cases of polycystic echinococcosis have been described, all in Central and South America. Until 2005, only four *Echinococcus* species were recognised, but a fifth species, *E. shiquicus*, has now been described in small mammals from the Tibetan Plateau, although its zoonotic potential is unknown (Craig *et al.*,2007)**.**

History:

Hydatid disease has been known as a clinical entity since ancient times. Its parasitic nature was recognized as early as 1684 by Redi, Harmann and others. Goeze in 1782 pointed out that the scolices were of teanial origin and differentiated the hydatid cyst from cysticercus and the coenurus. The adult worm was observed in the intestine of dogs in 1808 by Rudolphi, but it was not until 1850 that it was recognized by Van benden as distinct species which he later named Taenia nana. In 1852 Von Siebold recovered the adult worm from dogs that had eaten echinococcal cysts of cattle (Belding , 1965).

The life cycle:

The life cycle of *Echinococcus granulosus* (*E. granulosa*) is similar to that of other tapeworms transmitted between predators and their prey In a typical cycle, the definitive hosts are carnivores (primarily dogs and wolves) that become infected by eating offal-containing hydatid cysts with viable protoscoleces. Protoscoleces evaginate and attach to the mucosa of the small intestine of the animal, where they grow and develop into the adult stage Although the parasites penetrate deep into the mucosa, there are no pathogenic effects from this stage of the life cycle, even in animals harboring thousands of parasites(Gavidia *et al.,* 2008).

E. granulosus requires both an intermediate host usually(a sheep, a cattle,or a swine), and a primary canine host. A man becomes both an accidental and an intermediate host through contact with infected dogs or by ingesting food or water contaminated with eggs of the parasite. One can never be surprised to find out that this disease is most commonly found in the temperate and sheep-raising areas of the world (Gavidia *et al.,* 2008).

The parasite's domestic life cycle is maintained through dogs (which harbour the adult tapeworm) and a range of domestic livestock intermediate host species, including goats, sheep, cattle and camels. Due to the high biotic potential of E.granulosus, infected dogs can excrete a large number of parasite's eggs with their faeces, contaminating wide range of soil, and spreading the disease,The parasite spends most of its adult life in the intestine of the definitive host, particularly in dogs (Ibrahim , 2010) .

The adult parasite produces eggs that shed with faeces and contaminate the pasture. The intermediate hosts, commonly herbivores ingest the egg while grazing and then hydatid cysts develop in their body. Human beings suffer from the disease if exposed to the eggs accidentally or consumed with contaminated green food or water (Melaku *et al.*, 2012). The definitive host is infected by ingestion of infected offals of herbivores. The infection rate to dogs is directly proportional to the fertility of cysts (Melaku et *al.*, 2012). So cyst characterization is important to assess the infectivity of the parasite. Adult cestodes live attached deep in the mucosal crypts of small intestine of dogs . The parasite is 3 to 6 mm long. It has 22 large hooks and 18 small hooks on scolex and usually has three proglottids, of which only the last is gravid (Acha and Szyfres, 2001).

The gravid proglottid contains several hundred eggs , detaches from strobila is expelled with feces , and distintegrates in the environment. Each egg contains an embryo (oncophere) with six hooks (hexacanth), which is infective when ingested by intermediate host and continue its development. Intermediate hosts are sheep, goats, bovine ,swine, equine, camelids, canids and man. The most common localization of these cysts in the intermediate hosts are the liver (in about two-thirds of the cases) and the lungs (in about fourth of the cases) . On rare occasions they may become situated in some other organs such as the kidneys, spleen, bones and brain (Acha and Szyfres,2001).

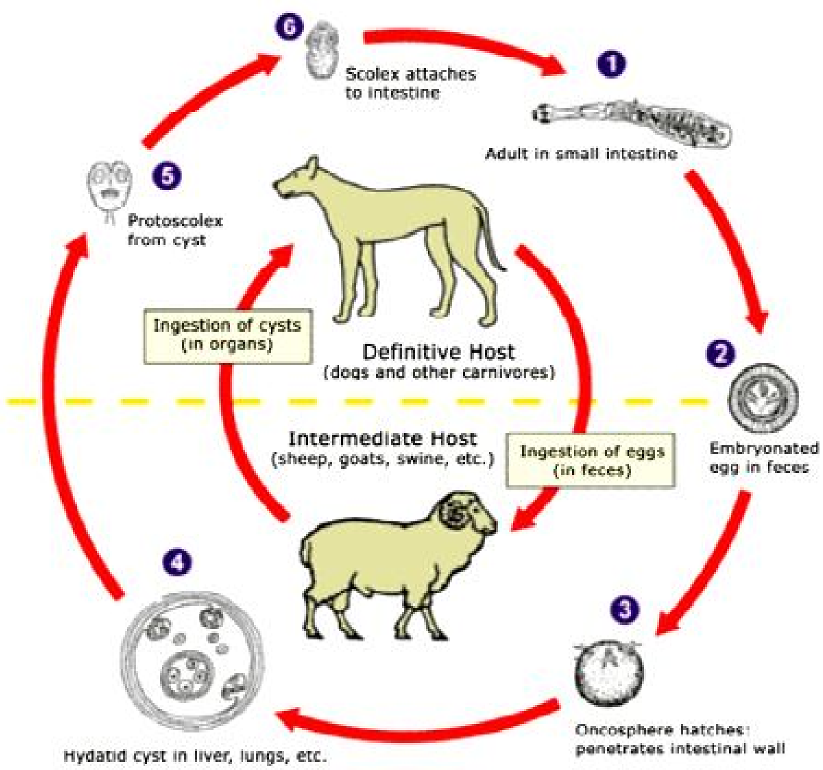


Figure (1): Life cycle of *Echinococcus species* (El-Ibrahim**,** 2009).

The disease state caused by *E. granulosus* is sometimes 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(Shakespeare , 2001) .

Disease description :

The disease does not produce any clinical signs in animal 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 human the cyst can reside and grow in 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 North Kordofan , hydatidosis may be one of the major infectious zoonotic diseases becuase most slaughter house in North Kordofan are not well qualified , where sheep , cattle and goats are still slaughtered traditionally and carcasses wastes are easily accessible to scavenging dogs and other wild carnivores, which are roaming freely and in large groups every where, due to absence of control programs for killing stray dogs by veterinary services . Because there is no study or only scantly study so this study is therefore undertaken to determine the spread of animal hydatidosis among slaughtered animals and breed of animals infected with hydatid cyst disease . Since the animals share the same life cycle as man , therefore determination of the prevalence of the disease in North Kordofan is very important in order to explore the size of the problem which helps to control the disease.

Objectives :

The objectives of this study were:

1\ To estimate the prevalence of sheep hydatidosis in North Kordofan.

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

Chapter One

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***

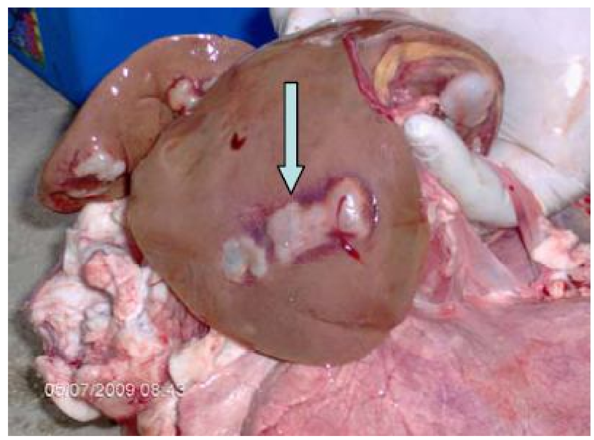
E. gr.canadesis

1.2 Etiology :

The adult and larval stage (metacestode) of cestodes of the genus echinococcus family taenidae, of the four species in the genus *Echinococcus*, namely *Echinococcus granulosus, Echinococcus multicelularis, Echinococcus vogeli and Echinococcus oligan*. The first two species are of veterinary medicine and public health significance. *E. granulosus* is found in the small intestine of carnivores (particularly the dog) and the metacestode (hydatid cyst) is found in a wide variety of ungulates (sheep, cattle, pigs, goats, horse and camels) and man.(Terefe *et al.*, 2012).

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,. 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 Epidemiology:

A three - year (2005-2007) retrospective study was carried out to investigate the occurrence of cystic echinococcosis in cattle and sheep slaughtered at Arusha municipal abattoir, Tanzania. A total of 115186 cattle and 99401 shoats were slaughtered, cattle liver, lungs, spleen and heart condemnation rate was 16.35%, 13.04%, 2.09% and 3.06% respectively, while 17.63%, 7.63%, 0.38% and 0.04% of shoats liver, lungs, spleen and heart respectively condemned. Highly significant ($P<0.001$) cystic echinococcosis infection rate was recorded in shoats (6.05%) than in cattle (40.2%) probably because of differences in grazing patterns (Omer, 2013).

