بسم الله الرحمن الرحيم

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Prevalence and risk factors of Sheep Hydatidosis in East Nile locality, Khartoum State, Sudan

نسبة الإصابة وعوامل الخطر لمرض الأكياس العدارية في الضان بمحلية شرق النيل, ولاية الخرطوم, السودان

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

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الآية

بِسْمِ اللهِ الرَّحْمنِ الرَّحِيمِ

وَلَوْلاَ فَضْلُ اللَّهِ عَلَيْكَ وَرَحْمَتُهُ لَهَمَّتْ طَّائِفَةٌ مِنْهُمْ أَنْ يُضِلُّوكَ وَمَا يُضِلُّونَ إِلاَّ أَنْفُسَهُمْ وَمَا يَضُرُّونَكَ مِنْ شَيْءٍ وَأَنْزَلَ اللَّهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللّهِ عَلَيْكَ عَظِيماً)

صدق الله العظيم

(سورة النساء الآية 113)

Dedication

To my mother

To my father

Abstract

To my sister

To my brothers

To all who inspired me to face

The ups and downs of life.

Acknowledgements

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

With a great touch of pleasure and gratitude, I would like to express thanks to my supervisor, Professor Galal Eldin Elazhari Mohammed Elhassan for his advice, direction and continuous interest and constructive criticism in reviewing the dissertation.

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Abstract

An abattoir survey was conducted on 332 sheep slaughtered at El-hag Yousif abattoir, East Nile Khartoum State, Sudan, during the period extended from December 2014 to February 2015. The objective was 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 spleen).Examined sheep originated from three areas: Buttana, East Nile, and White Nile. The overall prevalence was 3% . The prevalence of hydatid cysts infection according to age of sheep was 3.7% in animals equal and more than one years and 2.11% in animals less than one year. The distribution of the hydatid cysts according to the area (source) of

sheep was 2.4% in Buttana, 2.19% in East Nile, and 5.6% in White Nile. As for body condition the prevalence was 3.3% in good body condition and 0.0% in poor body condition. The prevalence of hydatidosis in ecotype of animals was 2.3% in Baldy ecotype ,5.7% in Hamary ecotype , 2.4% in Dubasy ecotype and 5% in Kabashy ecotype. The results of the univariate analysis by using the Chi-square for the following potential risk factors were : ecotype (P-value = 0.578), age of animal (p-value = 0.407), origin of animal (P-value = 0.359), body condition (p-value = 0.321), grazing (p-value =0.100),and present of dog (p-value =0.343) . The grazing of animal was found to be significantly associated with hydatidosis (p-value =0.1).

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 the investigated risk factors.

Our study showed that the liver was the most infected organ (6 cysts), while two cysts was found in the lung, and two cyst was found in the lung and liver. No cyst was found in heart or spleen . Microscopic examination of the 12 cysts (found in 10 affected animals) revealed that, eight cysts was sterile, two cysts were fertile.

ملخص البحث

أجرى البحث على 332 رأس من الضأن مذبوحاً في مسلخ الحاج يوسف (محلية شرق النيل) في ولاية الخرطوم ، السودان . خلال الفترة التى إمتدت من ديسمبر 2014 إلي فبراير 2015 ، كان الهدف هو تقدير معدل إنتشار مرض الأكياس العدارية في الضأن والتحقيق من عوامل الخطر المرتبطة بهذا المرض . أجرى التفتيش الروتينى للحوم للكشف عن وجود الأكياس العدارية في الأحشاء الداخلية.

كان مصدر الضأن المختار من ثلاثة مناطق وهي منطقة البطانة , منطقة شرق النيل , ولاية النيل الأبيض . كان معدل إنتشار المرض فى كل الحيوانات 3 %. كان معدل إنتشار عدوى الأكياس العدارية وفقاً لسن الماشية 3.68% في الحيوانات التى عمرها يساوي سنة أو أكبر, 2.11% في الحيوانات التى عمرها أقل من سنة . وكان معدل إنتشار الأكياس وفقاً للمناطق التى جاءت منها الحيوانات :2.4% في البطانة و 2.19% في شرق النيل و 5.6% في النيل الأبيض . أما بالنسبة لحالة الجسم كان معدل إنتشار المرض هو 3.3% من حالة الجسم الجيد و 0.0% في حالة الجسم الهزيل . وكان معدل إنتشار الأكياس العدارية وسلالة الضأن هو 2.27% في الضأن البلدي ، 2.36% في الضأن الدباسي و 2.6% في الضأن الحمري و 5% في الضأن الكباشي .

وعندما تم تحليل عوامل الخطر بواسطة التحليل الاحادي وبإستخدام مربع كاى كانت نتيجة التحليل : سلالة الحيوان (0.578P = القيمة) ولعمر الحيوان(0.407P = القيمة) ولمصدر الحيوان(0.359P = القيمة) ولحالة الجسم (0.321P = القيمة) ولنظام رعي الحيوان (0.100P = القيمة) ولتواجد الكلاب مع القطيع (p = 0.343القيمة).

بإستخدام مربع كاى لتحليل قيمة عوامل الخطر وجد أن : نظام رعي الحيوان (P 0.100 = القيمة) كانت له علاقة معنوية بإنتشار المرض . وعندما تم تحليله بواسطة التحليل المتعدد لمعرفة درجة الإرتباط بينه وبين العوامل الاخري وجد أن عمر الحيوان لاعلاقة معنوية له بالمرض (P 0.100 = القيمة). وأظهرت الدراسة أن الكبد هي العضو الأكثر إصابة (6 أكياس) بينما الإصابة في الرئة كانت إصابتين (2) , أيضاً كانت توجد إصابتين (4 اكياس) في الرئة والكبد لكل حيوان على حده , ولا يوجد كيس في القلب والطحال. الفحص المجهري للأكياس وجد أن هنالك (8) أكياس عقيمة و كيسين خصبين.

