Sudan University of science and Technology

College of Graduate Studies

Prevalence and Risk Factors of Ovine Hydatidosis In West Omdurman Locality-Sudan

نسبة الإصابة وعوامل الخطرلمرض الأكياس العدارية في الضأن بمحلية غرب أمدرمان

A Thesis Submitted to the College of Graduate Studies in partial fulfillment of the Requirements for the Degree of Master in Preventive Veterinary Medicine (M.P.V.M)

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الآية

بسم الله الرحمن الرحيم

قَالَ تَعَالَىٰ:

﴿ وَلَوْلَا فَضْلُ ٱللَّهِ عَلَيْكَ وَرَحْمَتُهُۥ لَهَمَّت طَّآئِفَةٌ مِّنْهُمْ أَن يُضِلُّوكَ وَمَا يُضِلُّونَ إِلَّآ أَنفُسَهُمْ ۖ وَمَا يَضُرُّونَكَ مِن شَىْءٍ ۚ وَأَنزَلَ ٱللَّهُ عَلَيْكَ ٱلْكِتَٰبَ وَٱلْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُن تَعْلَمُ ۚ وَكَانَ فَضْلُ ٱللَّهِ عَلَيْكَ عَظِيمًا ﴿١١٣﴾ ﴾

صدق الله العظيم

سوررة النساء: الاية ١١٣

Dedication

- *To my kind unfailing support mother*
- *To my colleagues and friends*
- *To all who have helped me*

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Firstly, praise to Almighty Allah for giving me the strength and stamina to finish this work.

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Abstract

This study was conducted on 176 sheep slaughtered at Al-sabaloga abattoir, West Omdurman, Khartoum State, Sudan, during the period extended from October2016 to December 2016. The objectives were to estimate the prevalence of hydatid cysts in sheep and to investigate risk factors associated with the disease. Routine meat inspection procedure was employed to detect the presence of hydatid cysts in visceral organs (liver, lung, heart and muscle). The Examined sheep originated from two areas: Southern Kordofan, and White Nile. The overall prevalence was 2.8% . The prevalence of hydatid cysts infection according to age of sheep was 1.2% in animals equal or less than one years of age and 4.3% in animals of age more than one year. The prevalence of hydatid cysts infection according to grazing was 8.3% in close grazing and was 2.0% in open grazing systems .The distribution of the hydatid cysts according to the area (source) of sheep was 4.0% in Southern Kordofan, and 1.3% in White Nile. As for body condition the prevalence was 3.0% in good body condition and 0.0% in poor body condition. The prevalence of hydatidosis according to the breed of animals was 2.5% in Hamary ecotype and 3.2% in Kabashy breed. The distribution of the hydatid cysts according to the using of treatment was5.7% in animals which were using drugs and was 1.1% in animals which were not using drugs ,the prevalence of hydatid cysts infection according to the present of dogs was 1.7% in area where dogs were present and was 1.1% in area where dogs were not present. Liver is the most infected organ (4cysts), but there is one infection in muscle, and there is no cyst in heart and lungs. In microscopical investigation ;three cysts are found sterile, and two cysts are found fertile.

The results of the univariate analysis by using the Chi-square for the following potential risk factors were: breed (P-value = 0.784), age of animal (p-value = 0.208), origin of animal (Pvalue = 0.288), body condition (p-value = 0.081), grazing (p-value =0.081), present of dog (p-value =0.669), and use of treatment (p-value =0.139).

The multi variete analysis was not used because the result of univariate analysis showed that there is no significant association between hydatidosis with any of the investigated risk factors.

ملخص البحث

أجري البحث على 176راس من الضأن مذبوحا في مسلخ السبلوقة (محليةغرب أمدرمان) في ولاية الخرطوم, السودان. خلال الفترة التي امتدت من أكتوبر2016 الى ديسمبر2016.

كان الهدف هو تقدير معدل إنتشار مرض الأكياس العدارية في الضأن والتعرف على عوامل الخطر المرتبطة بهذا المرض.تم إجراء التفتيش الروتيني للحوم للكشف عن وجود الأكياس العدارية في الأحشاء الداخلية(الكبد,الرئتين,القلب والعضلات). كان مصدر الضأن المختار من منطقتين وهي منطقة جنوب كردفان وولاية النيل الأبيض. كان معدل إنتشار المرض في كل الحيوانات هو 2.8%, وكان معدل انتشار عدوى الأكياس العدارية هو وفق عمر الماشية 1.2% في الحيوانات التي عمرها يساوي سنة أو أقل , 4.3%في الحيوانات التي عمرها أكبر من سنة.أما بالنسبة لنظام الرعي,2.0% لنظام الرعي المفتوح و8.3% لنظام الرعي المغلق .وكان معدل انتشارالأكياس وفق للمناطق التي جاءت منها الحيوانات 4.0% في جنوب كردفان و 1.3% في النيل الأبيض .أما بالنسبة لحالة الجسم كان معدل انتشار المرضهو 3%من حالة الجسم الجيد و0% في حالة الجسم الهزيل.وكان معدل انتشار الأكياس العدارية وفقا لسلالة الضأن هو 2.5% في الضأن الحمري و 3.2% في الضأن الكباشي. وكان معدل انتشار المرض بالنسبة لإستخدام العلاج ,كان معدل انتشار المرض في المناطق التي استخدم فيها العلاج 1.6% وكان 5.7% في المناطق التي لم يتم فيها استخدام العلاج . أما بالنسبة لوجود الكلاب كان معدل انتشار المرض 1.7% في المناطق التي وجدت فيها كلاب وكان معدل انتشار المرض 1.1% في المناطق التي لم توجد فيها كلاب. الكبدهي العضوالأكثر إصابة 4أكياس بينما الإصابة في العضلات كانت إصابة واحدة,ولا يوجد كيس في القلب والرئة , في الفحص المجهري للأكياس وجد أن هنالك3 أكياس عقيمة و 2 أكياس خصبة.

وعندما تم تحليل عوامل الخطر بواسطة التحليل الأحادي وباستخدام مربع كاي كانت نتيجة التحليل :القيمةp=(0.288) لمصدر الحيوان, القيمة p=(0.208) لعمر الحيوان , القيمةp= (0.081) لحالة الجسم,

القيمة p=(0.784) لسلالة الحيوان ,القيمةp=(0.081)لنظام رعي الحيوان , القيمةp=(0.669) لتواجد الكلاب مع القطيع ,القيمةp=(0.139) بالنسبة لإستخدام الأدوية. وأظهرت الدراسة أنه لا يوجد علاقة معنوية بين انتشار المرض و بين العوامل الأخرى لذلك لم يتم استخدام التحليل المتعدد .

Introduction

Background:

Echinococcosis and hydatidosis are terms used to describe infection of animals and humans with the adult tapeworm or larval metacestode stage of cestode species belonging to the genus *Echinococcus*. Members of this genus within the family of *Taeniidae* are small tapeworms at 1.2-7mm in length, possessing only a maximum of 7 segments (proglottids). The parasite is of pathogenic and economic significance in intermediate and aberrant intermediate hosts, where the larval parasite develops into a hydatid cyst, a fluid -filled cystic or vesicular structure composed of two main layers or membranes. The laminated layer is a carbohydrate –rich, a cellular structure which is unique for the genus *Echinococcus*. It is both supportive and also physically encloses the asexually produced protoscolices which bud off from the living germinal layer and are the infective stage for the definitive host. Production of protoscolices by *Echinococcus* spp. is prolific ensuring high worm burdens in the carnivore definitive host. Infection with *E.granulosus* metacestodes results in the development of one or several unilocular hydatid cysts that may grow for the life of the host. *Echinococcus* species are of medical and veterinary importance because infection with metacestodes may cause severe illness and death in the intermediate host (Rihab ,2006).

Both man and animals as intermediate hosts acquire the infection by accidental ingestion of the eggs from the environment. Contaminated foodstuffs and infected dogs carrying the tapeworm eggs in their fur are suspected to be important sources of infection to the intermediate hosts (Nadia ,2010).