In another study cattle lungs were more affected by CE (22.5%) than liver (19.7%), Three hundreds seventy cysts coming from 50 humans, 166 cattle, 155 sheep and 3 camels were collected in order to establish some epidemiological molecular information in Tunisia for the first time (M'ad *et al.*, 2005). The analysis by PCR-RFLP of I+SI sequence showed that all the human, ovine and bovine cysts were due to the common sheep strain by *E. granulosus*. (M'ad *et al.*, 2005). In Algeria, cystic echinocossosis is serious economic and public health problem. Examination of 6237 carcasses in a slaughterhouse showed high infection and fertility rates in cattle and camels. Using molecular biology approach to identify the *E. granulosus* strain (s) involved, 45 samples from various origins were collected. They were analysed using comparison of PCR amplified DNA sequences with one genomic (BG⅓) and two mitochondrial (Co1 and NAI) targets. Results show the presence of “sheep” strain of *E. granulosus* in North Algeria circulating between cattle and ovine and infectious to human, whereas in South Algeria, a “camel” strain and a “sheep” strain were found to circulate in camels and sheep respectively (Bardonnet *et al.*, 2003).

An infection rate of 8.4% with cystic echinococcosis was recovered among 1,050 sheep, goats, cattle and camels in Shanat abattoir in Al-Jabal, libya. Of 338 goats, 18 (5.4%) goats were infected. Of 124 cattle, 8 (6.4%) cattle were infected and of 40 camels 14 (35.0%) camels 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% was in lungs and 12.5% was in the spleen , The cysts of all infected cattle (87.5%), except one cow (12.5%), were sterile . In an attempt to establish the prevalence of cystic echinococcosis, a study was conducted on slaughtered animals in three divisions of Northern Turkana, Kenya , A total of 5752 goats, 588 sheep, 381 cattle and 70 camels were examined at slaughter. Hydatid cysts were found in 19.4% of the cattle, 3.61% of sheep, 4.5% of goats and 16.4% of camels. The prevalence of cystic echinococcosus in cattle, sheep and goats was higher in Lokichogio than in either Kakuma or central divisions. The prevalence of the disease in camels was higher in central (84.6%) than either Lokichogo (70.6%) or kakuma (50%). The differences in prevalence rates in different study areas are attributed to differences in environmental conditions (Al-Khalidi , 1998).

Hydatidosis, caused by hydatid cysts, is a widespread and hazardous disease in humans and animals worldwide. The disease is very common in Turkey, causing serious economic losses. In a previous study, the seroprevalence of hydatidosis was determined by enzyme-linked immunosorbent assay (ELISA) and indirect fluorescence antibody technique (IFAT). A total of 597 serum samples were collected from cattle of various breeds and ages in eight provinces in Eastern Turkey. Partially purified cyst fluid antigen from sheep hydatid cyst fluid was used as antigen in ELISA and whole protoscolex antigens were used in IFAT. The results showed that 63.3% and 54.9% of 597 cattle were positive with ELISA and IFAT, respectively. The highest seroprevalence was in Mub (85.3%) and the lowest was in Kars (46.6%) by ELISA. The seroprevalence was between 77.3% (Muß) and 35.1% (Erzurum) by IFAT (ŞimŞek *et al.*, 2005).

The variation in cystic echinococcosis prevalence and mean intensity was studied in relation to site, season and host age and sex. A total of 12,911 slaughtered animals, 140 camels, 2668 cattle, 6525 sheep and goats 3578 were inspected for hydatid cysts in Al Baha region, Saudi Arabia, in three study areas during four seasons from June 2008 to May 2009 (Ibrahim, 2010). The prevalence of infection was 32.85%, 8.28%, 12.61% and 6.56% in camels, cattle, sheep and goats respectively. The prevalence of the parasite varied significantly in relation to site, season and host age classes and sex in most host species. Spring showed the highest prevalence in camels, cattle and sheep. A significant association was found among host age classes and likelihood of infection in all examined hosts and the oldest age class was significantly more likely to be infected. The main effects in parasite intensity were host sex and age in most examined host species. A positive correlation was found between intensity of CE and host age class in all animal species examined. The most commonly infected organs were liver and lungs which constituted 48.75% and 32.83% respectively, of the total infected organs. There was a significant difference among host species in fertile cysts ($P < 0.0001$). The higher percentages of fertile cysts were in sheep (47.67%) and goats (23.99%) indicating that sheep and goats are the most important intermediate hosts for *E. granulosus*. Examined hydatid cysts of the liver had a higher fertility rate (38.79%) than those of the lungs (25.13%). Cysts size ranged from 1 to 8 cm in diameter. The mean cyst diameter was found in the lungs higher than that in the liver in all hosts. The range in the number of cysts was 1–33 in infected animals. The mean number of cysts was higher in lungs than that in liver in all examined animals. The viability rate of protoscoleces of liver fertile cysts (62.20%) was significantly higher than that of lung cysts (52.73%). In conclusion, these findings of infection, mean abundance and fertility rates of

CE in slaughtered animals, prompt plans for further epidemiological studies and control programmes (Ibrahim , 2010).

Another 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, 2011). An abattoir survey was carried out in 849 cattle and 3850 sheep slaughtered in the study area during January 2010 to June 2010. 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, 2011).

A previous study was conducted to determine the prevalence of hydatidosis in dogs(Salem *et al.,* 2011). The prevalence rate was 14%. The average number of *E. granulosus* per dog was 172 and 1227 on the positive dogs. Concerning the livestock, hydatid cysts found in 30.1% of the dromedary , 5.5% of the cattle and 6.5 of the sheep. The fertility rate of hydatid cysts in humans 75% and camels 76% was significantly higher than that of sheep 24% and cattle 23% (P<0.0001). Hydatid cyst infestation is characterized globally by the dominance of pulmonary localizations in humans 50% and camels 72.7% and in the liver in sheep (76.1%) and cattle (82.3%).(Salem *et al.,* 2011).

Another study was performed to determine the prevalence of hydatid cysts in slaughtered livestock in Uramia city (Tappe *et al.*, 2011). In this descriptive cross sectional study, arranged with the veterinary office and slaughterhouse of Uramia, 4564 livestock slaughtered were investigated for hydatid cysts. The isolated innards of the slaughtered animals were examined of having hydatid cyst by trained experts administrated by researchers. If a cyst be traced by experts, all information about slaughtered livestock and contaminated organ were recorded on special sheets and then sent to the Research Laboratory of Parasitology Department, Medicine Faculty, to determine its fertility status. Of 4564 livestock studied 245 (5.4%) were infected by *E. granolosus*, among them, 2.7% were sheep, 8.6% were cattle, and 12.9% were water buffalos. The highest frequency of cysts was pulmonary type of hydatid cyst. About 38% of cysts were fertile and the other 62% were infertile. The fertility rates of hydatid cyst in sheep, was 37% for liver and 26% for lung, in water buffalo, it was 46% for liver and 44% for lung, and in cattle, it was 43% for liver and 39% for lung infection. The results of this study showed that the rampancy of contamination by hydatid cyst as well as its fertility rate was obviously high in slaughtered water buffalos. (Tappe *et al.* , 2011).

A previous study was conducted to determine the prevalence of hydatid cyst disease in cattle, camel, sheep and goats, over a one year period (Oct 2003- Sept 2004) (Abdullahi *et al.*, 2011). Forty six thousand two hundred and twenty three (46223) cattle , 3545 camel, 16345 sheep and 14134 goats were examined at post mortem for evidence of hydatid cyst lesions. Prevalences of 0.07%, 8.97%, 0.14% and 0.03% were found for cattle, camel, sheep and goats, respectively. Locations of the cyst lesions in the examined animals shows liver was the most predominant site in cattle 61.76%, sheep 78.26% and goats 75.0%. For camels, lungs showed the most number of CE lesions 91.51%. Overall, the least number of hydatid cyst lesions were observed in the heart. There was significant association (p <

0.001) between the species of animals and infection. (Abdullahi *et al.*, 2011).

A previous study was conducted to determine the prevalence of *E. granulosus* in domestic and wild carnivores and the infection rate of hydatid cyst in slaughtered animals and people in Kashan area, central Iran (Arbabi and Hooshyar, 2006). A total of 14 carnivores including 70 stray dogs, 40 jackals, 22 red foxes, and 10 wolves were examined for the presence of *E. granulosus*, as well as, 170510 slaughtered sheep, 162665 goats and 13059 cattle for hydatid cyst infection. In addition, 500 inhabitants in rural areas were examined for antibodies to hydatid cyst. Results indicated that 43.7% of carnivores were infected with *E.* granulosus. Infection rate in slaughtered animals was 2.7%.Overall, the seroprevalence rate in human cases was 2.4%. Eighty-five patients including 47 females and 38 males were hospitalized. The mean annual incidence rate of hydatidosis in human was three cases per 100 000 populations. In general, the situation of hydatidosis in the livestock and human and echinococcosis in carnivores of the Kashan is similar to the other zones in Iran (Arbabi and Hooshyar, 2006).

