بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate studies

Study of Prevalence and Risk Factors of Sheep Hydatidosis in Khartoum state – Sudan

دراسة عن معدل انتشار مرض الاكياس العدارية وعوامل الخطر في الضان في ولاية الخرطوم –السودان

This thesis is submitted in partial fulfillment of the Requirements for the Master Degree of Preventive Veterinary Medicine(MPVM)

By:

Nousiba Zakaria Mohammed Adam

Supervisor :

Professor : Mohammed Abdelsalam Abdalla

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بسم الله الرحمن الرحيم

قال تعالى : (وَلَوْلَا فَضْلُ اللَّهِ عَلَيْكَ وَرَحْمَتُهُ لَهَمَّتْ طَائِفَةٌ مِنْهُمْ أَنْ يُضِلُّوكَ وَمَا يُضِلُّونَ إِلَّا أَنْفُسَهُمْ وَمَا يَضُرُّونَكَ مِنْ شَيْءٍ وَأَنْزَلَ اللَّهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا)

صدق الله العظيم

سورة النساء الآية (113)

Dedication

***To my lovely father who was always behind me providing all the support encouragement , power and strength.**

***To my kind mother who has supported me and gave me her blessing to overcome all the difficulties I face during my work.**

***To my lovely sisters who inspired me to face the ups and downs of life.**

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With a great touch of pleasure and gratitude, I would like to express thanks to my supervisor, Professor : Mohammed Abdelsalam Abdalla , for this guidance , help and support in revising the text and giving valuable advices through different stage of this study .

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Abstract

This study was conducted on 332 sheep slaughtered at Al-Baraka Modern abattoir, West Omdurman Khartoum State, Sudan, during the period extended from March to April 2019. the objective was to estimate the prevalence of hydatid cyst in sheep and to investigate risk factors associated with the disease. Routine meat inspection procedure was employed to detect the prevalence of hydatid cyst in visceral organs (liver, lung, heart and spleen). Examined sheep originated from three areas: North Kordofan, Omdurman and Algadarif. The overall prevalence was 4.5%. The prevalence of hydatid cyst infection according to age of sheep was 5.64% in old animals and 2.91% in young animals. The distribution of the hydatid cyst according to the area(source) of sheep was 5% in North Kordofan , 5.4% in Omdurman and 2.5% in Algadarif. As for body condition the prevalence was 4% in good body condition and 9.8% in poor body condition . The prevalence of hydatidosis ecotype of animals was 4.41% in Hamary , 6.25% in Balady ecotype and 3.44% in Kabashy ecotype. The prevalence of hydatid cysts according to sex of sheep was 3.5% in female and 5.2% in male . The results of the univariate analysis by using the Chi-square for the following potential risk factors were:

age (p-value = 0.240) , sex of animal (p-value = 0.436) , ecotype (p-value = 0.712) , origin of animal (p-value = 0.590) , body condition (p-value = 0.146) , grazing (p-value = 0.006) and present of dog (p-value = 0.210) . The grazing of animal was

found to be significantaly associated with hydatidosis (p-value = 0.006) .

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.

The liver was the most infected organ(9 cysts), while four cyst was found in lung and two cyst was found in muscle. No cyst was found in heart or spleen . Microscopic examination of the 15 cysts (found in 15 affected animals) revealed that, twelve cyst were sterile, three cyst were fertile.

ملخص البحث

اجري البحث على 332 رأس من الضأن مذبوحا في مسلخ البركة الحديث (محلية غرب امدرمان) في ولاية الخرطوم ،السودان. خلال الفترة التي امتدت من مارس إلى ابريل 2019، كان الهدف هو تقدير معدل انتشار مرض الأكياس العدارية في الضان والتحقيق من عوامل الخطر المرتبطة بالمرض . تم إجراء التفتيش الروتيني للحوم للكشف عن وجود الأكياس العدارية في الأحشاء الداخلية.

كان مصدر الضأن المختار من ثلاث مناطق وهي ولاية شمال كردفان،امدرمان والقضارف . كان معدل انتشار المرض في كل الحيوانات 4.5%. كان معدل انتشار عدوى الأكياس العدارية وفقا لسن الماشية 5.64 % في الحيوانات الكبيرة ، 2.91% في الحيوانات الصغيرة .وكان معدل انتشار الأكياس وفقا للمناطق التي جاءت منها الحيوانات : 5% في شمال كردفان ، و 5.4% في امدرمان و 2.5% في القضارف . اما بالنسبة لحالة الجسم كان معدل انتشار المرض هو 4% من حالة الجسم الجيد و 9.8% في حالة الجسم الهزيل . وكان معدل انتشار الاكياس العدارية وسلالة الضان هو 4.41% في الضان الحمري ، 6.25% في الضان البلدي و 3.44% في الضان الكباشي . وكان معدل انتشار الأكياس العدارية وفقا لجنس الماشية 3.5% في الإناث و 5.2% في الذكور .