Echinococcus granulosus is a worldwide distributed parasite. The parasite has been extensively studied in a number of different geographical areas. Pastoral communities in developing countries with poor hygiene have been reported to be highly at risk of becoming infected with *E. granulosus* due to their close association with dogs. The suitable climatic and ecological features, traditional situations such as large numbers of small, ill lequipped and unsupervised abattoirs, home slaughtering and big population of stray dogs, are the main factors influencing the persistence of *E. granulosus.* This parasite causes serious public health problems and economic losses due to condemnation of affected organs (Nadia ,2010).

OBJECTIVES:

The objectives of this study were:

1/To estimate the prevalence of bovine hydatidosis in Khartoum state, Omdurman locality.

2/To investigate the risk factors associated with the disease.

Chapter one

Literature review

1.1 Classification:

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

Kingdom: Animalia

Phylum: Platyhelminths

Class: Eucestoda

Order: Taenidea

Family: Taenidae

Genus: *Echinococcus*

Species: *E. granulosus*

Subspecies: *E. gr.granulosus*

E. gr.canadesis

2.2 Etiology*:*

Hydatidosis is caused by *E. granulosus, E. multilocularis, E. oligarthusus* and *E. vogeli.* Adult tapeworms are present in dogs , but the intermediate host harbor the larval stage which is known as hydatid cyst (Ethar,2015).

1.2.1 Morphology of *Echinococcus*:

Echinococcus exhibits certain characteristics that differentiate it from the other major genus in the family *Taenia*. The adult *Echinococcus* is only a few millimetres long (rarely more than 7mm) (Figure 1) and usually has no more than six segments, whereas species of *Taenia* can grow to several meters in length and consist of several thousand segments. Like all tape worms, *Echinococcus* has no gut and all metabolic interchange takes place across the synctial outer covering, the tegument (Eckert.2004).

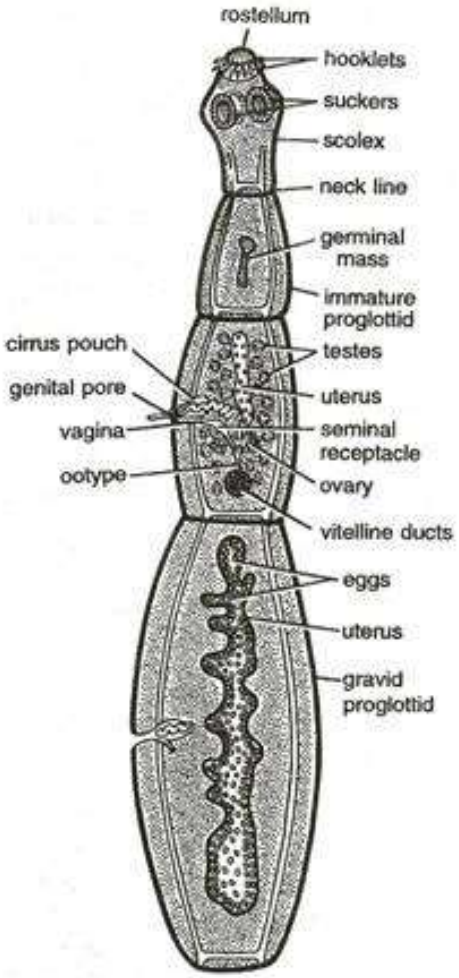


Fig. 199. *Echinococcus granulosus*

Figure1 Morphology of mature adult worm of *E.granulosus.* **(Wikipedia)**

1.2.2 Morphology of *Echinococcus* egg:

Echinococcus eggs contain an embryo that is called an oncosphere or hexcanth.The name of this embryo stems from the fact that these embryos have six hooklets. The eggs are passed through the faeces of the definitive host and it is the ingestion of these eggs that lead to infection in the intermediate host (David and Petri, 2006).

1.2.3 Morphology of cyst:

The hydatid cyst, after 3 weeks, measures 250 μm in diameter and has central cavity. Around fifth months, it measures approximately one- cm and it is apparent that its wall consists of two layers: an external cuticular, or laminar layer, formed by numerous thin lamina that resembles the cross-section of an onion , and another, internal layer germinative or proligerous, which is delicate cellular syncytium . Larval form of *E. granulosus* typically consists of single cavity (unilocular). The interior of a hydatid cyst is filled with fluid. During the same period, brood capsule buds off from the germinative layer, and forming an invaginated protoscolices (Pedro and Boris, 2001).

1.3 Life cycle:

Like other cestodes, species of *Echinococcus* require two different host species to complete their life cycles (fig2). Definitive hosts harbouring the adult tapeworm in the small intestine are exclusively carnivores and intermediate hosts harbouring the larval stage (metacestodes) are herbivorous or omnivorous. The adult worms are less than 7mm in length. They feed on the intestinal contents of the host without causing any symptoms as they do not invade tissues. When mature, *Echinococcus* worms shed the terminal proglottids containing eggs which pass with the faeces to the environment. The intermediate hosts acquire the infection by accidental ingestion of the eggs with contaminated food or water. Larvae contained in the eggs (oncospheres) emerge from the eggs in the small intestine, invade blood vessels and may migrate into almost every part of the body. There, the metacestodes grow for months or years forming fluid-filled cysts or vesicles. Protoscolices are produced within the metacestode in a phase of non-sexual reproduction. Once the metacestode is eaten by a suitable definitive host, these protoscolices will grow into

adult tapeworms. The occurrence of a parasite in a particular host assemblage like dog/sheep or dog/horse reflects a variable degree of host parasite adaptation (Rihab , 2006).

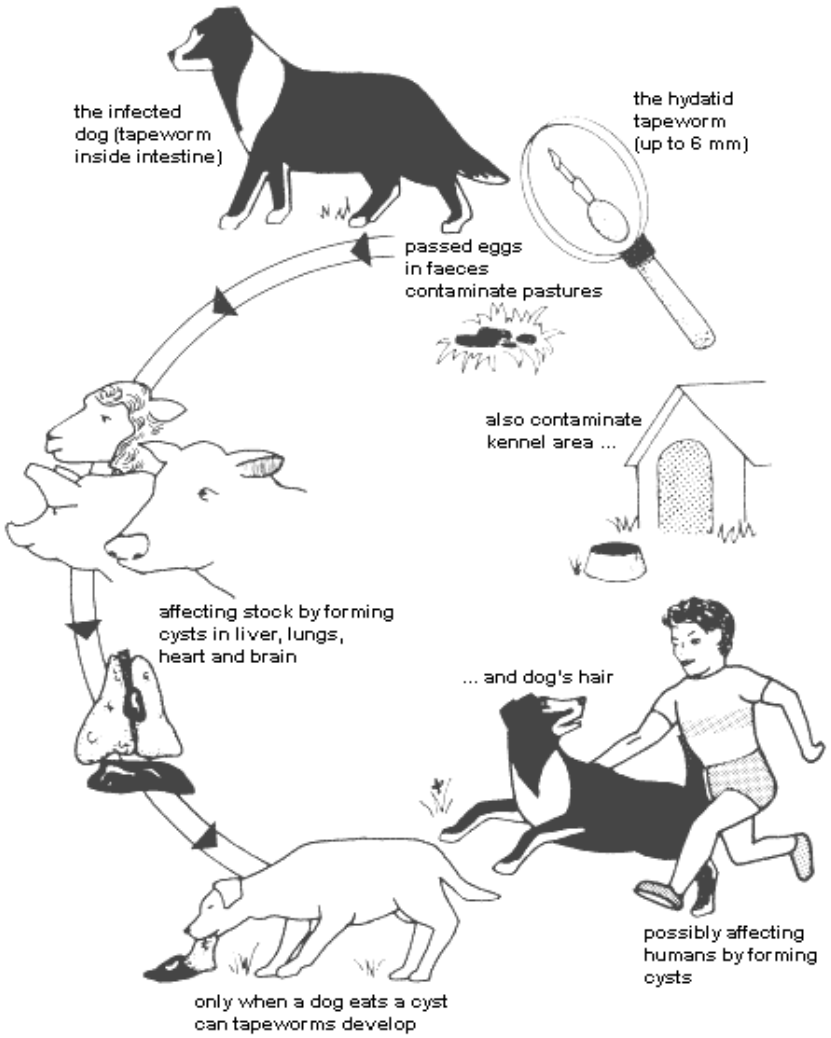


Figure2 Life cycle of *E.granulosus*(Rihab,2006).