Hydatidosis / echinococcosis (*Echinococcus granulosus*, Batsch, 1786) is 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, 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, 8036/22,863 (35.15%) cattle, 768/6518 (11.78%) sheep, 36/1753 (4.9%) goats, 70/417 (16.79%)

camels and 0/150 (0%) pigs slaughtered in 21 different abattoirs located in various parts of the country were found harbouring hydatid cysts. A statistical discernible significant difference ($p<0.001$) 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. Their 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 serves as a quick reference source on hydatidosis in the country and basis for future studies (Formsa and Jobre, 2011).

Another study was conducted in order to determine the prevalence of hydatidosis and the fertility/sterility rates of hydatid cysts in cattle and sheep slaughtered in Addis Ababa Abattoir, Ethiopia (Fikire *et al.,* 2012) . Postmortem examination, hydatid cyst characterization and questionnaire survey were conducted. In the study, 19.7% cattle and 13.47% sheep were found harboring hydatid cyst. Though it was difficult to know the exact origin of the animals, cattle brought from Harar 36%, northern Shewa 28%, Nazareth 22%, Arsi 10% and others 4% were infected. Difference in prevalence rates were highly significant ($p < 0.005$) between cattle and sheep. The occurrences of hydatid cyst were 48, 31.7, 16.3, 1.7 and 2.4% in cattle and 41.7, 56.7, 0.8 and 0.8% in sheep, lung, liver, kidney, spleen and heart, respectively. Of the total of 1479 hydatid cysts in cattle and 175 in sheep counted 38.2, 29.8, 7.3, and 24.7% in cattle and 64, 11.4, 1.7 and 22.9% in sheep were found to be small, medium, large and calcified cysts, respectively. Among the hydatid cysts, 55.4, 19.3 and 25.3% in cattle (n = 1479) and 22.5, 59.1 and 18.5% in sheep (n = 175) were sterile, fertile and calcified, respectively. Viability rates of 60.5% in cattle and 78.3% in sheep were observed. The rate of calcification was higher in the liver than in the lung while fertility rate was higher among the cysts of the lung for both cattle and sheep (Fikire *et al.,* 2012).

Another study was conducted in order to investigate the percent of infection with hydatid cystic disease (HCD) in human and slaughtered animals in Erbil province, Kurdistan-Iraq. For humans a statistical analysis of documents, 149 cases have been recorded due to cystic echinococcosis, and treated surgically in private and governorate hospitals in Erbil province. Among a total of 17598 patients admitted to the surgical department, 0.846 % of which were found to be infected with cystic echinococcosis, and about 6.3 /100,000 persons among Erbil population. The results of this study showed that the number and rate of infection in rural was 82 (55.03%) higher than in urban 67(44.97%). According to the occupations of patients, housewives were highly infected than others, and among different organs involved, liver was higher infected 83 (55.7%), and then lungs 30 (20,1%). In comparison to age groups, the highest rate of infection was found among the age group 41-50 years 29 (19,46%). During the examination of 1090 sheep, 360 cows and 240 goats, their infection rates was 121 (11.1%), 28 (7.77%) and 4 (1.66%) infected with cystic echinococcosis, respectively. The livers of these infected animals had the highest involvement, and as follows: 50.4% in sheep, 75%in cows and 25 % in goats. The percent of fertile cysts in infected animals were: sheep (94.11%), cows (80.64%), and goats (91.66%). The viability of protoscolices were as follows: in sheep (92±3.256% in liver and 85±2.350% in lungs), cows (78±4.23% in liver and 70±3.15± % in lungs) and goats 90±2.15 in liver and 86±2.25 in lungs). The economic losses due to cystic echinococcosis of 149 patients treated surgically was approximately 372,500,000 ID or 298,000 US$ and in slaughtered animals the losses of 153 animals infected were 1579000 ID or 1338 US$.(Saida And Nouraddin, 2011)

In another survey, internal organs of 1,200 sheep and 1,200 goats, including liver, lung, heart, and kidney, were randomly inspected to estimate prevalence rate of hydatidosis and its relationship with season, sex, age, and infected organs. It was found that a total of 335 (27.9 %) of the 1,200 slaughtered goats and a total of 546 (45.5 %) of the 1,200 slaughtered sheep were infected with the hydatid cysts. Prevalence of hydatidosis in females was significantly ($p < 0.05$) more than males, and the infection rate was significantly ($p < 0.05$) increased by age. The most infected organs were liver and lung, respectively, and the least infected organs were kidney and heart, respectively. High prevalence of hydatidosis in Iran can be a result of conventional slaughtering of sheep and goats, availability of carcass westal and offal for scavenging stray dogs and other wild carnivores, and close relation between shepherd dog and these animals. The prevalence rate can be decreased by interrupting *Echinococcus granulosus* life cycle, stopping illegal slaughtering, and increasing public awareness about the infection. (Khanjari *et al.*, 2012).

Another study was performed to determine the prevalence and types of hydatid cysts in slaughtered livestock in Urmia city. In this descriptive cross sectional study, arranged with Veterinary Office and Slaughterhouse of Urmia, all 4564 livestock slaughtered along the study were investigated of having hydatid cyst after butchering and separation of internal organs. The isolated innards of the slaughtered animals were examined for presence of hydatid cyst by trained experts administrated by researchers. If a cyst be traced by experts, all information about slaughtered livestock and contaminated organ were recorded on especial sheets and then the cyst were sent to Research Laboratory of Parasitology Department of Medicine Faculty of Urmia city to determine its fertility status. Of 4564 livestock studied 245 (5.4%) were infected with Echinococcus granolosus, among them, 2.7% were sheep, 8.6% were cattle, and 12.9% were water buffalos. The highest frequency of cysts was pulmonary type of hydatid cyst. About 38% of cysts were fertile and the other 62% were infertile. The fertility rates of hydatid cyst in sheep, was 37% for liver and 26% for lung; in water buffalo, it was 46% for liver and 44% for lung; and in cattle, it was 43% for liver and 39% for lung infection. The results of this study showed that the rampancy of contamination by hydatid cyst as well as its fertility rate was obviously high in slaughtered water buffalos. So, because of economic forfeitures of obliteration of these contaminated entrails and to prevent the transmission of the infection to human, it is extremely necessary to control propagation of the disease in this region.(Tappe *et al.*, 2011).

Another study was conducted to determine the incidence and geographical distribution of hydatidosis was examined in sheep from ten localities in Libya. A total of 402 cases of hydatid disease (7.85%) were confirmed in a total of 5118 sheep examined; 12.74% of adult sheep were infected, but only 0.29% of lambs. The liver was the organ most commonly infected (97.26% of all infections), followed by the lungs (58.70%), kidneys (1.76%), spleen (0.74%) and heart, mesentery and muscles (0.24% each). The intensity of infection varied from one to more than ten fertile or sterile cysts. Infections were light in 43.73% of livers and 47.03% of lungs, medium in 33.24% of livers and 42.79% of lungs, heavy in 13.55% of livers and 7.62% of lungs, and very heavy in 9.96% of livers and 2.54% of lungs. A total of 73.13% of the infections were found to be fertile, 18.90% sterile and 7.96% both sterile and partly calcified. Lung hydatids tended to be more fertile than liver cysts(Al-Khalidi , 1998).

In another study, 115 stray dogs (56 males and 59 females, mixed breed), 86 golden jackal (*Canis aureus*, 42 males and 44 females), 60 red foxes (*Vulpes vulpes*, 33 males and 27 females), and three female wolves (*Canis lupus*) were examined for *Echinococcus granulosus* infection, as well as, 32898 sheep, 10691 goats, 15779 cattle and 659 buffaloes for hydatid infection from five provinces in western Iran during 3 years (1997–2000). Meanwhile fertility rates of different types and forms of cysts isolated from infected animals and the viability of protoscolices were also determined. Results indicated that 19.1% of the dogs, 2.3% of the golden jackals and 5% of the red foxes were infected with *Echinococcus granulosus*. 11.1% of the sheep, 6.3% of the goats, 16.4% of the cattle and 12.4% of the buffaloes were also found to be infected with hydatid cyst. The cysts isolated from liver and lungs of the sheep show higher fertility rate than the cysts of liver and lungs of goats, cattle and buffaloes.(Dalimi *et al.,* 2002).

In another study age-prevalence and age-intensity data of *Echinococcus granulosus* infection in sheep populations were collected in an abattoir in the Xinjiang Uygur Autonomous Region, People's Republic of China. The frequency distribution of the larval cysts per sheep was empirically described by the negative binomial model, with parameter *k* being 0.5273. A mathematical model for the life cycle of *E. granulosus* was applied to the collected data and the results show that the infection pressure on sheep was 0.4362 (female) or 0.4119 (male) infections per year, the mean number of cysts increased linearly by 0.8824 (female) or 0.9971 (male) cysts every year and acquired immunity was too low to depress this rate of increase. According to certain definitions of steady states for taeniid populations, it was concluded that at least in some parts of Xinjiang, the life cycle of *E. granulosus* was and may still be in an endemic steady state. Consequently, the regular dog-dosing program would readily drive the infection from an endemic state towards extinction.(Ming *et al.,* 1992).