وعندما تم تحليل عوامل الخطر بواسطة التحليل الأحادي وباستخدام مربع كاي كانت نتيجة التحليل:

عمر الحيوان (0.240P = القيمة) ولجنس الحيوان (0.436P = القيمة) ولسلالة الحيوان (0.712P = القيمة) ولمصدر الحيوان (0.590P = القيمة) ولحالة الجسم (0.146P = القيمة) ولنظام رعي الحيوان (0.006P = القيمة) ولتواجد الكلاب مع القطيع (0.210P = القيمة) .

وباستخدام مربع كاي لتحليل قيمة الخطر وجد أن : نظام رعي الحيوان (0.006P = القيمة) كانت له علاقة معنوية بانتشار المرض . وعندما تم تحليله بواسطة التحليل المتعدد لمعرفة درجة الارتباط بينه وبين العوامل الأخرى وجد نظام رعي الحيوان

له علاقة معنوية بالمرض(0.006P = القيمة) وأظهرت الدراسة أن الكبد هو العضو الأكثرإصابة (9أكياس) بينما الاصابه في الرئة كانت أربعة إصابات ،أيضا كانت توجد إصابتين في العضلات ، ولا يوجد كيس في القلب والطحال. الفحص المجهري للأكياس وجد أن هنالك (12)أكياس عقيمة وثلاث أكياس خصبة

Introduction

Cystic echinococcosis or hydatidosis is an important cyclo-zoonotic disease caused by the larval stage of the tape worm *Echinococcus granulosus* .The parasite cycles in apredator or prey relationship between carnivore (definitive) hosts and herbivore (intermediate) hosts . *Echinococcus granulosus* has aworldwide geographical distribution that occur in all continents of the world and in some areas it ranks as the leading disease of puplic health significance (Eckert *et al* ., 2001). Definitive hosts of this parasite is carnivores and the intermediate host is wild and domastic ruminants (Andersons *et al*.,1997, Benner *et al*., 2010). The disease is manifested as fluid-filled cysts formed in certain parts of the body (lung , liver, spleen, and hearts). Domestic intermediate hosts (cattle, sheep, goat, and camels) are amajor source of the infection to the dogs which is caused by the adult stage of the *Echinococcus granulosus*.

Both man and animals acquired the infection by accidental ingestion of the eggs from environment . Contaminated food stuffs and infected dogs carrying the tapeworm eggs in their fur are suspected to be important sources of the infection (Benner *et al* ., 2010).

Pastoral communities have been reported to be highly at risk of becoming infected with *E. granulosus* due to their close association with dogs . Between January 1998 and July 2000, 325 patients , most of them suffering from cystic echinococcosis

were reported to African Medical and Research Foundation (AMREF) hydatid control centre for treatment at the Kenya-Sudan border. However, there is scanty information on the epidemiology of cystic echinococcosis in most parts of Southern Sudan .The disease is particularly important in developing countries where many rural inhabitants live under poor sanitary conditions and in close proximity to their domestic animals (Andersons *et al* ., 1997). In the Sudan , studies on cystic echinococcosis in domesticated animals were carried out by various workers (Elkhawad *et al*.,1979,Mohammed,1979; Elmahadi *et al*.,2003). In an attempt to establish the prevalence of the , amass survey was performed in the pastoral community of Southern Sudan .

The occurrence of human hydatidosis in the Sudan was reported by many workers (Eisa *et al*., 1962, Tola, 1987, Magambo *et al* .,1996,Almahadi,2003) Hydatid disease is an important health and socio-economic problem in Sudan (Almahdi, 2003; Budke *et al*., 2006).

The parasite life cycle is maintained through dogs (which harbor the adult worm in their small intestine) and a range of domestic livestock that serves as intermediate hosts. *E-granulosus* eggs are excreted in the feces of infected dogs and may thus contaminate soil, grass and water . Ungulates (hoofed animals) can become infected by grazing on pasture contaminated with dog feces(Mohammed,2004). Ingested eggs hatch inside the

intestine, penetrate the gut wall and are carried by the bloodstream to different organs and tissues(mainly the liver and lungs) where they develop into cysts (metacestodes) that can eventually cause severe pathological damage.Humans can become infected by ingesting eggs through consuming contaminated food and water or from handling the feces of infected dogs(Daniel, *et al*., 2008, Benner, *et al*., 2010).