The definitive hosts for *E.granulosus* (canids, felids, andhyaenids) become infected when they ingest cysts (metacestodes)in the tissues of the intermediate hosts. Feeding the viscera of intermediate hosts to dogs perpetuates cycles in domesticated animals. The cysts develop into tapeworms, which mature in the host's small intestine. Gravid proglottids or eggs are shed in the feces, and are immediately infective. *Echinococcus* eggs have a sticky coat that will adhere to an animal's fur and other objects (Kholoud ,2015).

Insects such as flies and beetles, or birds, can also act as mechanical vectors. In addition, the shed proglottids may perform rhythmic contractions that help to disperse the eggs widely on pasture (Kholoud, 2015).

Under ideal conditions, *E.granulosus* eggs remain viable for several weeks or months in pastures or gardens, and on fomites (Kholoud ,2015)

They survive best under moist conditions and in moderate temperatures. Viable eggs have been found in water and damp sand for three weeks at 30°C, 225 days at 6°C and 32 days at 10-21°C. The eggs survive for only short periods of time if they are exposed to direct sunlight and dry conditions (Kholoud ,2015).

The intermediate hosts include a large number of domesticated and wild animals, particularly herbivores. Humans can also be infected. If an intermediate host ingests the eggs, the larvae are released, penetrate the intestinal wall, and are carried in blood or lymph to the target organs.

Etiology of hydatidosis is caused by *E.granulosus, E.multilocularis, E.oligarthusus and E.vogeli*. Adult tapeworms are present in dogs , but the intermediate host harbor the larval stage which is known as hydatid cyst (Kholoud ,2015).

The morphology of hydatid cyst has three layers:

1. The outer pericyst is a dense and fibrous zone and composed of modified host cells. It is the protective layer.

2. The middle is the laminated membrane. It is a cellular and allows the passage of nutrients.

3. The inner layer is the germinative layer which gives rise to the hydatid fluid and small secondary cysts (brood capsules) which bud internally from this layer. Fragmentation of the germinative layer and brood capsules gives rise to daughter cysts. These may develop within the original cyst or separately.

The middle laminated membrane and the germinal layer form the true wall of the cyst, usually referred to as the endocyst, although the a cellular laminated membrane is occasionally referred to as the ectocyst (Kholoud,2015).. Daughter vesicles (brood capsules) are small spheres that contain the protoscolices and are formed from rests of the germinal layer. 10-12 months after infection, protoscolices are produced in broad capsules.

Cysts containing protoscolices are fertile and can produce daughter cysts, whereas cysts without protoscolices are sterile.

Before becoming daughter cysts, these daughter vesicles are attached by a pedicle to the germinal layer of the mother cyst. At gross examination, the vesicles resemble a bunch of grapes.

Daughter cysts may grow through the wall of the mother cyst ,particularly in bone disease (Kholoud ,2015).

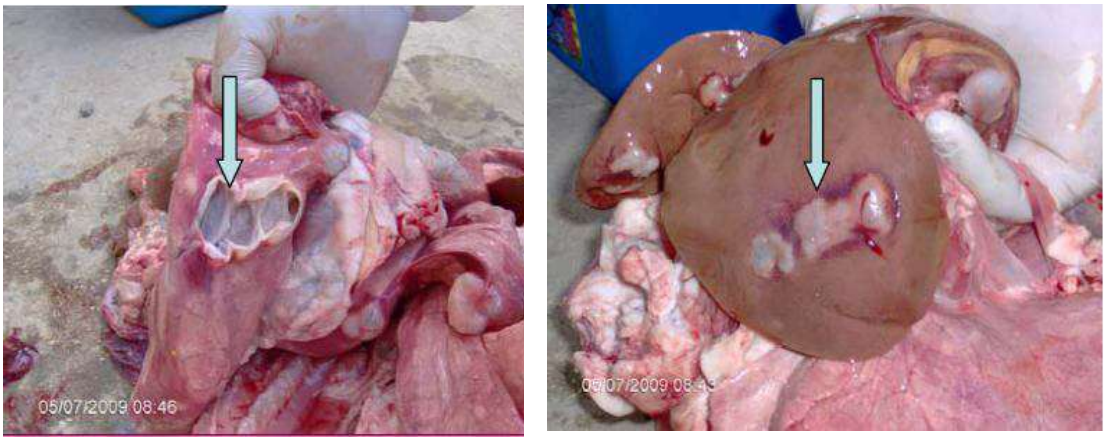
The hydatid cyst, after 3 weeks, measures250 μm in diameter and has central cavity. Around fifth months ,it measures approximately one- cm and it is apparent that its wall consist of two layers :an external cuticular, or laminar layer, formed by numerous thin lamina that resembles the

cross-section of an onion, and another, internal layer germinative or proligerous, which is delicate cellular syncytium . Larval form of *E.granulosus* typically consists of single cavity (unilocular). The interior of a hydatid cyst is filled with fluid. During the same period , brood capsule buds off from the germinative layer, and forming an invaginated protoscolices . Echinococcosis is caused by several species of *Echinococcus*,which is a tiny cestode parasite in the family Taeniidae. The twomost important species are *Echinococcus granulosus* and *Echinococcus multilocularis. E.granulosus* causes a type of echinococcosis known as cystic echinococcosis, unilocular echinococcosis or cystic hydatid disease. Different strains of *E.granulosus* can be found in sheep, cattle, pigs, horses and reindeer.

All of the strains, except possibly the horse strain, infect humans.

E. multilocularis causes a type of echinococcosis known as alveolar *Echinococcosis*, alveolar hydatid disease, multilocular echinococcosis or multivesicular hydatidosis (OIE , 2005).

All *Echinococcus* spp. have an indirect life cycle, cycling between a definitive and an intermediate host. Intestinal infections occur in the definitive host, and tissue invasion is seen in the intermediate host. Carnivores are the definitive hosts for *Echinococcus*, and usually have no symptoms of infection. Disease may be seen in the intermediate hosts, including humans (OIE , 2005).



(A) **(B)**

Figure(3) Hydatid cysts in lung (A) and liver (B) (El-Ibrahim, 2009)

1.5 Pathogenicity and Clinical Signs:

There are no pathogenic effects in definitive hosts even if the animals are heavily infected with *E. granulosus* (Eckert and Deplazes, 2004). Therefore, infected final hosts (mostly dogs), show no clinical signs except itching on the back (sledge-like position) but if a large number of parasites are present, they may have diarrhoea. The pathogenicity of the hydatid cyst in the intermediate hosts depends on the severity of the infection and the organs involved. The clinical signs are not obvious (Eckert and Deplazes, 2004), and the disease is rarely diagnosed before slaughter of the animals. Sometimes animals show clinical symptoms, such as bronchopneumonia, hepatic disorders leading to ascitis; jaundice; heart failure; slow growth; weakness and lameness, but symptoms depend on the location of the cysts (OIE, 2005).

These cysts are not destroyed by the body's defense mechanism, and may develop into large hydatid cysts. Clinical signs can take months to years to develop and become more apparent as the cysts grow. As the cysts increase they can cause pain in the upper abdominal region, occlusion of ducts, pressure atrophy or dysfunction of the affected organs. The most serious development is occured if the cyst ruptures. The cysts may rupture into the thoracic or peritoneal cavity, causing anaphylaxis or

secondary cysti0c echinococcosis, leading to cholangitis and cholestasis (Eckert and Deplazes, 2004).

1.6 Diagnosis:

Parasitological methods in sheep, diagnosis of cystic echinococcosis is mainly through post-mortem findings during meat inspection. The presence of hydatid cysts in internal organs is a very important tool of diagnosis in that it actually confirms the disease.

The most reliable method for diagnosis of *Echinococcus* spp. in definitive hosts is by necropsy, because worm burdens can be accurately estimated and parasites are collected for identification (Eckert, 1997).