In abattoir study, 514 camels, slaughtered for meat production in different areas of northern Libya were examined for the presence of cystic echinococcosis (CE). In addition, 367 sheep and 184 goats were examined. The overall prevalence of infection with CE was 48% in camels, 15.8% in sheep and 3.8% in goats. The infection rate, number and size of cysts were significantly higher in older camels. In six city abattoirs across northern Libya, i.e. Zawia, Tripoli, ElKhumes, Mesurata, Sirt and Benghazi, the prevalence rate of infection in camels ranged from 38.7% to 55.2%, in comparison with sheep and goat rates which were between 0% and 37.9%

and 0% and 8.2%, respectively. In camels, the lungs were the most frequently infected organs (85.4%) with liver cysts occurring at a significantly lower rate (33%). In contrast, the liver was the predominant infected site with prevalence values of 86% and 100% in sheep and goats, respectively. More than 90% of camel hydatid cysts were fertile. (Ibrahem and Craig, 1998) .

Another study demonstrated that human hydatidosis was generally due to G1 genotype of *Echinococcus granulosus* throughout the world. Nevertheless, some other genotypes, such as G3, were recently identified for human cyst. The present work confirms the predominance of the sheep strain G1 in humans, bovine and ovine and demonstrates for the first time the occurrence of the buffalo strain G3 in human and bovine in Tunisia (M'rad *et al.,* 2010).

In another study, a total of 2871510 sheep slaughtered in the governmental abattoirs over five years (1995-1999) showed an overall hydatidosis of 0.33%. The highly infected site was the lung followed by the liver. Cystic infection in other sites rarely occurred. Generally hydatidosis is not a so dangerous public health problem in Egypt. However, sheep play the important role in dissemination of the disease. This is due to the fact that their cysts are the highly fertile ones as compared to other animal intermediate hosts. So, the risk cycle in hydatidosis is sheep-dog-man.(Haridy *et al.,* 2000).

In Ethiopia a total of 6518 sheep were slaughtered in 9 abattoirs, of which 768 (11.78%) were found infected with hydatid cysts. Furthermore, 531(8.15%) had hydatid cysts in the lungs, 483 (7.41%) in the liver, 21

(0.3%) in the spleen, 8 (0.12%) in the kidneys and hearts. In most of Ethiopia abattoirs, the infection prevalence reached 10%. In Assela, the recorded prevalence was higher in the most recent report of 1997 (53.5%, 130/243) than in 1990 (2.18%, 3/137). Similarly, in Kombolcha, the recorded prevalence was higher in 1996 (15.1%, 93/617) than in 1989 (4.4%, 39/888). The aggregated highest prevalence (35%) was recorded in Assela and the lowest prevalence (6.63%) in Nazareth abattoirs(Formsa and Jobre, 2011).

1.5 Geographical distribution:

The global distribution of the parasite **(**Figure:3) is due in part to its ability to adapt to wide variety domestic and wild intermediate hosts. The disease occurs throughout the year as long as final hosts are available .(Terefe *et al.,* 2012).

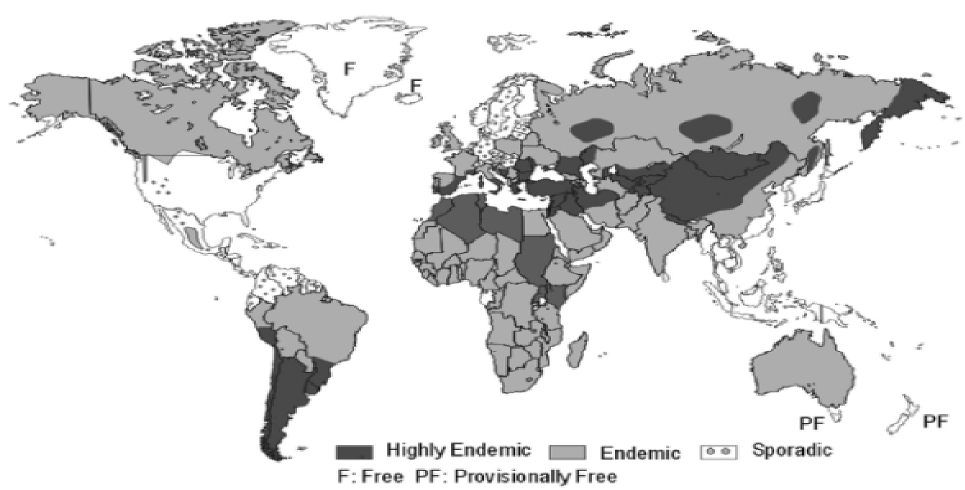
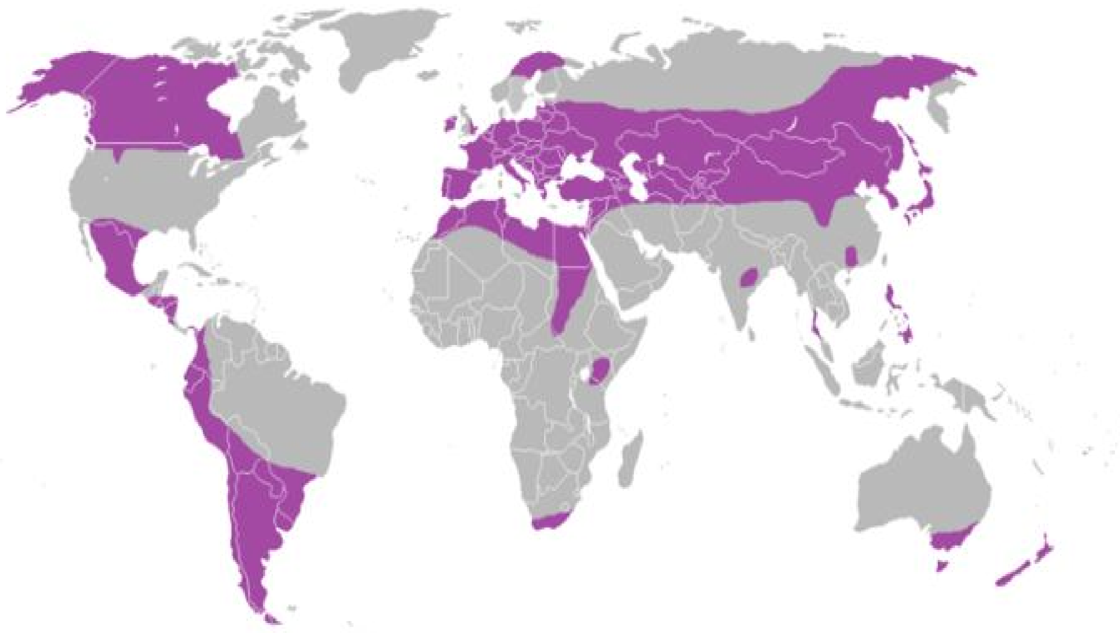


Figure:3

World distiribution of *Echinococcus* . (Eckert *et al.*, 2001).



Infection with *E. granulosus*

No infection

Figure 4 :
Global distribution of *Echinococcus granulosus* (Omer, 2013).

E. granulosus is the most widespread (Figure 4) of the species with areas of high endeminicity in southwestern Asia, northern Africa ,Australia, Kenya and Uganda. The distribution of *E. multilocularis* is limited to the northern hemisphere . The most Important endemic areas are northern Tundras of Europe, Asia, America and central Siberia, *E. oligarthrus* and *E. vogeli* are present only in South and Central America. Although the areas of infection coincide, since the definitive host of *E. vogeli* exists only from Panama to northern Argentina, cases of polycystic hydatidosis outside this area are probably imported or due to *E. oligarthrus.* (Acha and Szyfres, 2001).

1.6 Diagnosis:

In man combination of imaging and serology usually enables diagnosis. The standard diagnostic approach for cystic echinococcosis involves imaging techniques, predominantly ultrasonography, computed tomography (CT), X-ray examinations, and confirmation by detection of specific serum antibodies by immunodiagnostic tests. Enzymelinked immunosorbent assay (ELISA) test using hydatid cyst fluid has a high sensitivity (>95%) but its specificity is often unsatisfactory. Finding a cyst using ultrasound, X-ray, or CT is typically expected in Echinococcus infection (Bek\cci., 2012).Human infestation with *E. granulosus* determines an increased production of seric immunoglobulins and the formation of IgG, IgM, IgE and IgA specific antibodies .It is known that IgG is high in the whole current infestations and in any localization, and it persists a different number of years after the ablation of the cyst (Florea *et al.*, 2011).

The most valuable diagnostic method in pulmonary hydatid disease is the plain chest radiograph, Compared with human diagnostic testing and research, little has been done in the intermediate hosts such as sheep and cattle. The diagnosis of Hydatid cyst in animals is based on necropsy procedures or during meat inspection in slaughterhouses. Serological screening in livestock is difficult due to cross-reaction with other cestodes such as *Taenia hydatigena* and *Taenia ovis.* Moreover, these intermediate hosts do not have strong antibody responses compared to humans. For instance, sheep antibodies to several antigens, including antigen 5, are only detectable in a subset of infected sheep. Antigen detection is also not useful for diagnosis (McManus *et al.,* 2003).

1.7 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., 2012). During 1984–1986, the World Health Organization (WHO) 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. 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., 2012).