Abstract

Chapter One

Introduction

Background:

Hydatid disease is caused by cestoda *Echinococcus granulosus* of 5.7 mm length with a scolex bearing four suckers and with body containing 2-6 proglottids (terminal segments), this worm lives in dog intestine . The adult worm in dog intestine was discovered by Hartmann (1695) and distributed throughout temperate and subtropical regions of world . The proglottids (terminal segments) release eggs that are passed in feces, after infection by an intermediate host such as sheep, goats, swine, cattle, horse, and man, the eggs hatch in the small bowel and release an oncophere (hexacanth embryo) that penetrate the intestinal wall and migrates thought the circulatory system into various organs, especially the liver and lung, in these organs the oncosphere develops into cysts that gradually enlarges . Sheeps are more sensitive to the disease; its distribution is normally associated with under developed countries, especially in rural communities, where man maintains close contact with dog, the definitive host which may act as intermediate host . Hydatidosis occurs in all breeds, sex, and ages of sheep but animals of 5 years of age and older have higher infection rates and greater of cysts, animals heavily infested sheep are undernourished, their wool is strangely and a characteristic cough is noted with signs of weakness, anorexia, dyspnea, loss of weight, and finally death . The sheep strain is the main cause of infection in human . In the endemic Mediterranean area sheep and dromedaries are intermediate host . Hydatidosis is wide spread parasitosis and causes a great health problem in many countries (Waleed *et al* .,2013).

Hydatidosis is a chronic cyst-forming parasitic helminthic disease of human beings as well as domestic and wild ungulates. It is caused by infection with the larval (metacestode) stages of dog tapeworms belonging to the genus *Echinococcus* (family Taeniidae) and is also referred to as echinococcosis. Three broad morphological forms of echinococcosis are recognized clinically: Cystic echinococcosis caused by *E granulosus*, alveolar echinococcosis caused by *E multilocularis*, and polycystic echinococcosis caused by *Echinococcus vogeli* or *Echinococcus oligarthrus* . 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. The global burden (disability-adjusted life years) for human cystic echinococcosis was recently estimated to be more than that for onchocerciasis and almost the same as that for African trypanosomiasis. (Craig *et al*., 2007).

Justification :

Echinococcosis is an important disease but it is a neglected public health problem in Africa, especially in rural communities . In East Nile locality (Khartoum) , hydatidosis may be one of the major infectious zoonotic diseases becuase most abattoirs in East Nile locality (Khartoum) is not well qualified , where sheep , cattle and goats are still slaughtered traditionally and carcass 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 . This study is therefore undertaken to determine the extent of spread of animal hydatidosis among slaughtered animals . It is clear that hydatidosis is considered a major public health problem in Sudan . Many animals are infected with hydatid cyst disease . Since the animals share the same life cycle as man , therefore determination of the prevalence of the disease in East Nile locality (Khartoum) 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 Ovine hydatidosis in Khartoum state, East Nile locality.

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

Chapter two

Literature review

2.1 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 .

2.2.1 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 *et. al*,2004).

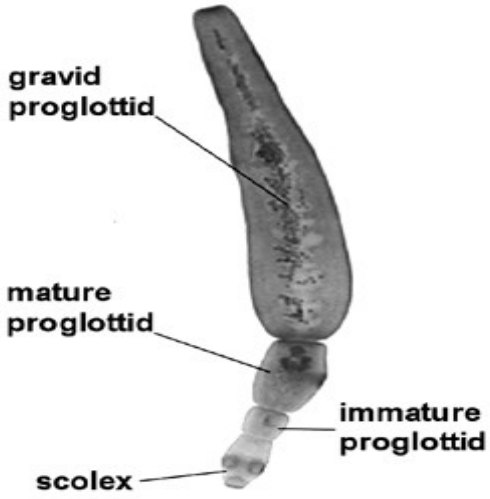


Figure 1 Morphology of a mature adult worm of *E. granulosus. (***Source: TMCR**
http://tmcr.usuhs.mil/tmcr/chapter3/epidemiology2.htm

2.2.2 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).

2.2.3 Morphology of cyst:

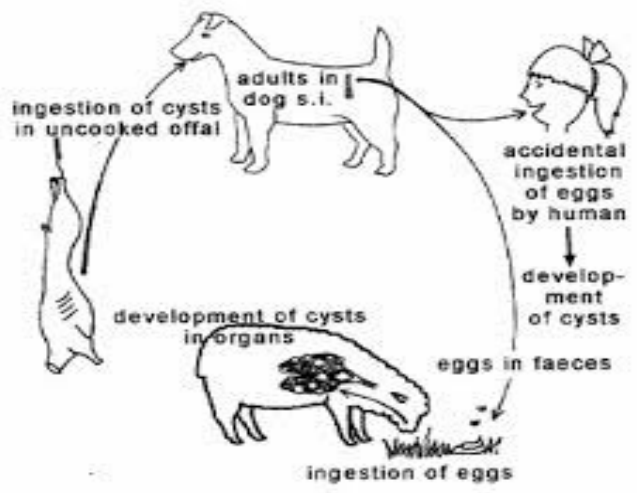
The hydatid cyst, after 3 weeks, measures 250 µm in diameter and has central cavity. Around fifth months ,it measures approximately one- cm and it is apparent that its wall consists of two layers :an external cuticular, or laminar layer,formed by numerous thin lamina that resembles the cross-section 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).

2.3 LIFE CYCLE:

Definitive hosts of *E. granulosus* are domestic dogs and some wild canids . Adult cestodes live attached deep inside mucosal crypts of definitive hosts 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 . 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 must be ingested by intermediate host to 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 (Pedro and Boris, 2001) . The disease state caused by *E. granulosus* is sometime known as unilocular hydatid , because only single site is initially colonized, whereas *E. multilocularis* colonizes multiple sites and therefore leads to more serious clinical disease . In human these tapeworms cause condition known as hydatid disease, where cysts of great size may develop and cover long period post-infection (Shakespeare, 2001) .