Examination of cysts for fertility and viability based on the presence or absence of brood capsules contain protoscolices in hydatid fluid, cysts were identified and classified as fertile and infertile according to the method described by Macpherson (1985). Infertile cysts were further classified assterile (fluid filled cyst without protoscoleces) or calcified (Soulsby, 1982). To test the viability, the cyst wall was penetrated by a needle and opened and the contents were examined microscopically (40x) for the amoeboid-like peristaltic movements of protoscoleces according to the standard procedure (Smyth and Barrett, 1980). In doubtful cases, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices on a microscope slide with the principle that viable protoscolices completely or partially exclude the dye while the dead ones take it up (Miheret *et. al*,2011).

Diagnosis of human hydatidosis is suspected based on the clinical symptoms and epidemiological circumstances. Imaging methods such as radiography, computerized tomography, ultrasonography and scintigraphy are usually used in human.

While they do not confirm the diagnosis, they are very helpful to the specialist. Ultrasonography is the first choice because it is economical, non-invasive, simple, and accurate and reveals developing cysts that generally cannot be found with Xrays. Numerous immunobiologic tests have been used in the diagnosis of human hydatidosis by *E. granulosus*, among them Casoni's intradermal test, complement fixation, indirect hemagglutination, latex agglutination electrosyneresis, and double diffusion to detect antibodies against the arc 5 antigen. Practically all have been displaced by ELISA and the immunoelectro-transfer or Western blot test. Caroni's intradermal test is not very sensitive and is nonspecific for the diagnosis. While it was once used for epidemiological surveys, the collection of drops of blood on filter paper now makes it possible to use serologic techniques that are much more sensitive and specific on a large scale. The complement fixation, indirect hem agglutination, and latex agglutination tests have no operational advantage over ELISA and are much less specific or sensitive. The techniques based on observation of arc 5 were abandoned when it was found that the respective antigen was specific not for *Echinococcus* but for many custodies. (Pedro and Boris, 2001).

ELISA diagnosed 96.6% of hydatidosis patients but cross-reacted with eniasis and ascariasis; indirect hem agglutination diagnosed 86% of patients but also gave cross-reactions, and the double diffusion test for arc 5 diagnosed 79% of patients but did not give false positives. Only ELISA gave false positives. Moreover, the test with selected antigens is not only highly sensitive and specific but can also distinguish among infections caused by different species of *Echinococcus*. ELISA for *E. multilocularis*, for example, showed a sensitivity of 93% and a specificity of 97%, in contrast to another ELISA for *E. granulosus* that showed a sensitivity of 89% and a specificity of 99%. But there seem to be wide variations in the

sensitivity and specificity of the test among different laboratories. For example, in Valdivia, Chile, that 28 of 29 patients (96.5%) with hydatidosis confirmed by surgery showed positive reactions to ELISA, and taenias is and ascariasis patients showed false positives. More recent reports compared ELISA with antigenelectrotransfer and attributed an 82% specificity to ELISA and a 94% to 97%specificity to the transfer test. More recently, the polymerase chain reaction (PCR)has also been used to detect nucleic acids from the parasite in patient's bloodstreams (Pedro and Boris, 2001).

1.7 Geographic distribution and prevalence of echinococcosis in selected regions of the world:

Echinococcus granulosus has a world-wide geographic range and occurs in ll continents including circumpolar, temperate, subtropical and tropical ones(Fig4). 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 degraded 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. Actually, this wide spectrum of intermediate hosts seems to correspond to genetic variability among E.*chinococcus granulosus* strains which can be assessed using nuclear and/or mitochondrial genotypic methods (Raether and Hanel, 2003; Eckert and Deplazes, 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(Ethar , 2015).

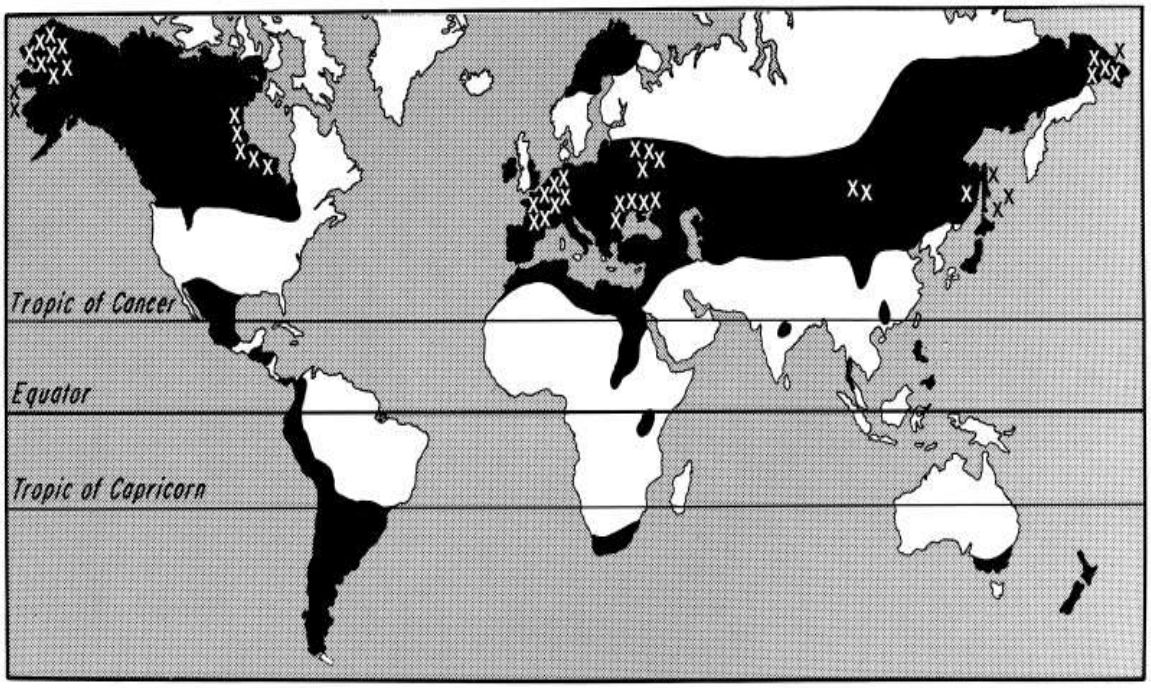


Fig4:Global distribution of ***E. granulosa*** (black) and ***E. multilocularis*** (x

Source: *TMCR* http://tmcr.usuhs.mil/tmcr/chapter3/geographic.htm

1.7.1 Prevalence of echinococcosis in Africa:

Studies conducted in North Africa have shown wide significant variation in infection to cattle and sheep depending on the location. The variation in infection is as a result of several factors which aide transmission of *Echinococcus spp*. The infection rates in cattle are especially high in Middle Atlas (8.72%) and in the Loukkos (37.61%)(Azlaf and Dakkak, 2006). A recent study in Ngorongoro District of Tanzania showed an overall prevalence of 47.9% and species prevalence of 48.7%, 34.7% and 63.8% in cattle, goats and sheep respectively(Kazwala, 2008). Countries around the Mediterranean region, have exhibited high prevalence of cystic echinococcosis CE in both humans and livestock. Egypt has recorded human cases between 1.34- 2.6 cases per 100,000 people through hospital surveys and 6.4% prevalence in cattle and buffalo through abattoir surveys (Kazwala, 2008). 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 sheep and goats 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 sheep and goats liver, lungs, spleen and heart respectively condemned. Highly significant ($P<0.001$) cystic echinococcosis infection rate was recorded in sheep (6.05%) than in cattle (40.2%) probably because of differences in grazing patterns. Cattle lungs were more affected by cystic *Echinococcus* CE (22.5%) than liver (19.7%) (Nonga and Karimuribo, 2007). Three handreds 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. 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'rad*et al.*, 2005). An infection rate of 8.4% with cystic echinococcosis was recovered among 1,050 sheep, goats, cattle and camels in Shanatm 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 (Al-Khalidi , 1998). The cysts of all infected cattle (87.5%), but one cow (12.5%), were sterile. In an attempt to establish the prevalence of cystic echinococcosis, a study was conducted in slaughter animals in three divisions of Northern Turkana, Kenya (Njorge *et al.,* 2002). 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. 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, 2012).