Objectives:

1-To estimate the prevalence of Ovine hydatidosis in Khartoum state.

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

Chapter One

Literature review

1.Literature review

1.1 Classification

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

kingdom : Animalia

Phylum : Platyhelminths

class : Eucestoda

Order : Taeniidea

Suborder: Taeniata

Family : taeniidae

Subfamily: Echinococcinae

Genus : *Echinococcus*

Species : *Echinococcus granulosus*

Biotype : Northern biotype , European biotype

1-2 Etiology:

Actually, six species of *Echinococcus* have been recognized, but the most important members of the genus in respect of their public health importance and their geographical distribution are *E.granulosus* which cause cystic echinococcosis and *E. multilocularis* which cause alveolar echinococcosis .(Madiha et al.,2014)

Infection with *E. granulosus* result in the development of one or several unilocular hydatid cyst that in human develop mainly in liver (70%) , but also lungs (20%) and 10% of cyst can occur almost anywhere in the body (e.g., brain , body musculature,

wall of the heart , kidney , orbit of the eye , marrow cavity of bones). *E.multilocularis* metacestodes develop as a series of small, interconnected cyst, growing as metastasising lesion almost exclusively in the liver (80% -100%), but in the later phaseof infection distant metastases in other organs may occur.

1-2-1 Morphology of *Echinococcus:*

Echinococcus exhibits certain characteristic that differentiate it from the other major genus in the family Taenia . The adult *Echinococcus* is only a few millimeter long (rarely more than 7mm) (Figure 1) and usually has no more than six segments . Like all tape worm , *Echinococcus* has no gut and all metabolic interchange takes place across the synctial outer covering, the tegument (Eckert et, al,2004).

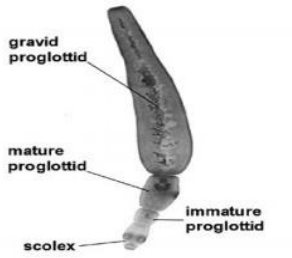

Figure 1 Morphology of a mature adult worm of *Echinococcus granulosus* (**Source:TMCR**)

Http://tmcr.Usubs.mil/tmcr/Chapter3/epidemiology2.htm

1-2-2 Morphology of *Echinococcus* eggs:

Echinococcus eggs contain an embryo that is called 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 the eggs that lead to infection in the intermediate hosts (Pedro and Boris , 2001).

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 from *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:

Definitive host 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 feaces, and distintegrates in the environment . Each egg contains an embryo (encophere) 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(Fig 2) . 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 kidney, spleen, bones and brain (Pedro and Boris, 2001). The disease state caused by *E-granulosus* is sometime known as unilocularhydatid , because only single site is initially colonized, whereas *E-multilocularis* colonizes multiple sites and therefore lead to more serious clinical disease, where cyst of great size may develop and cover long peroid post-infection (Shakespeare, 2001).

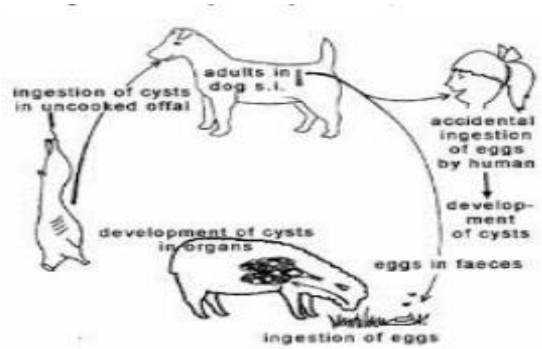

Figure 2 life cycle of *Echinococcus* species

WWW.Farmastyle.com.au

Hydatidosis is one of the parasitic disease which causes main problem for Human health . Larval stage of this parasite is located in liver and lung of cattle, sheep, goats and horses(Pedro and Boris , 2001).

1-4 pathogenesis and clinical signs:

After ingestion, *Echinococcus* egg hatch and release embryos in the small intestine. Penetration through the mucosa leads to

After ingestion, *Echinococcus* egg 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 *Echinococcus* 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 cysts often is tolerated well until it causes dysfunction because of its size (Daryani et al., 2009) .

The signs and symptoms of hepatic echinococcosis in human can include hepatic enlargement (with or without a palpaple mass in the right upper quadrant), right epigastric pain, nausea, vomiting . If a cyst ruptures, the sudden release of its contents can precipitate allergic reactions ranging from mild to fatal anaphylaxis . In the lung, ruptured cyst membranes can be evacuated entirely throught 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 (Pedro and Boris , 2001).