Hydatidosis is one of the parasitic diseases which causes main problem for human health . Larval stage of this parasite is located in liver and lung of cattle, sheep, goats and horses. Cystic echinococcosis (CE) is one of the most wide spread onthropozoonoses (Thompson and Lymbery, 1990) .



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2.4 Pathogenesis and Clinical signs:

After ingestion, Echinococcus eggs hatch and release embryos in the small intestine. Penetration through the mucosa leads to blood distribution to the liver and other sites, where development of cysts begins.

The clinical manifestations of cystic echinococcosis are variable and are determined by the site, size, and condition of the cysts.

The rates of growth of cysts are variable, ranging from 1 to 5 cm in diameter per year. The slowly growing echinococcal cyst often is tolerated well until it causes dysfunction because of its size. The signs and symptoms of hepatic echinococcosis

in human can include hepatic enlargement (with or without a palpable mass in the right upper quadrant), right epigastric pain, nausea, and vomiting. If a cyst ruptures, the sudden release of its contents can precipitate allergic reactions ranging from mild to fatal anaphylaxis. In the lungs, ruptured cyst membranes can be evacuated entirely through the bronchi or can be retained to serve as a nidus for bacterial or fungal infection. Dissemination of protoscolices can result in multiple secondary echinococcosis disease. Larval growth in bones is atypical; when it occurs,invasion of marrow cavities and spongiosa is common and causes extensive erosion of the bone (Pedro and Peter , 2009).

2.5 Diagnosis:

2.5.1 Parasitological methods

In cattle, 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).

2.5.2 Examination of cysts for fertility and viability

Based on the presence or absence of brood capsules containing 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 as sterile (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. 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 immunoelectrotransfer or Western blot test. Casoni'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 hemagglutination, 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 cestodes. ELISA diagnosed 96.6% of hydatidosis patients but cross-reacted with taeniasis and ascariasis; indirect hemagglutination 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 taeniasis and ascariasis patients showed false positives. More recent reports compared ELISA with antigen electrotransfer 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 patients' bloodstreams (Pedro and Boris, 2001).

2.6 Treatment:

Cystic Echinococcus 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. (Taha , 2012).

2.6.1 Surgery*:*

Surgical procedures range from simple puncture and aspiration of cyst content to partial resection of the affected organ. The most commonly used procedures can be divided in conservative and radical. Radical procedures aim at complete removal of the cyst with or without hepatic or lung resection. Peripherally located lung cysts of any size and small- to medium-sized centrally located cysts can be excised without sacrificing lung parenchyma. Standard radical procedures are wedge resection of lung parenchyma of less than one segment, and for liver and lung cysts, segmentectomy and lobectomy. Conservative procedures aim at sterilization and evacuation of cyst content, including the hydatid membrane (hydatidectomy), and partial removal of the cyst. The evacuation and the hydatidectomy consists of puncture of the cyst and aspiration of part of the content, to permit introduction of the scolicidal agent, and total aspiration thereafter (Taha , 2012).

2.6.2 Percutaneous treatment:

Historically, the first percutaneous treatment used was to puncture the cyst, aspirate cyst fluid, inject a scolicidal agent, and re-aspirate the cyst content.
Two types of approaches are currently in use: the catherization technique and the modified catherization techniques, in particular PEVAC (percutaneous evacuation) MoCaT (modified catheterization technique), and DMFT (dilatable multi-function trocar) (Taha , 2012).

2.6.3 Medical treatment:

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 (Taha , 2012).

2.7 Control:

Any approach to the control of echinococcosis should recognize the multiplicity of interacting extrinsic and intrinsic factors as well as the impact of socioecological factors on the dynamics of transmission. The established control measures were directed towords prevention of dogs gaining access to raw infected organs and the reduction of parasite biomass by reducing the tapeworm population or reducing the dog population. The control of stray dogs and health care of domestic ones will help in eliminating the source of human and livestock infection. Other methods used to reduce the dog and tapeworm population include spaying of bitches, mass killing and mass dog treatment progam. Some countries impose restriction on the importation of carnivores from zones endemic with *E. granulosus*, while others require the treatment prior to impotation. Community health education must be

regarded as basic component of all echinococcosis control programs. The effective control relies on active cooperation and participation of target groups which include political decision-makers, butchers, and slaughter houses workers (Mohammed ,1992) . By contrast with the predominant domestic animal transmission cycles that sustain *E granulosus* worldwide, the closely related species *E multilocularis* is transmitted only in the northern hemisphere and mainly within wildlife cycles. A number of fox species are highly susceptible to infection with the adult tapeworm, and a wide range of rodents (especially microtine voles) and small mammals can act as intermediate hosts. Human infection with the larval stage, alveolar echinococcosis, is consequently a rarer zoonosis than cystic echinococcosis. However, the greater pathogenicity, treatment difficulty, and higher mortality risk of alveolar echinococcosis has led to consideration of its control by intervention trials/programmes in endemic areas of Alaska (St Lawrence Island), Europe (southern Germany and northern Switzerland), northern Japan (Hokkaido), and southwest China (Craig, 2007).

2.8 Geographic distribution and prevalence of echinococcosis in selected regions of the world.

Echinococcus granulosus has a world-wide geographic range and occurs in all continents including circumpolar, temperate, subtropical and tropical zones (Craig *et al.,* 1996; Schantz *et al.,* 1995). The highest prevalence of the parasite is found in parts of Eurasia, Africa, Australia and South America. Within the endemic zones, the prevalence of the parasite varies from sporadic to high, but only a few countries can be regarded as being free of *E. granulosus.* The worldwide distribution of the disease is partly due to the easy adaptability of the parasite to several domestic and wild intermediate hosts (Bhatia, 1997). Actually, this wide

spectrum of intermediate hosts seems to correspond to genetic variability among *Echinococcus granulosus* strains which can be assessed using nuclear and/or mitochondrial genotypic methods (Raether and Hanel, 2003; Eckert and Deplazes, 2004).