In animal experiments, it has been shown that 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/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. Bone marrow toxicity probably occurred in two sheep (Morris *et al.*, 1985).

In human patients, serum drug levels of MBZ and ABZ may vary widely in individual patients, and correlation with oral doses and drug efficacy is inconsistent. Drug dosing in conjunction with a fatty meal improves intestinal absorption of benzimidazoles . The use of praziquantel (PZQ) (Biltricide®, Bayer, Germany), a heterocyclic pyrazinoisoquinoline derivative, has been proposed at a dose of 40 mg/kg bw once a week concomitantly with benzimidazoles. The PZQ might also be useful in cases of cyst content spillage during surgery. A recent study has shown that a combined treatment with albendazole (10 mg/kg/day) and praziquantel (25 mg/kg/day) given during the month prior to surgery increased the number of patients with nonviable protoscoleces as compared to monotherapy with albendazole , However, further studies are needed for evaluating the efficacy of the combined treatment. According to the manufacturer, the plasma levels of albendazole metabolites (sulphoxide) are increased 4.5 times if praziquantel is given simultaneously, and this may increase the rate of side effects . Hospitalisation is usually not necessary, but regular follow-up examinations are required. Costs of anthelmintics and repeated medical examinations may be considerable . The treatment in the intermediate animal host for *E.granulosus* is not justified. Cysts do not cause any symptoms and rarely affect sheep production (or at least, it is difficult to assess) Therefore, studies of the treatment of infected sheep are only a step before therapy can be implemented for humans. Sheep infection closely simulates what happens in human infections(Morris, 1985). Attempts to find therapies other than benzimidazoles have been made in sheep; studies have tested ivermectin, OXF, nitazoxanide (NTZ), and most recently, genistein. Synthetic genistein derivatives have exhibited some activity against protoscoleces by damaging the structural integrity of the germinal layer within 5 to 7 days of *in vitro* treatment (Omer, 2013).

1.8 Control :

A vaccine to protect sheep, goats, and bovines against hydatid disease caused by the cysts of *E.granulosus* is prepared as a recombinant fusion protein expressed in *Escherichia coli* . Solubilised inclusion bodies are injected, together with Quil A, subcutaneously on two occasions 1 month or more apart, and induce protection against infection which lasts for at least 12 months. A third injection given 6_ 12 months after the second injection induces a high and long-lasting protection against artificial or natural challenge infections. This review describes work carried out on the formulation, safety and efficacy of the vaccine under laboratory and field conditions, using artificial or natural challenges with E. granulosus eggs, followed by necropsy. Hydatid control programmes based on regular treatment of all dogs with the correct dose of a highly-efficient anthelmintic have sometimes not been successful in Continental environments. Access to dogs is difficult in summer because of the distances to summer pastures, and is often impossible in winter because of snow. A control program using strategic twice-yearly anthelmintic treatment of dogs is likely to be successful provided grazing animals are vaccinated as well. Vaccination as a control tool only requires the veterinarians to visit two times a year, and during veterinarian is visit, the dogs can be treated with anthelmintic for little additional cost. One visit should take place after the autumn kill of animals for winter consumption, and this is a good time to vaccinate animals born in the summer, and also all other animals while they are healthy and immunologically responsive. The other visit should take place in the spring, at which time animals born during winter can be vaccinated. Although a single immunization has been shown to induce a useful degree of protection, where possible it is best to give two initial injections, 1 month apart. If it is possible for veterinarians to stay in the field for 2 months in November/ December and March/April, in order to give the two injections, a more rapid onset of full protective immunity will initially be achieved than if the injections are given 6 months apart. A large-scale safety and efficacy trial involving 50,000 and 100,000 lambs in Qinghai and Xinjiang Provinces of China has taken place. Results have confirmed safety and efficacy. In most countries, prevalence of infection increases with age. The vaccine has no effect on established cysts, and therefore, in order to prevent the biomass of Echinococcus spp. from increasing, it might be an effective strategy to begin a control programme by vaccinating all animals. Because many of the older stock will already be infected, they will remain a source of infection for dogs for the average lifetime of the stock. Dogs will still be able to be infected from the older stock, and will continue to infect humans. We advocate that a vaccination programme be accompanied by education about hydatid disease, and anthelmintic treatment of dogs in late autumn and early spring. .(Heath *et al.,* 2003).

Experimental vaccine trials against hydatid disease have been undertaken in sheep using the EG95 recombinant vaccine. Challenge infection was with viable *Echinococcus granulosus* eggs obtained from a New Zealand isolate (dog/sheep cycle), an Australian isolate (dingo/wallaby cycle) and an Argentine isolate (dog/sheep cycle). Vaccination with EG95 conferred a high degree of protection against challenge with all three parasite isolates (protection range 96–100%). Taken together, the trials demonstrated that 86% of vaccinated sheep were completely free of viable hydatid cysts when examined approximately 1 year after challenge infection. Vaccination reduced the number of viable cysts by 99.3% compared with unvaccinated controls. These results suggest that the EG95 vaccine could have wide applicability as a new tool for use in hydatid control campaigns.(Lightowlers *et al.*, 1999).

Chapter Two

Materials and Methods

2.1.1 Study area:

The study was conducted at El-obied slaughter house in North Kordofan (Figure 5). North Kordofan lies in arid and semi-arid zones between Latitidues 11.15-16.45 N and longitudes 27-32.15 E. It also includes desert climate zone on the far northern parts and more humid climate to the south. The northern parts of North Kordofan State lie in the desert and semi-desert. May and June are the hottest months, July to October are the rainy months while December to February are the coldest months. In general two air movements affect the climate of the area. Avery-dry movements from the north to the southt in mid-winter and a moisture from the south and brings rains. The state covers an area of 58.7 million feddans (25 million hectars) out of which 14.5 million hectar are rangeland . The livestock population, mainly cattle, sheep, goats and camels are about 6894425 head (Goma, 2008). Generally, the state can be divided into four ecological zones extending from North to South as follows:-

- The desert zones with rainfall ranging between 0-75 mm per annum.
- The semi-arid zone with annual rainfall ranging between 75 - 300 mm per annum.
- The arid zones with poor savannah in sandy soil (central zone) with rainfall between 300 - 400mm per annum.
- The low rainfall savannah in clay soil zone with rainfall ranging between 400-500mm per annum.

The population of the state is 3.75 million, according to National gensus (1993) of which 64% are rural, 24% nomads and 13% urban. Animal population estimated at 5 to 6 millions animal unit . Water availability, social service and land for agriculture are the main determining factors for population settlements. The main people activity is agriculture, the major crops that are produced in the study area are millet, sorghum and ground nuts. The major cash crops are sesame, Hibiscus, watermelon, groundnut, Arabic Gum vegetable . Major tribes are Bederia, Shiweihat, Kababish, Kawahla, Hamar, Dar Hamid, Jawama and Maganeen (Goma, 2008).The animals examined in this study originated from six regions in north Kordofan state. These six regions, are Om simima , Elnihood, Bara, Elkhoway, Gibash and Elobied .

2.1.2 Criteria for selecting the area :

- Animals come from different States.

- Large numbers of animals.

- Varity of animals species.

- Easily accessible.

Figure 5 : North Kordofan State map (Kahabioa, 2011)

2.1.3 El-Obied slaughter house:

El-obied slaughterhouse is located near a residential area . Thus, constitutes nuisance and endangers the health of the community in the immediate surrounding environment. It is a small low-walled open-air slaughter house with an impermeable sloped killing floor. Its iron-bar doors permit the enterance of dogs specially at night thus, may contaminate the killing floor where dressing and evisceration of sheep, camels and cattle take place . Carcasses are cut into parts and hanged on fixed hooks for inspection. Sewege disposal is by collection into pits and then carried away in tanks to be disposed of in remote areas of town on open places where dogs can gain access to it. Because of the water problem in the town , water supply is insufficient specially during summer for cleaning.

2.2 Study design:

The study design was a cross sectional study which provides snapshot information on occurance of a disease (Martin *et al.* , 1987). A Cross-sectional study was conducted at Elobied slaughter house on three randomly selected days .These selected days were Sunday,Tuesday and Thursday. The animals in these days selected by systematic random sampling method. From each five animals, one was selected for examination.

2.3 Sample Size :

The expected prevalence of ovine hydatidosis for calculation of sample size was taken from the study in Ethiopia in which the prevalence of hydatidosis in sheep was 8.5% (Abiyot *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. 085

$Q^{\wedge}$ ≡ 1- P = 0.96

L ≡ Allowable error

$$\boldsymbol{n}= \frac{4 \text{ x}(0.085)\text{x } (0.915)}{,0025} \cong 124$$

The sample size calculated above (124) was multiplied by 2 to increase precission of the results (Thursfield, 2007).

2.4 Ante –mortem examination :

Regular visits were made by the investigator on Saturday, Monday and Wendesday for ante-mortem examination. A total of 248 sheep were examined in Elobied slaughter house during the survey period which extended from Aprile to August 2013. During the antemortem inspection, the sex, age, breed, body condition and origin(source of animal) of each animals were recorded . The age of animals was determined by Incisors of animals teeth. Body condition of each individual animal was assessed and recorded depending on their body condition score, were ranked as poor or good. Animal origin was also recorded as localities, from which the animal came .