1.7.2 Prevalence of echinococcosis in Sudan:

A study was conducted to estimate the infection rate of Hydatidosis caused by *E. granulosus* in cattle and sheep as intermediate hosts in slaughter houses of Khartoum State. 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).

Another study was conducted for determination of the prevalence, parasitological status and genetic identification of hydatid cysts from sheep in different parts of the Sudan. It was concluded that, sheep play a marginal role in the transmission cycle of the disease in Sudan. This fact is different from data obtained from other regions in Africa as well as parts from southern Sudan, where sheep are heavily involved in the transmission cycle of the disease. Both, the prevalence and fertility rates of the disease in sheep in Western Sudan were higher (11.9% and 19% respectively) comparing to those reported in other investigated areas in Sudan. *E.canadensis* (G6) was identified in all samples and confirmed by mitochondrial gene sequencing of a subset of 15 samples which showed 100% identity with the same strain when compared with data on the GeneBank TM (Accession No. 208063; Omer, 2003) .

An abattoir survey was conducted on 244 cattle slaughtered at Elobied abattoir in north Kordofan State, Sudan, during period which extended from March to April 2011. The objective was to estimate the prevalence of hydatid cyst in cattle and to investigate risk factor associated with the disease. Routine meat inspection procedure was employed to detect the presence of the hydatid cyst in visceral organs (liver, lung, heart and peritoneum). Selected cattle were originated from three States: Darfur, Kordofan and White Nile States. The overall prevalence of hydatid cysts infection according to age of cattle was: 4.4% in > 5 year and 1.2% in ≤ 5 years. The distribution of the hydatid cysts according to the area of cattle was: 3.4% in Darfur, 1.3% in Kordofan and 0.0% in White Nile. As for body condition the prevalence was: 2.5% in good body condition and 0.0% in poor body condition. Regarding distribution by sex, the prevalence of hydatid cysts was: 3.0% in male and 1.2% in female. Also prevalence between hydatidosis and presence of dogs was: 2.8% in

presence of dogs and 1.4% in absence of dogs. The prevalence between hydatidosis and breed of animals was: 8.3% in fuga, 2.5% in Baggara and 0.0% in Kenana. Also distribution of hydatidosis when carcasses not disposed was 2.9% and 0.0% when carcasses disposed. The study showed that the lung was the most infected organ 83.31 and 16.7% were in liver. No cyst in heart and peritoneum , microscopic examination of the 13 cysts revealed that, 12 cysts (92.3%) were sterile, one cyst (7.7%) were calcified cysts, No fertile cysts were found. The cyst in male were localized in lung, but in female were localized in liver (Nasr Eldin, 2011).

An abattoir survey was conducted on 248 sheep slaughtered at El-obied abattoir, North Kordofan State, Sudan, during the period extended from April to Augast 2013. The objective was to estimate the prevelance of Hydatid cysts inn sheep and to investigate risk factors associated with the disease. Routine meat inspection procedure was employed to detect the presence of hydatid cysts in muscles and visceral organs (liver, lung, heart, and peritoneum). Examined 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 animal less or equal to one year. The distribution of the hydatid cysts according to the area (source) of sheep was 2.08% in Omsimima, 2.6% in Elnihood, 0% in Bara, 0% in Elkhwoie, 0% in Gibash, and 0% in Shikan. As for body condition the prevalence was 1.9% in good body conadition and 0.0% in poor body condition. Regarding distribution by sex,the prevalence of hydatid cysts was 1.5% in male and 1.6% in female. The prevalence of hydatidosis in ecotype of animals was2.6% in Kabashi ecotype, 0.7% in Hamary ecotype, 2.9% in Garag ecotype and 3.2% in Shorany ecotype. Using multivariate analysis to determine possible

significant association between hydatidosis and potential risk factors, the result showed that there was no significant association with any of investigated risk factors (Khalid, 2014).

A study was designed to the prevalence fertility and infection rate in different states of Sudan. A total of 18571 carcasses of sheep, 1876 goats, 2806 cattle and 250 camels were examined for the presence of hydatid cysts in the central and southern Sudan. The study revealed an infection rate of 0.01% in sheep with fertility rate of 50% , 0.12% in cattle with fertility rate of 50% , 22% in camel that reach 80% with high fertility rate (20%). No infection was detected in goats. None of the carcasses examined from Khartoum State slaughterhouses were found infected. The high prevalence observed in camels and cattles suggests that these animals clearly have an important role in the continuation of the Echinococcus granulosus life cycle in Sudan (Shadia and Abdelrahim, 2014).

1.8 Therapy and Treatment:

1.8.1 Treatment against Tapeworms in Dogs:

A wide variety of anthelmentics (arecolin, niclosamide, benzimidazole compounds and praziquantel) are available for the treatment of echinococcosis indogs (Bhatia and Pathak, 1990). Praziquantel, the drug of choice, is effective against both juvenile and adult *Echinococcus* parasites. The dosage rate of praziquantel is 5 mg/kg (Eckert and Deplazes, 2004; OIE, 2005).

1.8.2 Treatment of Cystic Stages:

Surgical removal of the hydatid cyst is the treatment of choice for symptomatic cysts in humans (Safioeas *et al.*, 1999). Several of the benzimidazole compounds have been shown to have efficacy against hydatidcysts. Long term treatment with albendazole has a particularly

marked effect on the cysts, and is used as pretreatment before surgery (Morris *et al.* 1990; Horton, 2003). The albendazole sulphoxide was shown to be an active anthelminthic (Horton, 2003). The current recommendation by the World Health Organization is percutaneous puncture under sonographic guidance, aspiration of cystic fluid, injection of aotoscolicidal agent (alcohol) and reaspiration of cyst content. This procedure needs to be further evaluated in large scale studies (Riengchan *et al.*, 2004).

More recently, herbal extracts mainly garlic (*Allium sativum*) extracts were used as a protoscolicidal agent (Sadjjadi *et al.*, 2004).

1.8.3 Control and Eradication programs:

Some countries, such as Iceland and Cyprus, have already eradicated and rare close to eradicating the disease. Control measures in New Zealand and Australia have significantly reduced the prevalence of *E. granulosus.*

Successful control programmers are currently being conducted in Turkana (Kenya), Chile and China, (McManus and Smyth, 1986; Schantz, 1990).

Although control programmers resulting in a marked decrease in the incidence of the disease have been carried out in some countries, little effect has been achieved worldwide. There is some evidence that the disease is spreading because of a lack of meat control, dog management and appropriate legislation (Gemmell 1979; Schwabe, 1986).

1.8.4 Control Options and Prevention:

Several options for the control of *E. granulosus* have been thoroughly evaluated and are described in detail. One option **(**type I) emphasizes long-term measures of public health education with primary health care (Parodi *et al.*, 2001) and veterinary public health activities, such as the improvement of slaughter hygiene and meat inspection ,dog registration and sanitation measures(Gemmell *et al,*. 2001). Experience from several

countries has shown that this option alone may not be sufficient and may be too slow for effective *E. granulosus* control (Gemmell e*t al.*, 2001). Another option (type II) is based on legislation and includes specific measures targeted to interruption of parasite transmission. Prior to the "attackphase" of the program, base-line data are collected to serve as references for measuring control progress. Important base-line data are the prevalence of *E.granulosus* in dog populations, the age- dependent prevalence of cysts in animals and human cases of CE. Modern techniques can be used for surveys ;for example, the coproantigen ELISA can be used to detect *E. granulosus* in dog populations (instead of a recoline testing) and ultrasonography alone or in combination with serology can be used for mass diagnosis of CE in humans(Christofi*et al.*, 2002; Craig**,** 1997). Specific control measures include stray dog control, registration of all owned dogs, spaying of bitches and treatment of all (or most) dogs with praziquantel at predetermined intervals, for example every 6 or 8 weeks. These measures are complemented by upgrading of meat inspection, slaughter hygiene, slaughter offal disposal, public health education and other measures. Control programs in various countries haves hown that the attack phase can be successfully concluded in less than 15years if the necessary measures can be performed without major constraints and financial restrictions (Gemmell *et al.*, 2001).