E. granulosus is present virtually worldwide since there are very few countries that are considered to be completely free of *E. granulosus.* An important fact to keep in mind is that the areas of the world where there is a high incidence of infection by *E. granulosus* often coincide with rural, grazing areas where dogs are able to ingest organs from infected animals.

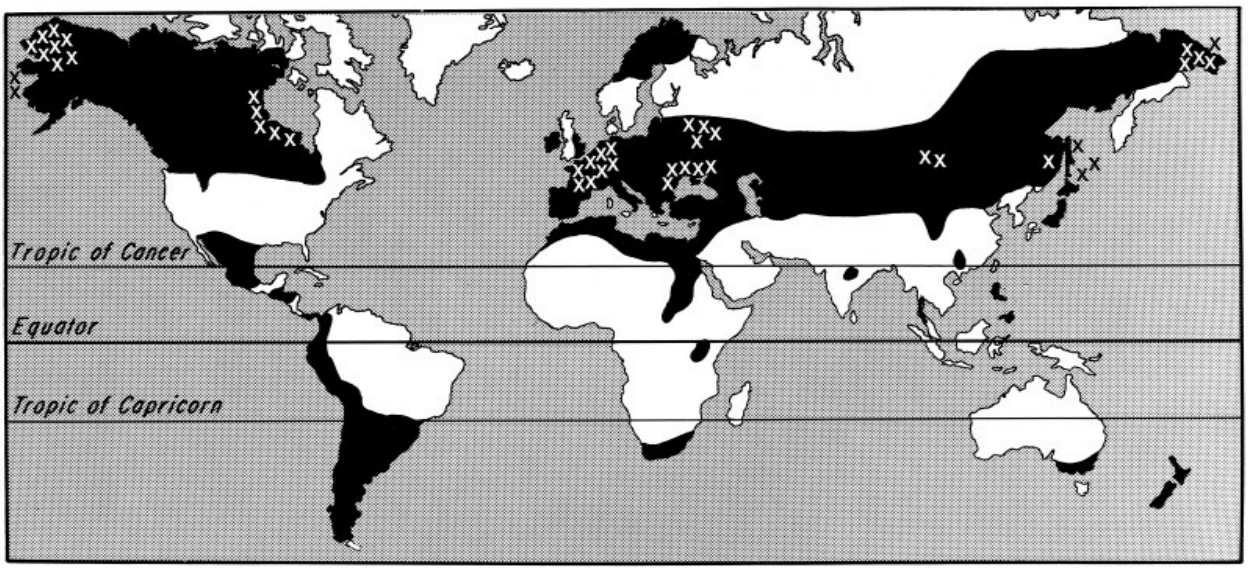
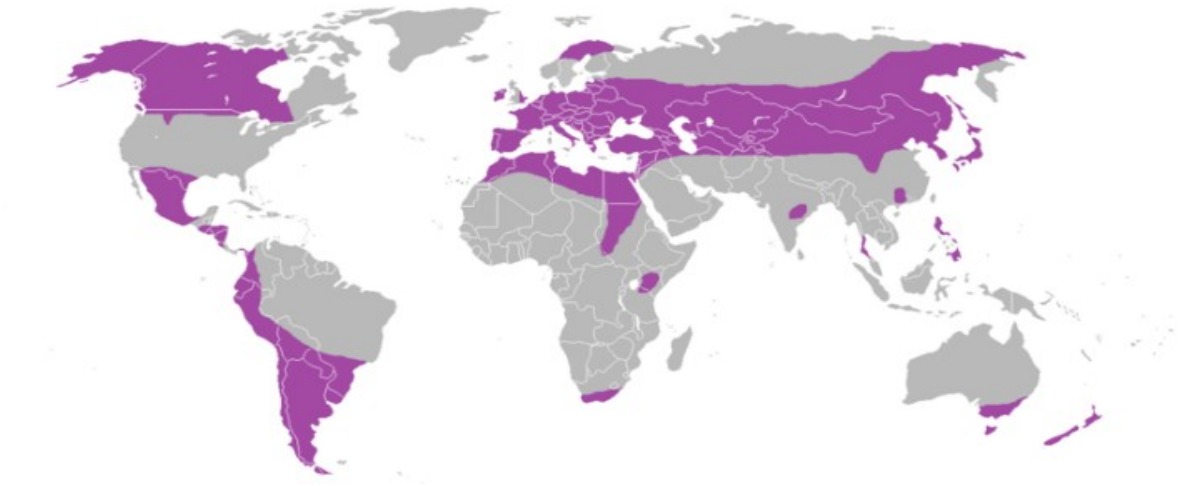


Figure 2 Global distribution of *E. granulosus* (black) and *E. multilocularis* (x) (Source: TMCRhttp://tmcr.usuhs.mil/tmcr/chapter3/geographic.htm)



Infection with *E. granulosus*

No infection

Figure 3 Global distribution of *E. granulosus* **(Omer, 2013).**

2.8.1 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 Echinococcus 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 shoats (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 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 (Al-Khalid , 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 *et al*, 2012).

2.8.2 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 form 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. (Omer *et al.*, 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 peritonieum , 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 detect 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).

Chapter Three

Materials and Methods

3.1 Study area:

The study was carried out in Khartoum state East Nile locality in El Hag Yousif abattoir.

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 longitude 21-24 East with a length of 250 k and a total area of 20,736 km^2 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 25-40 C^O during the months of April to June and between 20-35 C^O during July-October

Period. Temperature degrees continue to fall during the winter period between November-March to the level of 15-25 C^{O}.