2.5 Post -mortem examination :

During the postmortem examination, visual inspection , palpation and systemic incision of each visceral organs were performed particularly the liver , lungs, kidneys, heart, muscle and spleen . In parallel, the following data were recorded : Serial number, date, infection, infected organ and size of cyst. Infected organs were collected in polyethene bags and taken to Elobied veterinary hospital laboratory for further examination the cyst count, cyst size, cyst fertility and viability of protoscoleces were recorded.

2.6 Laboratory examination :

2.6.1 Examination of cysts:

The fertility of cysts were examined microscopically . Each cyst was cut opened with a pair scissors and the content of the cyst was poured into a clean petri dish. A drop of cyst fluid was put in a clean slide and for clear vision a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on microscope slide with the principle that viable protosclices should completely or partially exclude the dye while the dead ones take it up and then examined under the microscope (40×) for the presence of protoscolices (Ibrahim , 2010).

The viability of protoscolices was determined by flame cell motility. The cyst which contained no protoscolices as well as suppurative, caseaous, or degenerated were considered as sterile cyst .Whenever and wherever the cysts were present, they were removed and incised . The shrunk, evacuated, pus formatted cysts were classified as degenerated cysts, while the solid and sands contained ones were considered as calcified cysts, while the fluid filled ones and had no protoscolices by direct microscopic examination were considered as sterile cysts **(Omer, 2013).**

2.6.2 Size measurement (Volume) :

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

2.7 Statistical analysis :

Results of the study were analyzed using statistical package of social science (SPSS).

First :

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 analyse 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

3. Descriptive statistical analysis frequency tables, cross tabulation and association tables between the disease and risk factors:

3.1 Results:

Of the total 248 sheep inspected, only 4 (1.6%) animals were positive, and the rest were negative for hydatidosis (table 3.1.1).

Table 3.1.1: Distribution of hydatidosis infection among 248 sheep examined in El-obied slaughter house:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-ve	244	98.4	98.4	98.4
	+ve	4	1.6	98.4	100.0
	Total	**248**	**100.0**	**100.0**	

3.2 Sex of animals:

The results of this study showed the distribution of 248 sheep examined for hydatidosis according to sex. Total number of males examined was 66 individuals, while the total number of females examined was 182 (table 3.1.2). Among males, one animal was found infected. Rate of infection within males was 1.5%. While among females, 3 animals were infected. The rate of infection within females was 1.6% (table 3.1.3).

The Chi-square test showed no significant association between hydatidosis infection and sex of animal (p-value = 0.94), (table 3.1.4).

3.3 Age of animals:

Two hundred forty eight sheep of various ages were examined in this study. The presence of cyst in various organs was investigated. The result showed that age distribution of animals, 155 of the sheep were less and equal one years (young) and 93 of sheep were more than one years (old), (table 3.1.2). Among young animals 1 animal was found infected. Rate of infection within young animals was 0.64%. However among adults 3 animals were found infected. Rate of infection within adults was 3.2% (table 3.1.3).

The Chi- square test showed significant association between hydatidosis and age of animals (p-value = 0.118),(table 3.1.4).

3.4 Source of animals:

Of the total 248 local sheep ecotype inspected, 96 animals were from Omsimima,76 animal were from Elnihood,11 animals were from Bara, 50 animals were form Elkhowei,9 animals were from Shikan (El- obied) and only 6 animals were from Gibash.(table 3.1.2). Infected animals found in this study: 4 animals were from Omsimima, 2 animals and Elnihood 2 animals. The rate of infection in Omsimima was (2.08%) , Elnihood (2.6%), Bara 0%, Elkhowei 0%, Gibash 0% and 0% in Shikan. (table 3.1.3).

The Chi-square test showed no significant association between the infection and source of animal (p-value = 0.86), (table 3.1.4).

3.5 Breed:

The results of study showed distribution of hydatidosis in Elobied slaughterhouse according to ecotype. All the ecotypes were local ecotype s, 38 kabashi,145 hamary,34 garag and 31 shorany(crossing between kabashi and hamary) only one animal was positive from each ecotype (one kabashi, one hamary,one garag and one shorany) . (table 3.12). The rate of infection was 2.6% in kabashi breed ,0.7% hamary breed ,2.9% garag and 3.2% in shorany ecotype. (table 3.13).

The Chi- square test showed no significant association between the infection and breed (p-value = 0.59), (table 3.1.4).

3.6 Body condition:

The body condition of animals and the presence of infection were investigated. 206 of sheep were found to be in good condition, while 42 of sheep were found to be in poor condition (table 3.1.2). Among good body condition 4 animals were found infected. The rate of infection within good animals was 1.9%. However no animal was found infected among poor animals. The rate of infection within poor animals was 0.0% (table 3.1.3).

Chi- square test showed no significant association between the infection and body condition (p-value = 0.36), (table 3.1.4).

3.7 Location of cysts:

The location of cysts in different organs was investigated. Our results showed that liver was most infected organ with hydatidosis where in 3 cases, the cysts were found in the livers, and 1case was found in the thigh muscle. No infection was found on lungs or others organ. (Table 3.1.3).

Chi- square test showed significant association between the infection and location of cyst (p-value=0.00). (Table 3.1.4).

3.8 Size of cysts (volume) :

Distribution of small than or equal to 10 ml , more than10 ml and caseaous cysts in organs was listed in(table 3.1.2) . More than 10 ml size cysts has been found in one case and small than or equal to 10 ml cysts have been found in two cases , while the caseaous cyst have been found in one case, (table 3.1.3).

Chi- square test showed significant association between the infection and size of cyst(p-value=0.00) . (table 3.1.4) .

3.9 Fertility of cysts:

Macroscopic examination of the cysts revealed a total of 4 cysts, 3 cysts present in three cases were fertile viable and one cysts were sterile (table 3.1.3).

Chi- square test showed significant association between the infection and fertility of cyst (p-value=0.00). (table 3.1.4) .

Table 3.1.2: Summary of frequency tables for potential risk factors of hydatidosis in 248 sheep examined at El-obied slaughterhouse:

Risk Factors	Frequency	RelativeFrequency %	Cumulative Frequency %
Sex			
Female	182	73.4	73.4
Male	66	26.6	100
Age			
≤ 1 years	155	62.5	62.5
> 1 years	93	37.5	100
Source			
Om simima	96	38.7	38.7
Elnihood	76	30.6	69.4
Bara	11	4.4	73.8
Elkhowei	50	20.2	94.0
Gibash	6	2.4	96.4
Shikan	9	3.6	100
Breed			
Kabashi	38	15.3	15.3
Hamary	145	58.5	73.8
Garag	34	13.7	87.5
Shorany	31	12.5	100

Table 3.1.2 Continued

Risk Factors	Frequency	RelativeFrequency %	Cumulative Frequency %
Body condition			
Poor	42	16.9	16.9
Good	206	83.1	100
Location			
No cyst	244	98.4	98.4
Liver	3	1.2	99.6
Thigh	1	0.4	100
Volume			
Nocyst	244	98.4	98.4
≤10 ml	2	0.8	99.2
>10 ml	1	0.4	99.6
Caseaous	1	0.4	100
Fertility			
No cyst	244	98.4	98.4
Fertile viale	3	1.2	99.6
Sterile	1	0.4	100

Table 3.1.3: Summary of cross tabulation for potential risk factors of hydatidosis in 248 sheep examined at El-obied slaughterhouse:

Risk factors	No. inspected	No. affected (%)
Sex:		
Female	182	3(1.6)
Male	66	1(1.5)
Age:		
≤ 1 years	155	1(0.6)
> 1 years	93	3(3.2)
Source:		
Om simima	96	2(2.08)
Elnihood	76	2(2.6)
Bara	11	0(0)
Elkhowei	50	0(0)
Gibash	6	0(0)
Shikan	9	0(0)

Table 3.1.3 Continued:

Risk factors	**No. inspected**	**No. affected (%)**
Breed:		
Kabashi	38	1(2.6)
Hamary	145	1(0.7)
Garag	34	1(2.9)
Shorany	31	1(3.2)
Body condition:		
Poor	42	0(0)
Good	206	4(1.9)

Table 3.1.4: Summary of univariate analysis for potential risk factors of hydatidosis in 248 sheep examined at El-obied slaughterhouse using the Chi-square test:

Risk factors	No. inspected	No. affected (%)	d.f	Chi-square value	p- value
Sex:			1	0.005	0.941
Female	182	3(1.6)			
Male	66	1(1.5)			
Age:			1	2.4	0.118
≤ 1 **years**	155	1(0.6)			
> 1 **years**	93	3(3.2)			
Source:			5	1.8	0.86
Om simima	96	2(2.08)			
Elnihood	76	2(2.6)			
Bara	11	0(0)			
Elkhowei	50	0(0)			
Gibash	6	0(0)			
Shican	9	0(0)			