Chapter Two
Material and Methods

2.1 Study area:

Khartoum State lies at the junction of the two rivers, the White and the Blue Niles in the North Eastern part of central Sudan. It lies between latitude 15-16 N and longitude21-24 East with a length of 250 k and a total area of 20,736km2 the surface elevation ranges between 380 to 400 m a.s.l. Most of Khartoum State falls within the semi-arid climatic zone while the Northern part of it falls within the Arid climatic zone. The State is prevailed with a hot to very hot climate with rainy season during the summer and warm to cold dry winter. Rain fall ranges between 100-200 mm at the North Eastern parts to 200-300 mm at the Southern parts with 10-100 mm at the North Western parts. Temperature in summer ranges between 5-40 CO during the months of April to June and between 20-35 CO during July-October Period. Temperature degrees continue to fall during the winter period between November-March to the level of 15-25 CO. Khartoum State divided into three clusters (cities), built at the convergence of the Blue and White Niles: Omdurman to the northwest across the White Nile, North Khartoum, and Khartoum (Adel and Omer, 1999).

Al-SabalogaAbattior:

This abattoir is located in the west of Omdurman, Khartoum State.It consists of administrative building, Veterinary Services Department, Maintenance apartment, the health of the environment. Cattle is slaughtered in the basement, goats and sheep on the top floor. The capacity of slaughter house is 300 head of sheep per day. Electric bus is used to move the carcass. It provides services for carcass export and local consumption. The ante-mortem and post-mortem examination are conducted by veterinarians. Fluids are disposed off through the sewage system and the solid parts through burning in the incinerator.

2.2 Type of study:

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 Alsabaloga abattoir on three randomly selected days .These days selected were Sunday,Tuesday and Thursday.

The animals in these days selected by systematic random sampling method. From each five animals one animal was selected for examination.

2.3 Ante –mortem examination:

Regular visits were made by the investigator to conduct ante –mortem examination of slaughter animals. A total of 176 sheep were examined in the Alsabaloga abattoir during the survey period which extended from October 2016 to Desember 2016. During the ante-mortem inspection, the age, sex, breed, origin and body condition of each animals were determined . 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 by its state, from which the animal came.

2.4 Post -mortem examination :

During the post mortem examination, visual inspection ,palpation and systemic incision of each visceral organs were performed particularly the liver , lungs, kidneys, heart and spleen . In parallel, the following data were recorded :serial number, date, infection, infected organ, number of cysts, and size of cyst. Infected organs were collected in polyethene pages and taken to Hellait koko parasitology laboratory to conduct cyst count, cyst size cyst fertility and viability of protoscoleces.

2.5 Laboratory examination:

3.5.1 Examination of cysts:

Infected organs were transported to the laboratory of Hellait koko parasitology laboratory for further analysis to determine the state of the cysts . The fertility of cysts were examined 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 was put in a clean slide and then examined under the microscope (40×) for the presence of protoscolices. The viability of protoscolices was determined by flame cell motility. The cyst which contained no protoscolices as well as supportive, calcified, or degenerated were considered as unfertile cyst. 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 cyst and had no protoscolices by direct microscopic examination were considered as sterile cysts .

2.5.2 Size measurement:

Hydatid fluid was aspired from the cysts by syringe and the volume of cysts was estimated by measuring this fluid by using syringe.

2.6 Method of Sampling:

Systematic random sampling method was be chosen to collect cyst from the ovine n Khartoum state. Samples was be distributed according to the proportion of ovine distribution in the localities of the state, and distribution of herds populations within the locality. Sample size was be determined according to the following formula: **Sample size (n) = 4*Q^* P^/L2**The sample size will be conducted by using the formula, n = $4PQ/L^2$ n = Number of animals to be sampled.

P = Expected prevalence of sheep Hydatidosis in Sudan.

Q = 1-P. in this study

L = allowable error 5% (0.05).

The sample size calculated (44) multiplied by 4 to increase the precission of the result(thrusfield2007).

N=44*4=176

The previous prevalence selected equals 2.8 according to Kholoud (2015).

Accordingly the sample size equals176 animals after the inflation of the exact samples number by four to increase precision of the result(Thursfield, 2007).

2.7 Statistical analysis:

Frequency tables of the distribution according to the potential risk factors was constructed. Cross-tabulation of hydatidosis according to potential risk factors was made. Univariate analysis for risk factors associated with

disease was be analyzed by the Chi-square test by using statistical packets for Social Sciences (SPSS).Multivariate analysis by Logistic Regression models was performed for risk factors significant at level ≤ 0.25 in the Univariate model. The significant level in the Multivariate analysis was be ≤ 0.05.

Chapter three

Results

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

Out of total of 176 sheep inspected, only5 (2.8%) animals were positive, and the rest were negative for hydatidosis (Table1).

Table 1: Distribution of hydatidosis infection among 176 sheep examined in Al-sabaloga slaughter house in West Omdurman Locality-Khartoum State

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-ve	171	97.2	97.2	97.2
	+ve	5	2.8	2.8	100.0
	Total	176	100.0	100.0	

1. Origin of animals:

Out of the total of 176 local sheep ecotype inspected, 100 animals were from White Nile,76 animals were from South Kordofan (Table 2).Infected animals found in this study: 4 animals were from South Kordofan, 1animal from White Nile. The rate of infection in South Kordofan was (4.0%) and White Nile (1.3%) (Table 3).

The Chi-square test showed no significant association between the infection and source of animal (p-value = 0.288), (Table4).

2. Age of animals:

One hundred and seventy six 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, 84% of the sheep were less or equal than one year (young) and 92% of sheep were more than one year old (Table 2), Among young animals 1 animal were infected, however among adults 4 animals were found infected. Rate of infection within young animals was 1.2 % and 4.3% in old animals (Table 3).

The Chi- square test showed no significant association between hydatidosis and age of animals (p-value = 0.208),(Table4).

3. Breed:

The results of study showed distribution of hydatidosis in ALsabaloga slaughterhouse according to ecotype. All the ecotypes were local ecotypes, 81% Hamary, 95% Kabashy, but only two animals were positive from Hamary and only three animals were positive from Kabashy (Table 2). The rate of infection was 2.5% Hamary breed and 3.2% in Kabashy breed (Table 3).

The Chi- square test showed no significant association between the infection and breed (p-value = 0.784), (Table4.4).

4. Grazing:

The number of animals in closed grazing were24, and in open grazing were 152 (Table 2).The number of infected animals in closed grazing was 2 and 3 animals in open grazing. The rate of infection was 8.3% in closed grazing and 2.0% in open grazing (Table 3).

Chi- square test showed no significant association between the infections and grazing system(p-value=0.081%). (Table 4).

5. Body condition:

The body condition of animals and the presence of infection were 168 animals found to be in good condition, while 8 of these were found to be in poor condition (Table 2). Among good body condition 5 animals were found infected. The rate of infection within good animals was 3.0% . However no animal was found infected among poor animals 0.0% (Table 3).

Chi- square test showed no significant association between the infection and body condition (p-value = 0.621), (Table 4).

6. Using of treatment:

The number of owners who used treatment were 53 and those not using treatment was 123 (Table2).The number of infected animals in those using treatment group was 3 and in group not using treatment was 2 ,the rate of infection in animals those using treatment was 5.7% , and in the group not using treatment was 1.6% (Table 3).

Chi- square test showed there is no significant association between the infection and using of treatment (p-value=0.139). (Table 4) .

7. present of dogs:

The number of peoples who said no for the presence of dogs was 87 and peoples who said yes for the presence of dogs was 89 (Table 2).The rate of infected animals in peoples who said no for the presence of dogs was 1.1% and was1.7% of peoples who said yes for the presence of dogs (Table 3).

Chi- square test showed no significant association between the infection and present of dogs (p-value=0.182). (Table 4).