Khartoum State is 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 itself on the southern bank of the Blue Nile (Adel and Omer, 1999).

East Nile locality locates at the eastern north of Khartoum state, its bounded by Nile from west, Nahar Nile state at north, Kassala state on east and both Gadarif and Eljazera states from south (www.eastnile.gov.sd).

3.1.1 El-Hag Yousif abattoir :

El-Hag Yousif slaughter house 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 floor. Its iron-bar doors permit the enterance of dogs specially at night thus, may contaminate the 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 get access to it. Because of the water problem in the town , water supply is insufficient specially during summer for cleaning.

3.2 Type of the study:

A Cross-sectional study was conducted at abattoir on three randomly selected days . The animals in these days selected by systematic random sampling method. From each five animals one animal was selected for examination. The study was performed in the period between December2014 to February2015 to determine

the prevalence and risk factors associated with the disease at a particular point of time.

3.3 Examination:

3.3.1 Ante –mortem examination :

Regular visits was made by the investigator to conduct ante -mortem examination of animals for slaughtering. During the ante mortem inspection, the age, sex, breed, origin and body condition of each animals most be determined .

3.3.2 Post -mortem examination :

During the post mortem examination, visual inspection , palpation and systemic incision of each visceral organs was performed particularly the liver , lungs, kidneys, heart and spleen . Infected organs were collected in polyethene pags and taken to laboratory to conduct cyst count, cyst size, cyst fertility and viability of protoscoleces.

3.3.3Laboratory examination :

3.3.3.1Examination of cysts :

The fertility of cysts was examined microscopically . Each cyst was cut-open 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 suppurative, calcified, or degenerated were considered as unfertile cyst .

3.3.3.2Size measurement :

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

3.4 Sample Size *:*

The expected prevalence of sheep hydatidosis for calculation of sample size was taken from the study in sudan (Sheep Hydatiosis in Khartoum State, Sudan) in which the prevalence of hydatidosis in sheep was 10.7% (Abdalraswal, 2011).

Sample size was calculated according to the formula by Martin et al.1987

$$n = \frac{4 \times P \times Q}{L2}$$

Where:

n≡ Required Sample Size

P≡ Expected prevalence = 10.7

Q ≡ 1- P = 1-10.7

L≡ Allowable error =(0.05)

$$n = \frac{4 \times 10.7 \times (1-10.7)}{0.0025} = 166$$

The small sample size calculated (166) was multiplied by 2 to increase precission of the results (Thursfield, 2007).

3.5 Statistical analysis:

Frequency tables of the distribution according to the potential risk factors were .constructed

Cross-tabulation of Hydatiosis cysts per according to potential risk .factors was made

Univariate analysis for risk factors associated with sheep Hydatiosis in Khartoum state, Sudan were 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 ≤ 0.05

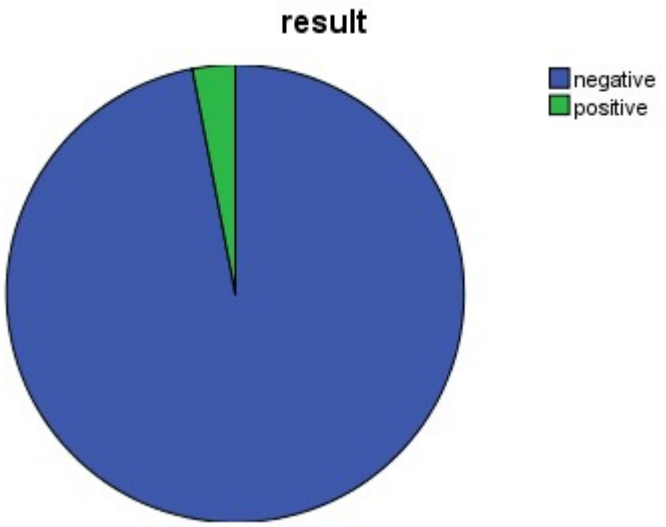
Chapter Four
Results

4.1 Results:

Of the total 332 sheep inspected, only 10 (3%) animals were positive, and the rest were negative for hydatidosis (table 1.1).

Table 1.1: Distribution of hydatidosis infection among 332 sheep examined in El-Hag Yousif slaughter house:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	322	97.0	97.0	97.0
	1	10	3.0	3.0	100.0
	Total	332	100.0	Abstract100.0	



4.2: Age of animals :

Three hundred thirty two sheeps of various ages were examined in this study . The presence of hydatid cyst in various organs was investigated . Table 1 shows the age distribution of sheep . 142 of sheep were less than year and 190 of sheep were equal and more than year . infection was high in animals which were equal or more than one year (3.68%) but in animals less than one year the infection rate was (2.11%)

The chi square test showed no significant association between infection and age of animal (p- value 0.4) (Table 1.4)

4.3: Area (state) or origin :

Of the total 332 sheep inspected , 10(3 %) animals were positive for sheep hydatidosis . Table (3) summarizes the number of infected animals with hydatidosis in various states . The highest rate of infection was in White Nile (5.56%). Buttana had infection rate (2.4%) and the less rate of infection was in East Nile (2.19%) .

The Result of study showed that there is no significant association between hydatid infection and origin of animal (p-value 0 .359).(Table 1.4)

4.4: Body condition :

The body condition of animals and the presence of hydatid cyst had been investigated . 302 of sheep were found to be in good condition and rate of infection was (2.98%) followed by 30 of sheep were found to be in poor condition and rate of infection was (3.3 %).

Chi square test showed no significant association between the infection and body condition (p – value 0.9) (Table 1.4)

4.5: Presence of dogs :

The presence of dogs and presence of hydatid cyst infection had been investigated . The total number of infection was higher in presence of dogs (4.2%), the infection was low in area where dogs were absent (2.34%) .

The chi-square test showed no significant association between infection and presence of dogs(p-value 0.523) (Table 1.4).