Table 3.1.4 Continued

Risk factors	No. inspected	No. affected (%)	d.f	Chi-square value	p- value
Breed:			3	1.9	0.591
Kabashi	38	1(2.6)			
Hamary	145	1(0.7)			
Garag	34	1(2.9)			
Shorany	31	1(3.2)			
Body condition:			1	0. 82	0.36
Poor	42	0(0)			
Good	206	4(1.9)			

Table 3.1.5: Multivariate analysis of hydatidosis and potential risk factors in 248 sheep examined at El-obied slaughterhouse using logistic Regression:

						95 % C.I. for Exp (B)	
Risk factors		**Animals examined**	**Positive (%)**	**Exp (B)**	**p-value**	**Lower**	**Upper**
Sex							
	Female	182	3(1.6)	0.538	0.941	0.46	6.326
	Male	66	1(1.5)	Ref			
Age							
	≤ 1 years	155	1(0.6)	Ref			
	> 1 years	93	3(3.2)	0.108	0.118	0.009	1.265
Source					0.86		
	Om simima	96	2(2.08)	6.46	0.397	0.00	-
	Elnihood	76	2(2.6)	7.90	0.640	0.00	-
	Bara	11	0(0)	0.43	0.751	0.00	-
	Elkhowei	50	0(0)	Ref			-
	Gibash	6	0(0)	0.255	0.664	0.00	-
	Shikan	9	0(0)	0.179	0.311	0.00	-

Table 3.1.5 Continued

Risk factors		Animals examined	Positive (%)	Exp (B)	p-value	95 % C.I. for Exp (B)	
						Lower	Upper
Breed					0.59		
	Kabashi	38	1(2.6)	0.285	0.171	0.016	5.033
	Hamary	145	1(0.7)	Ref			
	Garag	34	1(2.9)	1.770	0.588	0.081	38.850
	Shorany	31	1(3.2)	2.088	0.508	0.092	47.323
Body condition	Poor	42	0(0)	Ref			
	Good	206	4(1.9)	0.000	0.363	0.00	---

Chapter Four

Discussion

The real magnitude of the disease in domestic animals, wild animals and man in the Sudan is still need further investigation . Slaughtered animals may pass through several owners on their way to the slaughterhouse, this may create difficulty to trace infected animals. In the present study the prevalence of hydatidosis in sheep slaughtered in El-obied slaughterhouse, North Kordofan, Sudan was 1.6%. This result is in agreement with the result of another study carried out in Khartoum State in which the rate of infection was 1.4% (Mohamadin and Abdelgadir, 2011). The prevalence of hydatid cyst in this study (1.6%). was lower than the prevalence in other studies in different countries, which was 2.7% in Northwest Iran (Tappe *et al*., 2010), 3.61% in Kenya (Njoroge *et al.*, 2002), 4.9% in Ethiopia (Formsa and Jobre, 2011), 8.4% in Libya (Al-Khalidi , 1998), 11.1% in Iran (Dalimi *et al.,* 2002) 11.1% in Iraq (Saida And Nouraddin, 2011), 12.61% in Saudi Arabia (Ibrahim , 2010), 12.9% in Jordan (Kamhawi *et al.*,1996), 13.47% in Ethiopia (Fikire *et al.,* 2012) and 45.5% in Iran (Khanjari *et al.,* 2012). This might be due to the variation in environmental condition because; the eggs survive 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, the nature of the pasture and the way of raising these animal, levels of exposure and the maturity and viability of eggs (Njoroge *et al.,* 2002). Moreover, the environmental conditions in North Kordofan State are not suitable for the eggs to survive for long periods of time and this strengthens our study and support that, why our prevalence was lower than other studies. However, recent studies have shown prevalences lower than the present prevalence, 0.6% in Sinnar area , Blue Nile State, Sudan (Ibrahim *et al .,* 2011), 0.14% in Nigeria (Abdullahi *et al.,* 2011) and 0.33% in Egypt (Haridy *et al.,* 2000).

The prevalence of hydatid cyst infection according to source of investigated animals (origin) has been estimated in this study. The rate of infection in Om simima was 2.08%, in Elnihood was 2.6%, in Bara was 0.0%, Elkhowei was 0%, Gibash was 0% and Shikan was 0%. There was no significant association between the hydatidosis and origin of the animals (p-value = 0.86). This result is in agreement with the result of another study carried out in Ethiopia (Formsa and Jobre, 2011). The highest rate of infection was found in Elnihood (2.6%) followed by Om simima (2.08). This could be attributed to the geographic location, outdoor rearing in open grazing areas, dense dog population (sheep dogs and wild carnivores) and absence of hygienic elimination of sheep offals which leads to environmental parasite contamination.

This study showed that ewes have numerically higher rate of infection than rams. The rate of infection in female animals was 1.6%, while in male animals was 1.5%. There was no significant association between hydatidosis and sex of animals (p-value = 0.941).

Logically, females have a higher rate of infection than males, because the female remain longer for reproductive purposes so the cysts have a chance to develop. For this reasons female animals have more chances to be exposed to the disease. Although female animals are more affected with hydatid cyst as compared to males, 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 graze together on the same pasture. This result is in agreement with the result of another study carried out in Northwest Iran (Daryani *et al.*, 2009) and in sudan (Abdalraswal, 2011).

With regards to rate of infection of hydatidosis in different age groups of sheep, no significant association (p-value = 0. 118) was observed. Animals of more than one year of age were more affected (3.2%) compared with animals less or equal to one year (0.6%). The difference in infection rate could be attributed mainly to the fact that aged animals have longer exposure time to *E. granulosus* (Khanjari *et al.*, 2012). And also due to the fact that hydatid cyst infection is a chronic disease , the older 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 larger size of cysts. Also the older animal cysts have more time to enlarge. Beside that 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 (Omer, 2013). This result is in agreement with the result of investigation carried out in Sinnar area , Blue Nile State, Sudan

(Ibrahim *et al .,* 2011), in Jordan (Kamhawi *et al.*, 1995), and in Northern Iran (Daryani *et al.*, 2009).

The results of the current study showed that the prevalence of hydatid cyst infection within 2 categories of body condition of the animals was: 1.9% in good body condition and 0.0% in poor body condition. However, there was no significant association between hydatid cyst infection and body condition of animals (p-value = 0.36). This could be attributed to the fact that, the hydatid cyst infection is a mild disease which may not affect the general health of the affected animals. Also lack of variability in relation to body condition might be due to the little tendency of excluding emaciated animals form being slaughtered. This result is in agreement with the result of another study carried out in sudan (Abdalraswal, 2011).

The prevalence of hydatid cyst infection related to breed of animals was 3.2% in Shorany, 2.9% in Garage 2.6% in Kabashi and 0.7% in Hamary. There was no significant association between breed and hydatid cyst infection (p-value = 0.59).

The occurence of hydatid cyst infection in relation to the location of cyst in animals was high in liver. There was a significant association between hydatid cyst infection and location of cysts (p-value =0.00). The liver in our study was the most affected organs. These findings are consistent with the observations reported in Libya (Ibrahem and Craig, 1998), Iran (Tappe *et al*., 2010) and (Khanjari *et al.*, 2012), Ethiopia (Fikire *et al.*, 2012), Nigeria (Abdullahi *et al.*, 2011), Mauritania (Salem *et al.*, 2011), Sudan (Mohamadin and Abdelgadir, 2011) and (Ibrahim *et al .*, 2011), Saudi Arabia (Ibrahim , 2010), Sudan and Kenya(Njoroge *et al.*, 2002). The liver was the most common site of infection in sheep, this could be due to the fact that the liver is the first organ the blood flows through after leaving the intestine and filtered in it. The ova that are not trapped in the liver passed to the lungs then to other organs (Soulsby, 1982).

The reason for no significant assoiation could be attributed to the similarity regarding to the source of animal. This result is in agreement with the result of another study carried out in Ethiopia .(Terefe *et al.,* 2012).

Fertility of cyst is an important factor that can affect stability of *E .granulosus* cycle depending on geographical situation, kind of infected host and size of cyst. In our study there was significant association between hydatidosis and fertility of cyst (p-value=0.00). Most cysts in this study were fertile viable (3 cases), and one cyst was sterile (one case). This result agrees with a study conducted in Jordan (Kamhawi *et al.,* 1995) and in Northern Iran (Daryani *et al.,* 2009) .

Gerater than 10 ml volume cysts in our study has been found in one carcass and lesser than or equal to 10 ml cysts have been found in two carcass , while the caseaous cyst have been found in one case. This result is compatible with a study conducted in Sinnar area , Blue Nile State, Sudan (Ibrahim *et al .,* 2011), and Ethiopia (Kebede *et al.,* 2009).