8. Location of cysts:

The location of cysts in different organs was investigated. The results showed that liver was the most infected organ with hydatidosis in 4 cases

and 1 case was found in the muscle. No infection was found on lungs or others organs. (Table 3).

Chi- square test showed significant association between the infection and location of cyst (p-value=0.00). (Table 4).

9. Size of cysts (volume):

Distribution of small than or equal to 3 ml , more than 3 ml cysts in organs was listed in Table2 . More than 3 ml size cysts was found in 4 cases and small than or equal to 3 ml cysts was found in 1 case (Table 3).

Chi- square test showed significant association between the infection and size of cyst (p-value=0.00) (Table 4).

10. Fertility of cysts:

Microscopic examination of the cysts revealed a that 2cysts were fertile and viable , sterile cysts were 3.

Chi- square test showed significant association between the infection and fertility of cyst (p-value=0.00) (Table4).

Table 2: Summary of frequency and cross tables for potential risk factors of hydatidosis in 176 sheep examined at Alsabaloga slaughter house in West Omdurman locality –Khartoum State

Risk Factors	**Frequency**	**Relative Frequency%**	**No.affected(%)**
Origin			
South Kordofan	100	57	4(4.0%)
White Nile	76	43	1(1.3%)

Age ≤1years >1years	 84 92	 47.7 52.3	 1(1.2%) 4(4.3%)
Body codition Poor Good	 8 168	 4.5 95.5	 0(0%) 5(3.0%)
Breed Hamary Kabashy	 81 95	 46 54	 2(2.5%) 3(3.2%)
Grazing Close Open	 24 152	 13.6 86.4	 2(8.3%) 3(2.0%)

Table 2: Continued

Risk Factors	Frequency	RelativeFrequency(%)	No.affected(%)
Present of dog	87	49.4	2(1.1%)
No	89	50.6	3(1.7%)
Yes			
Use of Treatment			
Yes	53	30	2(1.6%)
No	123	70	3(5.7%)
Volume			
Nocyst	171	97.2	0(0%)
≤3 ml	1	1.1	2(2.3%)
>3 ml	4	1.7	3(0.6%)
Fertility			
No cyst	171	97.2	0(0%)
Fertile	2	1.1	2(1.1%)
Sterile	3	1.7	3(1.7%)
Location			
No cyst	171	97.2	0(0%)
Liver	4	2.3	4(2.3%)
Muscle	1	0.57	1(0.6%)

Table3: Summary of univariate analysis for potential risk factors of hydatidosis in176 sheep examined at Alsabaloga slaughterhouse using the Chi- square test

Risk Factors	**No. inspected**	**No.affected (%)**	**d.f**	**Chi-square Value**	**p- value**
OriginSouthern Kordofan White Nile	100 76	4(4.0) 1(1.3)	1	1.127	0.288
Age ≤1years >1years	84 92	1(1.2) 4(4.3)	1	1.586	0.208
Body codition Poor Good	8 168	0(0) 5(3.0)	1	0.245	0.081
Breed Hamary Kabashy	81 91	2(2.5) 3(3.2)	1	0.075	0.784
Grazing Close Open	24 152	2(8.3) 3(2.0)	1	3.037	0.081

Table3: Continued

Risk Factors	No. inspected	No. affected (%)	d.f	Chi-square Value	p- value
Present of Dog					
No	87	2(1.1)	1	0.183	0.669
Yes	89	3(1.7)			
Use of Treatment					
Yes	53	3(5.7)	1	2.184	0.139
No	123	2(1.6)			

Table 4: Summary of univariate analysis for potential risk factors of hydatidosis in 176 sheep examined at Alsabaloga slaughterhouse using the OR test:

Risk Factors	No. inspected	No. Affected (%)	d.f	OR	p-value	95%CI for	
						Lower	Upper
Origin							
Southen Kordofan	100	4(4.0)	1	0.320	0.288	0.035	**2.923**
White Nil	76	1(1.3)		Ref			
Age							
≤1years	84	1(1.2)	1	Ref	0.208	**0.413**	**34.451**
>1years	92	4(4.3)		3.773			

Table 4: Continued

Risk Factors	No. inspected	No. Affected (%)	d.f	OR	p-value	95%CI for	
						Lower	Upper
Body codition							
Poor	8	0(0)	1	_	0.081	_	_
Good	168	5(3.0)					
Breed							
Hamary	81	2(2.5)	1	Ref	0.784	**0.210**	**7.904**
Kabashy	91	3(3.2)		1.288			
Grazing							
Close	24	2(8.3)	1	Ref	0.081	**0.305**	**1.401**
Open	152	3(2.0)		0.221			
Present of Dogs							
No	89	4(4.5)	1	0.247	0.182	**0.027**	**2.256**
Yes	87	1(1.1)		Ref			
Use of Treatment							
Yes	53	3(5.7)	1	Ref	0.139	**0.045**	**1.699**
No	123	2(1.6)		0.275			

The multivariete analysis was not used in this study because the result of univariate analysis showed that there is no significant association between Hydatidosis with any of the investigated risk factors.

Chapter Five

Discussion

In the present study the prevalence of disease was 2.8% in sheep slaughtered in Alsabaloga slaughterhouse, West Omdurman ,Sudan. The result is similar to that of another study carried out in Alsabaloga slaughterhouse, West Omdurman also, from where the rate of infection was 2.8 % (Kholoud ,2015) , Sinnar area ,Blue Nile State, Sudan from where the rate of infection in cattle was 2.7% (Ibrahim *et al* ., 2011). Another studies showed also similar rate of ovine infection in Sudan which was 3% (Elmahdi *et al.,* 2002).

The prevalence of hydatid cyst in this study (2.8%). was lower than theprevalence in other studies in different countries, which was 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°Cand 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 of these animal, levels of exposure and the maturity and viability of eggs (Njoroge *etal.*, 2002). Moreover, the environmental conditions in Sudan, 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 in other countries. 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) and0.33% in Egypt (Haridy *et al.*, 2000).

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

The prevalence of hydatid cyst infection by origin has been investigated in this study. The rate of infection in Southern Kordofan was 4.0% and in White Nile was 1.3%. There was no significant association between the hydatidosis and origin of the animals (p-value = 0.288). 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 Southern Kordofan (4.0%) followed by White Nile(1.3%). 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 parasitic contamination.

With regards to rate of infection of hydatidosis in different age groups of sheep, no significant association (p-value = 0.208) was observed.

Animals of more than one year of age were more affected (4.3%) compared with animals less or equal to one year (1.2%). 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). Also the diffirence 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 least6- 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),and in Northern Iran(Daryani *et al.*, 2009).

Our study showed that the prevalence of hydatid cyst infection within different body condition of the animals was : 3.0 % 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 = 0.621), this could be attributed to the fact, the hydatid cyst infection is 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 including emaciated animals presented for slaughter . This result is agreement withthe result of another study carried out in Sudan **(**Abdalraswal, 2011). Butthis result disagrees with study conducted in Ethiopia (Melaku *et al.,*2012) ; (Fikrie et *al.,* 2012).

The prevalence of hydatid cyst infection related to breed of animals was assessed: 2.5% in Hamary breed and 3.2% in Kabashy breed.

However, these was no signification association between breeds and hydatid cyst infection (P-value = 0.784) . Hamary breed had higher rate of infection , this may be attributed to the nature of pasture – grazing patterns of animals, also movement between these topographical location for pasture.

In this study the prevalence of hydatidosis and presence of dogs was as follows :1.1% rate of infection in the absence of dogs and 1.7 % rate of infection in the precence of dogs, but there was no signification association between presence of dogs and hydatidosis (p-value =0.669) ,higher rate of infection was detected in presence of dogs. Logically this is truth because of dogs play important role in complete the life cycle of worms because as a final host, also improper disposal of offals which may lead to continuous source of infection to stray dogs and subsequently a source of infection to domestic animals in the area.

In this study the prevalence of hydatidosis and grazing was investigated: 8.3% rate of infection in close grazing and 2.0% rate of infection in opened grazing ,but there was no signification association between grazing and hydatidosis (p-value =0.), , higher rate of infection was detected in close grazing. Logically this is not truth, but the reason of this may be refers to that the animals previously , the way of grazing of them was opened grazing before buing these animals by a current owner, and then the way of grazing been close.