4.6: breed of animals :

The results of study showed distribution of hydatid cyst infection in El-hag Yousif slaughter house by breeds . Total number of Baldy breed was 132 animals , among these 132 animals 3 were found infected . The rate of infection was (2.27%) .Total number of Dubasy breed examined were 127 , among these there was 3 infections

with rate (2.36%). Total number of Hamary breed examined were 53 , among these 3 cases was infection with rate of infection (5.66%).Total number of Kabashy breed was 20 animals , amonge these 20 animals rate of infection (0%) (Table 2.5). The chi square test showed there is significant association between the hydatid cyst infction and breeds (p value-0.578) (Table 1.4) .

4.7:Grazing :

The grazing and presence of hydatid cyst infection had been investigated . The total number of infection was higher in open grazing (4.1%) more than infection were the grazing closed (0%).

The chi square test showed there is significant association between the hydatid cyst infction and grazing (p value-0.100) (Table 1.4) .

4.8 Location of cysts:

The location of cysts in different organs was investigated. The results showed that liver was most infected organ with hydatidosis where in 6 cases, the cysts were found in the livers, and 2 cases was found in the lung . Also 2 cases was found on lungs and liver in same animal. (Table 1.2).

Chi- square test showed significant association between the infection and location of cyst (p-value=0.00). (Table 1.4).

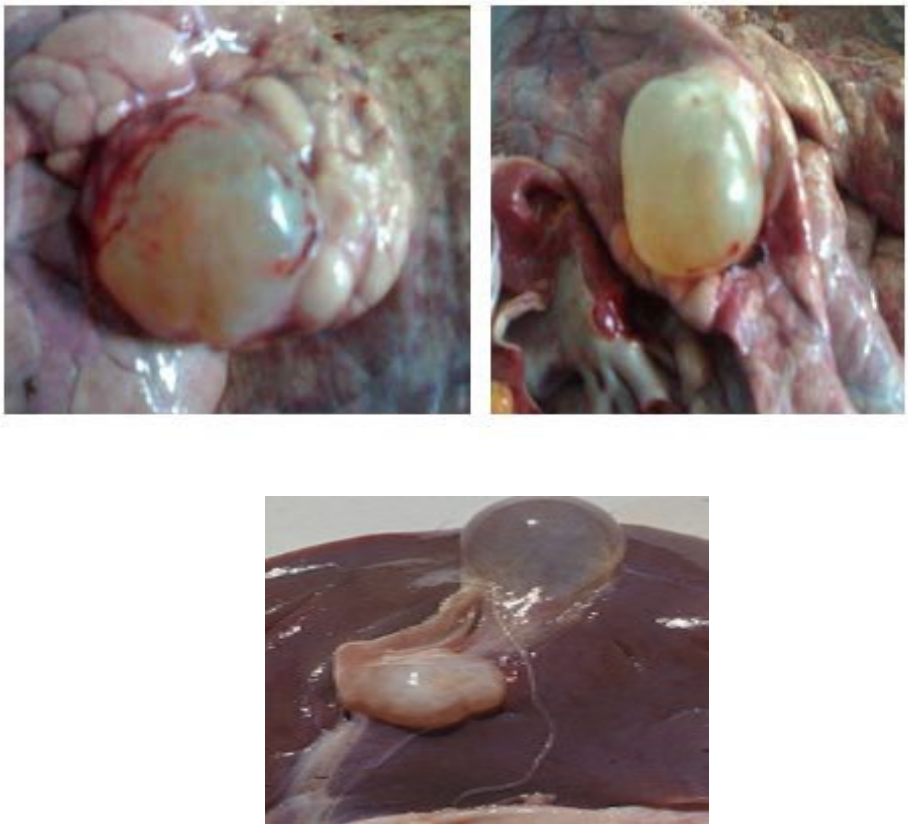


Figure (4): Hydatid cyst in lung and liver of sheep

4.9 Size of cysts (volume) :

Distribution of small cyst than 4 ml , equal or more than 4 ml in organs was listed in(Table 1.9) . Equal or more than 4 ml size cysts was found in six cases and small than 4 ml cysts was found in four cases , (Table 3.1.2).

Chi- square test showed significant association between the infection and size of cyst(p-value=0.00) . (Table 1.4) .

4.10 Fertility of cysts:

Macroscopic examination of the cysts revealed a total of 10 cysts, 2 cysts in two cases were fertile viable and eight cysts were sterile (table 3.1.2).

Chi- square test showed significant association between the infection and fertility of cyst (p-value=0.00). (table 1.4) .

Table 1.2: Summary of frequency tables for potential risk factors of hydatidosis in 332 sheep examined at El-HagYousif slaughterhouse:

Risk Factors	Frequency	RelativeFrequency %	Cumulative Frequency %
Age			
< 1 years	142	42.8	42.8
≥ 1 years	190	57.2	100
Source			
Buttana	123	37	37
East Nile	137	41.3	78.3
White Nile	72	21.7	100
Breed			
Baldy	132	39.8	39.8
Dubasy	127	38.3	78
Hamary	53	16	94
Kabashy	20	6	100

Grazing			
Close	114	34.3	34.3
Open	218	65.7	100

Table 1.2 Continued

Risk Factors	Frequency	RelativeFrequency %	Cumulative Frequency %
Body condition			
Poor	29	8.7	8.7
Good	303	91.3	100
Present of dog			
No	213	64.2	64.2
Yes	119	35.8	100
Location			
No cyst	322	97	97
Liver	6	1.8	98.8
Lung	2	0.6	99.4
Liver& Lung	2	0.6	100
Volume			
Nocyst	322	97	97
<4 ml	4	1.2	98.2
≥4 ml	6	1.8	100
Fertility			
No cyst	322	97	97
Fertile	2	0.6	97.6
Sterile	8	2.4	100