Conclusions

- The output of this study indicates that the overall prevalence of hydatid cyst was 1.6% .
- The distribution of prevalence of hydatid cysts infection by age showed that the prevalence in old animals was 3.2% which is numerically higher than in young animals (0.64%).
- For body condition the prevalence is higher in animals in good body condition (1.9%) and low in animals in poor body condition (0.0%).
- The prevalence of hydatid cyst infection according to the geographical areas of sheep was higher in Elnihood (2.6%), Omsimima (2.08%) and no infection in Bara, Elkhowei, Gibash and Shikan.
- Distribution by sex the prevalence of hydatid cyst infection was 1.5% in male and 1.6% in female.
- The prevalence of hydatid cyst infection according to the breed was higher in Shorany breed 3.2%, followed by 2.9% in Garag, 2.6% in Kabashi and 0.7% in Hamary.
- Significant association was observed in the univariate analysis between hydatidosis and the age of animals (p-value = 0.118) .
- Multivariate analysis showed no significant association between hydatidosis and any of the investigated risk factors.
- For the location of hydatid cyst in carcas organs, the liver was found to be the most affected organ (1.2%).
- Microscopic examination of hydatid cyst showed that one cyst was sterile (0.4%) and three cysts were fertile (1.2%).

Recommendations

More elaborate studies on *Echinococus granulosus* cyst are recommended in order to reveal:

- Its prevalence in other states.
- Economic importance of the disease.
- Stages of development of cyst to calcification.
- Enhancement of awareness of people about the economic and public health importance of the disease.
- The relation of echinococcosis to other disease status.

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Appendices

Appendix I

Frequency tables for distribution of infection among 248 sheep examined at El-obied slaughterhouse according to potential risk factors:

Table 1.1: Sex:

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Female	182	73.4	73.4	73.4
Male	66	26.6	26.6	**100**
Total	**248**	**100**	**100**	

Table 1.2: Age:

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
≤ 1 years	155	62.5	62.5	62.5
> 1 years	93	37.5	37.5	**100**
Total	**248**	**100**	**100**	

Table 1.3: Source of Animal:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Om simima	96	38.7	38.7	38.7
	Elnihood	76	30.6	30.6	69.4
	Bara	11	4.4	4.4	73.8
	Elkhowei	50	20.2	20.2	94.0
	Gibash	6	2.4	2.4	96.4
	Shikan	9	3.6	3.6	**100**
	Total	**248**	**100**	**100**	

Table 1.4: Breed:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid					
	Kabashi	38	15.3	15.3	15.3
	Hamary	145	58.5	58.5	73.8
	Garag	34	13.7	13.7	87.5
	Shorany	31	12.5	12.5	**100**
	Total	**248**	**100**	**100**	

Table 1.5: Body condition:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid					
	Poor	42	16.9	16.9	16.9
	Good	206	83.1	38.1	**100**
	Total	**248**	**100**	**100**	

Table 1.6: Location of cyst:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No cyst	244	98.4	98.4	98.4
	Liver	3	1.2	1.2	99.6
	Thigh	1	0.4	0.4	**100**
	Total	**248**	**100**	**100**	

Table 1.7: Size of cyst:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No cyst	244	98.4	98.4	98.4
	≤10 ml	2	0.8	0.8	99.2
	> **10ml**	1	0.4	0.4	99.6
	Caseaous	1	0.4	0.4	**100**
	Total	**248**	**100**	**100**	

Table 1.8: Fertility:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No cyst	244	98.4	98.4	98.4
	Fertile viable	3	1.2	1.2	99.6
	Sterile	1	0.4	0.4	**100**
	Total	**248**	**100**	**100**	

Appendix II

Cross tabulation of distribution and prevalence of hydatidosis in 248 sheep examined at El-obied slaughterhouse according to potential risk factors:

Table 2.1: Sex :

	Sex of animal		**Total**
	Female	**Male**	
Results - ve	179 179/182x100 98.3%	65 65/66x100 98.5%	244 244/248x100 98.4%
+ ve	3 3/182x100 1.6%	1 1/66x100 1.5%	4 4/248x100 1.6%
Total	**182** **100%**	**66** **100%**	**248** **100%**

Table 2.2: Age :

	Age of animal		**Total**
	≤ 1 **years**	> 1 **years**	
Results **- ve**	154 154/155x100 99.3%	90 90/93x100 96.7%	244 244/248x100 98.4%
+ ve	1 1/155x100 0.64%	3 3/93x100 3.2%	4 4/248x100 1.6%
Total	**155** **100%**	**93** **100%**	**248** **100%**

Table 2.3: Source of Animal:

	Animal source						Total
	Om simima	**El nihood**	**Bara**	**Elkhowei**	**Gibash**	**Shikan**	
Results	94 94/96x100	74 74/76x100	11 11/11x100	50 50/50x100	6 6/6x100	9 9/9x100	244 244/248x100
- ve	98%	97.3%	100%	100%	100%	100%	98.4%
+ ve	2 2/96x100 2%	2 2/76x100 2.6%	0 0/11x100 0%	0 0/50x100 0%	0 0/6x100 0%	0 0/9x100 0%	4 4/248x100 1.6%
Total	**96** **100%**	**76** **100%**	**11** **100%**	**50** **100%**	**6** **100%**	**9** **100%**	**248** **100%**

Table 2.4: Breed :

	Breed				Total
	Kabashi	**Hamary**	**Garag**	**Shorany**	
Results **- ve**	37 37/38x100 97%	144 144/145x100 99.3%	33 33/34x100 97%	30 30/31x100 96.75%	244 244/248x100 98.4%
+ ve	1 1/38x100 2.6%	1 1/145x100 0.9%	1 1/34x100 2.9%	1 1/31x100 3.2%	4 4/248x100 1.6%
Total	**38** **100%**	**145** **100%**	**34** **100%**	**31** **100%**	**248** **100%**

Table 2.5: Body Condition :

	Body condition		Total
	Poor	**Good**	
Results **- ve**	42 42/42x100 100%	202 202/206x100 98 %	244 244/248x100 98.3%
+ ve	0 0/42x100 0%	4 4/206x100 1.9%	4 4/248x100 1.6%
Total	**42** **100%**	**206** **100%**	**248** **100%**

Table 2.6: Location of cyst:

	location of cyst			Total
	No cyst	**Liver**	**Thigh**	
Results **- ve**	244 244/244x100 100%	0 0/3x100 0%	0 0/3x100 0%	244 244/248x100 98.4%
+ ve	0 0/244x100 0%	3 3/3x100 100%	1 1/1x100 100%	4 4/248x100 1.6%
Total	**244** **100%**	**3** **100%**	**1** **100%**	**248** **100%**

Table 2.7: Cyst volume :

	Cyst volume				Total
	No cyst	**≤10 ml**	**> 10ml**	**Caseaous**	
Results **- ve**	244 244/244x100 100%	0 0/2x100 0%	0 0/1x100 0%	0 0/1x100 0%	244 244/248x100 98.4
+ ve	0 0/244x100 0%	2 2/2x100 100%	1 1/1x100 100%	1 1/1x100 100%	4 4/248x100 1.6%
Total	**244** **100%**	**2** **100%**	**1** **100%**	**1** **100%**	**248** **100%**

Table 2.8:Fertility of cyst :

	Fertility of cyst			Total
	No cyst	Fertile viable	Sterile	
Results - ve	244 244/244x100 100%	0 0/3x100 0%	0 0/3x100 0%	244 244/248x100 98.4%
+ ve	0 0/244x100 0%	3 3/3x100 100%	1 1/1x100 100%	4 4/248x100 1.6%
Total	**244** **100%**	**3** **100%**	**1** **100%**	**248** **100%**

Appendix III

Association between hydatidosis infection and potential risk factors using the Chi- square test:

Table 3.1: Sex:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	.005	1	.941
Continuity correction	.000	1	1.000
Likelihood Ratio	.005	1	.941
Linear-by-LinearAssociation	.005	1	.941
No. of Valid Cases	248		

Table 3.2: Age:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	2.43	1	.118
Continuity correction	1.084	1	.298
Likelihood Ratio	2.366	1	.124
Linear-by-LinearAssociation	2.430	1	.119
No. of Valid Cases	248		

Table 3.3: Source of Animal:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	1.87	5	.866
Likelihood Ratio	3.012	5	.698
Linear-by-LinearAssociation	1.252	1	.263
No. of Valid Cases	248		

Table 3.4: Breed:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	1.91	3	.591
Likelihood Ratio	1.899	3	.594
Linear-by-LinearAssociation	.390	1	.532
No. of Valid Cases	248		

Table 3.5: Body Condition:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	.892	1	.363
Continuity correction	.057	1	.812
Likelihood Ratio	1.498	1	.221
Linear-by-LinearAssociation	.826	1	.364
No. of Valid Cases	248		

Table 3.6:Location of cystTable :

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	2.48	2	.000
Likelihood Ratio	40.952	2	.000
Linear-by-LinearAssociation	220.149	1	.000
No. of Valid Cases	248		

Table 3.7:Volume of cyst:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	2.48	3	.000
Likelihood Ratio	40.952	3	.000
Linear-by-LinearAssociation	201.112	1	.000
No. of Valid Cases	248		

Table 3.8:Fertility:

	Value	Df	Asymp.sig (2-sided)
Pearson chi- square	2.48	2	.000
Likelihood Ratio	40.952	2	.000
Linear-by-LinearAssociation	220.149	1	.000
No. of Valid Cases	248		