The occurrence of hydatid cyst infection in relation to the no using of treatment in animals was higher in animals that using treatment, rate of infection was 5.7%and lower in animals with using treatment, rate of infection was 1.6%, there is was no significant association between using

of treatment and hydatidosis (p-value =0.139), this mean due to no using treatment are higher at risk to hydatidosis so infection is high.

The occurence of hydatid cyst infection in relation to the location of cyst in animals was higher in liver. There was a significant association between hydatid cyst infection and location of cysts (p-value =0.00).

These findings are consistent with the observations reported in Libya (Ibrahem and Craig, 1998), Iran (Tappe *etal*., 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 that 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).

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 sterile (3cases) , fertile viable (2cases),. This result agrees with a study conducted in Northern Iran (Daryani *et al.*, 2009).

The variation in fertility, sterility and calcification may be related with strain difference, Arene, 1985; Mc Mans, 2006. Genotype of infection strain affects the fertility rate of cysts in the intermediate hosts and there by the infectivity of strain for the subsequent (Mwambete *et al.*, 2004).

The occurrence of hydatid cyst infection in relation to volume of cyst fluids was greater than 3 ml volume cysts found in four carcasses and lesser than or equal to 3 ml cysts found in one carcass. There was a significant association between hydatid cyst infection and volume

(pvalue=0.00). 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

This study indicates that the overall prevalence of hydatid cyst was 2.8%. No Significant association was observed in the univariate analysis between hydatidosis and any of the investigated risk factors.
For the location of hydatid cyst in carcass organs, the liver was found to be the most affected organ (2.3%).

Recommendations

- The present research work that is to alert policy makers to design governmental control programs against hydatid cyst infection to minimize the prevalence in Sudan and ensure effective protection not only for animal population but also for humans at risk of contracting the infection.
- Control programs for killing stray dogs should be used by local veterinary and public health authorities.
- Vaccination of dogs with clear identity card and collar for these dogs. Treatment of animal with anti-parasite medicine (specially sheep and dogs) and prophylactic anthelmentic dosage 3 time yearly for all farm animals.
- Public health education through media and teaching livestock holders and people who are at risk about periodic epidemiologic investigations.
- Enhancement of awareness of people about the economic and public health importance of the disease.

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Appendices

Appendix I

Origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	southern kordofan	100	56.8	56.8	56.8
	white nile	76	43.2	43.2	100.0
	Total	176	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than or equal year	84	47.7	47.7	47.7
	more than year	92	52.3	52.3	100.0
	Total	176	100.0	100.0	

Body condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	poor	8	4.5	4.5	4.5
	good	168	95.5	95.5	100.0
	Total	176	100.0	100.0	

Breed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hamari	81	46.0	46.0	46.0
	kabbashi	95	54.0	54.0	100.0
	Total	176	100.0	100.0	

Grazing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	close	24	13.6	13.6	13.6
	open	152	86.4	86.4	100.0
	Total	176	100.0	100.0	

Present of dogs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	non precnse	87	49.4	49.4	49.4
	precense	89	50.6	50.6	100.0
	Total	176	100.0	100.0	

Using of treatment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	using	53	30.1	30.1	30.1
	not using	123	69.9	69.9	100.0
	Total	176	100.0	100.0	

Location of cyst

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	absence of cyst	171	97.2	97.2	97.2
	cyst found in liver	4	2.3	2.3	99.4
	cyst found in muscle	1	.6	.6	100.0
	Total	176	100.0	100.0	

Volume of cyst

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	abcense of cyst	171	97.2	97.2	97.2
	equal or smaller than 3 ml	1	.6	.6	97.7
	more than 3 ml	4	2.3	2.3	100.0
	Total	176	100.0	100.0	

Fertility of cyst

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	abcense of cyst	171	97.2	97.2	97.2
	fertile	2	1.1	1.1	98.3
	sterile	3	1.7	1.7	100.0
	Total	176	100.0	100.0	

Appendix II

Origin

Count	Origin		Total
	Southern Kordofan	White Nile	
Result			
-ve	**96**	**75**	**171**
+ve	**4**	**1**	**5**
Total	**100**	**76**	**176**

Age

Count	Age		Total
	≤1years	>1years	
Result			
-ve	**83**	**88**	**171**
+ve	**1**	**4**	**5**
Total	**84**	**92**	**176**

Body condition

Count	Body condition		Total
	Poor	good	
Result			
-ve	8	163	171
+ve	0	5	5
Total	8	168	176

Breed

Count	Breed		Total
	Hamary	Kabashy	
Result-ve			
+ve	79	92	171
Total	2	3	5
	81	95	176

Grazing

Count	Grazing		Total
	Close	Open	
Result			
-ve	22	149	171
+ve	2	3	5
Total	24	152	176

Present of dogs

Count	Present of dogs		Total
	No	Yes	
Result			
-ve	85	86	171
+ve	2	3	5
Total	87	89	176

Using of treatment

Count	Using of treatment		Total
	Yes	No	
Result			
-ve	50	121	171
+ve	3	2	5
Total	53	123	176

Location of cyst

Count	Location of cyst			Total
	No cyst	Liver	muscle	
Result				
-ve	171	0	0	171
+ve	0	4	1	5
Total	171	4	1	176

Volume of cyst

Count	volume of cyst			Total
	No cyst	equal and less than3	More than 3 ml	
Result				
-ve	171	0	0	171
+ve	0	1	4	5
Total	171	1	4	176

Fertility of cyst

Count	Fertility of cyst			Total
	No cyst	Fertile	Sterile	
Result				
-ve	171	0	0	171
+ve	0	2	3	5
Total	176	2	3	176

Appendix III

Origin

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.127(b)	1	.288
Continuity Correction(a)	.364	1	.546
Likelihood Ratio	1.230	1	.267
Fisher's Exact Test			
Linear-by-Linear Association	1.121	1	.290
N of Valid Cases	176		

Age

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.586(b)	1	.208
Continuity Correction(a)	.648	1	.421
Likelihood Ratio	1.710	1	.191
Fisher's Exact Test			
Linear-by-Linear Association	1.577	1	.209
N of Valid Cases	176		

Body condition:

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.245(b)	1	.621
Continuity Correction(a)	.000	1	1.000
Likelihood Ratio	.472	1	.492
Fisher's Exact Test			
Linear-by-Linear Association	.244	1	.622
N of Valid Cases	176		

Breed

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.075(b)	1	.784
Continuity Correction(a)	.000	1	1.000
Likelihood Ratio	.076	1	.783
Fisher's Exact Test			
Linear-by-Linear Association	.075	1	.785
N of Valid Cases	176		

Grazing

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.037(b)	1	.081
Continuity Correction(a)	1.170	1	.279
Likelihood Ratio	2.207	1	.137
Fisher's Exact Test			
Linear-by-Linear Association	3.020	1	.082
N of Valid Cases	176		

Present of dogs

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.183(b)	1	.669
Continuity Correction(a)	.000	1	1.000
Likelihood Ratio	.184	1	.668
Fisher's Exact Test			
Linear-by-Linear Association	.182	1	.670
N of Valid Cases	176		

Use of treatment

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.184(b)	1	.139
Continuity Correction(a)	.967	1	.325
Likelihood Ratio	1.967	1	.161
Fisher's Exact Test			
Linear-by-Linear Association	2.172	1	.141
N of Valid Cases	176		

Location of cyst

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	176.000(a)	2	.000
Likelihood Ratio	45.467	2	.000
Linear-by-Linear Association	157.041	1	.000
N of Valid Cases	176		

Volume of cyst

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	176.000(a)	2	.000
Likelihood Ratio	45.467	2	.000
Linear-by-Linear Association	166.536	1	.000
N of Valid Cases	176		

Fertility of cyst

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	176.000(a)	2	.000
Likelihood Ratio	45.467	2	.000
Linear-by-Linear Association	159.600	1	.000
N of Valid Cases	176		