Table 1.3: Summary of cross tabulation for potential risk factors of hydatidosis in 332 sheep examined at El-Hag Yousif slaughterhouse:

Risk factors	No. inspected	No. affected (%)
Age:		
< 1 years	142	3(2.1)
≥ 1 years	190	7(3.68)
Source:		
Buttana	123	3(2.4)
East Nile	137	3(2.18)
White Nile	72	4(5.55)
Body condition:		
Poor	29	0(0)
Good	303	10(3.3)
Present of dog		
No	213	5(2.34)
Yes	119	5(4.2)

Table 1.3 Continued:

Risk factors	No. inspected	No. affected (%)
Br**eed:**		
Baldy	132	3(2.27)
Dubasy	127	3(2.36)
Hamary	53	3(5.66)
Kabashy	20	1(5)
Grazing:		
Close	114	1(0.877)
Open	218	9(4.12)

Details of cross tabulation for potential risk factors of hydatidosis in 332 sheep examined at El-Hag Yousif slaughterhouse:

Table 1.3.1: Age :

	Age		
Results	≥ year	<year	Total
+ ve	3	7	10
% of total	2.11%	3.68%	3%
- ve	139	183	322
% of total	97.88%	96.3%	96.98%
	142	190	332
% of total	100%	100%	100%

Table 1.3.2: Origin (State) :

Results		State or origin of Animal		
Infected	Buttana	East Nile	White Nile	Total
Yes	3	3	4	10
%	2.4%	2.19%	5.56%	3%
No	120	134	68	322
%	97.5%	97.8%	94.4%	96.98%
Total	123	137	72	332
	100%	100%	100%	100%

Table 1.3.3: Body condition :

	Body condition		Total
Results	Poor	Good	
+ve	0 0%	10 3.3%	10 3%
- ve	29 100%	293 96.69%	322 96.98%
Total	30 100%	302 100%	332 100%

Table 1.3.4: present of dog :

Results	Presence of dogs		Total
	No	Yes	
+ ve %	5 2.34%	5 4.2%	10 3%
_ve %	208 97.7%	114 95.8%	322 96.98%
Total	213 100%	119 100%	332 100%

Table 1.3.5: Breed :

	Breed				Total
	Balady	Dubasy	Hamary	Kabashy	
Results + ve	3 2.27%	3 2.36%	3 5.66%	1 5%	10 3%
-ve	129 97.7%	124 97.63%	50 94.3%	18 95%	322 96.98%
Total	132 100 %	127 100%	53 100%	19 100%	332 100%

Table 1.3.6: Grazing :

Results	Grazing		Total
	Closed	Open	
+ ve %	1 0.87%	9 4.128%	10 3%
_ve %	113 99.12%	209 95.87%	322 96.98%
Total	114 100%	218 100%	332 100%

Table 1. 4: Summary of univariate analysis for potential risk factors of hydatidosis in 332 sheep examined at El-Hag Yousif slaughterhouse using the Chi- square test:

Risk factors	**No .inspected**	**No affected (%)**	**Df**	**X^2**	**p- value**
Origin			2	2.05	0.359
Buttana	123	3 (2.4)			
East Nile	137	3 (2.19)			
White Nile	72	4 (5.56)			
Age			1	.687	0.407
<years	142	3 (2.11)			
≥years	190	7 (3.68)			
Body condition			1	0.987	0.321
Poor	29	0(0)			
Good	303	10(3.3)			
Presence of dog			1	0.899	0.343
Yes	119	5 (4.2)			
	213	5 (2.34)			

no **Breed** Baldy Dubasy Hamary Kabashy	 132 127 53 20	 3 (2.27) 3 (2.36) 3 (5.66) 1 (5)	3	1.974	0.578
Grazing Open Close	 218 114	 9 (4.12) 1 (0.87)	1	2.709	.100*

*Is mean significant value

Table 1. 5: Summary of univariate analysis for potential risk factors of hydatidosis in 332 sheep examined at El-Hag Yousif slaughterhouse using the Odds Ratio(**OR**) test:

Risk factors	**No .inspected**	**No affected (%)**	**Df**	**Odds Ratio (OR)**	**p- value**	**95%CI For Exp(P)**	
						Lower	**Upper**
Age <years ≥years	 142 190	 3 (2.11) 7 (3.68)	1	1.77	0.407	0.450	6.977

Body condition Poor Good	 29 302	 0(0) 10(3.3)	1	0.891	0.321	0.109	7.281
Presence of dog Yes no	 119 213	 5 (4.2) 5 (2.34)	1	1.82	0.343	0.517	6.435
Grazing Open Close	 218 114	 9 (4.12) 1 (0.87)	1	4.86	.100*	0.609	38.89

*is mean significant value

Table 1. 6: Summary of multivariate analysis for potential risk factors of hydatidosis in 332 sheep examined at El-Hag Yousif slaughterhouse using the Exp(**P)**

Risk factors	**No .inspected**	**No affected (%)**	**Df**	**Exp (P)**	**p- value**	**95%CI For Exp(P)**	
						Lower	**Upper**
Origin Buttana East Nile White Nile	 123 137 72	 3 (2.4) 3 (2.19) 4 (5.56)	2	 Ref 0.00 1.41	0.548	 0.00 0.00	 _ _

Age			1		0.261		
<years	142	3 (2.11)		Ref		_	_
≥years	190	7 (3.68)		2.1		0.512	8.876
Body condition			1		0.784		
Poor	29	0(0)		Ref		_	_
Good	302	10(3.3)		3.92		0.00	7.47
Presence of dog			1		0.742		
Yes	119	5 (4.2)		Ref		_	_
No	213	5 (2.34		1.222		0.327	4.562
Breed			3		0.837		
Baldy	132	3 (2.27)		Ref		_	_
Dubasy	127	3 (2.36)		1.4		0.00	2.02
Hamary	53	3 (5.66)		0.00		0.00	0.00
Kabashy	20	1 (5)		0.00		0.00	_
Grazing			1		.157		
Open	218	9 (4.12)		Ref		_	_
Close	114	1 (0.87)		6.085		0.507	73.05

Chapter Five
Discussion

The prevalence of hydatid cyst in this study (3%) , was higher than the prevalence in other studies in sudan, which was 1.6% in north kordofan (Khalid ,2014) , 1.4% in Khartoum state (Mohamadin and Abdelgadir, 2011).

The present result is in agreement with the result of another studies in different countries which was 3.61% in Kenya (Njoroge *et al.*, 2002) , and 2.7% in northwest Iran (Tappe *et al.*, 2010).

On the other hand the prevelance of hydatid cyst recorded during this study is lower than the results in other studies which was 4.9% in Ethiopia (Formsa and Jobre .,2011) , 8.4% in Libya (Al-Kalidi ., 1998) , 11.1% in Iran (Dalimi *et al* .,2002) , 11.1% in Iraq (Saida and Nouraddin .,2011) , 12.61% in Saudia Arabia (Ibrahim .,2010) , 12.9% in Jordan (Kamhawi *et al* .,2012) and 45.5% in Iran (Khanjari *et al* .,2012). This might be due to the variation in environmental condition because; as it is known that 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. Also the eggs survive best under moist conditions and in moderate temperatures (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).

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 Buttana was (2.4%) , in East Nile was (2.19%) , and in white Nile was (5.56%). There is no significant association between hydatid cyst infection and origin of animal (p-value =0.359).

With regards to rate of infection of hydatidosis in different age groups of sheep, no significant association (p-value = 0. 407) was observed. Animals of one year and more than one year of age were more affected (3.68%) compared with animals less than one year (2.11%). 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 inspectioAbstractn 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). The result are in agreement with the result of investigations 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: 3.3% 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 = 0.321). 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 as related to breed of animals was 2.27% in Baldy, 2.36% in Dubasy, 5.66% in Hamary, and 5% in Kabashy. There was no significant association between breed and hydatid cyst infection (p-value = 0.578). 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 the 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).

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 (8 cases), and two cysts was fertile (two case).

Conclusions

- This study indicates that the overall prevalence of hydatid cyst was 3% .
- The distribution of prevalence of hydatid cysts infection by age showed that the prevalence in old animals was 3.68% which is numerically higher than in young animals (2.11%).
- Body condition as related to the prevalence is higher in animals in good body condition (3.3%) 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 White Nile (5.56%), followed by Buttana (2.4%) and then East Nile (2.19%).
- Distribution according to grazing indicate that the prevalence of hydatid cyst infection was 4.1% in open grazing and 0.87% in close grazing.
- The prevalence of hydatid cyst infection according to the breed was higher in Hamary breed 5.66%, followed by 5% in Kabashy, 2.36% in Dubasy and 2.27% in Balady.

- Significant association was observed in the univariate analysis between hydatidosis and the grazing of animals (p-value = 0.100) .
- Multivariate analysis showed no significant association 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 (1.8%).
- Microscopic examination of hydatid cyst showed that eight cysts was sterile (2.4%) and two cysts were fertile (0.6%).

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 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

Frequency tables for distribution of infection among 332 sheep examined at El-Hag Yousif slaughterhouse according to potential risk factors:

Table 1.1: Age :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	142	42.8	42.8	42.8
	1	190	57.2	57.2	100.0
	Total	332	100.0	100.0	

Table 1.2: Origin :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	123	37.0	37.0	37.0
	2	137	41.3	41.3	78.3
	3	72	21.7	21.7	100.0
	Total	332	100.0	100.0	

Table 1.3: Body condition :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	poor	29	8.7	8.7	8.7
	good	303	91.3	91.3	100.0
	Total	332	100.0	100.0	

Table 1.4: Present of dog :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	213	64.2	64.2	64.2
	1	119	35.8	35.8	100.0
	Total	332	100.0	100.0	

Table 1.5: Breed :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	132	39.8	39.8	39.8
	2	127	38.3	38.3	78.0
	3	53	16.0	16.0	94.0
	4	20	6.0	6.0	100.0
	Total	332	100.0	100.0	

Table 1.6: Grazing:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	114	34.3	34.3	34.3
	1	218	65.7	65.7	100.0
	Total	332	100.0	100.0	

Appendix II

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

Table 2.1 : Age :

	Value	Df	Asymp. sig (2- sided)
Pearson chi-square	.687	1	0.407
Likelihood ratio	.713	1	0.399
linear by linear association	.685	1	0.408
No .of valid cases	332	1	

Table 2.2 : Origin :

	Value	df	Asymp.sig(2.sided)
Pearson chi- square	2.050	2	.359
Likelihood Ratio	1.781	2	.411
Linear by linear Association	1.173	1	.279
N. of valid cases	332		

Table 2.3 : Body condition :

	Value	Df	Asymp –sig(2-sided
Pearson chi-square	.987	1	0.321
Likelihood ratio	1.857	1	0.173

linear by linear association	.984	1	0.321
No . of valid cases	332	1	

Table 2.4: Presence of dogs:

	Value	Df	Asymp.Sig(2-sided)
Pearson chi- square	0.899	1	0.343
Likelihood ratio	0.863	1	0.353
Linear by linear association	0.896	1	0.344
No . of valid cases	332		

Table 2.5 : Breed :

	Value	Df	Asymp. Sig(2-sided)
Pearson chi- square	1.974	3	0.578
Likelihood ratio	1.711	3	0.635
Linear by linear association	1.321	1	0.250
No . of valid cases	332		

Table 2.6 : Grazing :

	Value	Df	Asymp. Sig(2-sided)
Pearson chi- square	2.709	1	0.100
Likelihood ratio	3.289	1	0.070
Linear by linear association	2.700	1	0.100
No . of valid cases	332		