Larval growth in bones in atypical, when it occurs, invasion of marrow cavities and spongiosa is common and causes extensive erosion of the bone (Pedro and peter,2009).

1-5 Prevalence of hydatid cyst in selected regions of the world:

The prevalence of hydatid cyst disease in animals has been studied extensively . *E. granulosus* has a worldwide distribution and occur in all continents, *E. multilocularis* occurs in wide areas of the northern Hemisphere, *E. shiquicus* is found in the peoples Republic of China and *E. oligarthrus* and *E-vogeli* are confined to the central and south America (WHO/OIE, 2001). All five species are infective to humans causing various forms of cystic echinococcosis. Human cystic echinococcosis , caused by *E. granulosus* and alveolar echinococcosis , caused by *E. multilocularis,* are the most important public health threats in many parts of the world and also polycystic echinococcosis caused by *E. volgeli* and *E. oligarthrus* (WHO/OIE, 2001).

Hydatid cyst is cyclozoonotic infection of worldwide distribution which found in various countries including : Iceland, Europe, Asia, Africa, America, and Oceania (Matossian *et al*., 1977) . The prevalence of hydatid cyst in sheep in Iran and Turkey has been reported to be 78.65% (Esfandiari and Yousseft, 2010) , 3.50% (Meltem *et al* ., 2007), respectively . In Iran many studies on sheep have been performed in Ardabil

province area , Mazandaran province area and central part of Iran.

The results indicated an infection rates of 42.6%(Daryani et al., 2009) , 9.3%(Fakhar and Sadjjadi, 2007) respectively . Another study on sheep which has been carried out in showed an infection rate of 3.2%of lambs and 50.9% of adults (Yield and Gurcan ,2003). In Wales control programme failed to prevent transmission of *E. granulosus* to sentinel lambs in three areas . The lambs were examined at 15 month of age and rate of infection was 6% , 4% and 10% in the three infected areas 1, 2 and 3 respectively (Lioyd *et al*., 1998). Study on the prevalence of the hydatidosis in sheep , goats and cattle was carried out in Ngorongoro district of Arusha region, Tanzania . A 4-year data from four slaughter slabs, the results showed a prevalence of 63.8%, 34.7% and and 48.7% in sheep , goats and cattle respectively (Emest *et al* ., 2009) . In Italy, 771 regularly slaughtered Sardinian breed sheep, 580(75%) were found infected with *Echinococcus granulosus* hydatid cysts (Scala *et al*., 2005). In a study in Comilla and Brahman area in Bangladesh, 460 sheep carcasses were examined from February and August, 2008. The prevalence was 16.95% (Hazzaz *et al*., 2010).

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

20.3%(Zuhair *et al*., 2001), 12.7% (Kassem, 2006). Another study in Jordan in 1992, using indigenous sheep from five region of Jordan showed an infection rate of 12.9%. Also an infection rate of 8.7% with cystic echinococcosis (hydatidosis) was reported on 554 sheep in Shahat abattoir in Al-Jabal , Libya (Al-Khalidi , 1998). The prevalence of hydatid cyst in sheep in Kenya and Egypt have been reported to be 8.1% (Calum and Macpherson, 1985) 1.33% (Rahman et al., 1992). An ultrasound examination of the liver and right lung was performed in 260 sheep and 320 goats from the Turkana district of Kenya. Hydatid cyst were visualized in 9.2% of the sheep and 2.5% of the goats. The animals positive on ultrasound and 87.5% received post-mortem examination (Abby *et al*., 1996).

The relationship between age of sheep and infection with *E.granulosus* was investigated in many studies. In Turkey 742 sheep slaughtered at Twelve abattoirs in Thrace were investigated for hydatid cysts, the cyst were found in 2.64% of 720 Lambs (< 1 year old) and in 31.8% of 22 sheep (between 1-6 years old) (Meltum *et al*.,2007). Also a study of 1081 sheep slaughtered in Central Krygyzstan, an area endemic for *echinococcus* the results demonstrated approximately 64% of sheep were infected with the prevalence increasing markedly with age (Togerson *et al*., 2009).

Location of cysts in sheep has been also investigated. The liver was the predilection site of infection. These finding were

reported from the studies in Egypt (Rahman *et al* ., 1992) and Kenya (Abby *et al*., 1996). In Libya 87.2% of the infection in sheep was in the liver , 33.4% was in the lung , 6.3% was in the peritoneal cavity and 2.4% was in the spleen (Al-Khalidi, 1998). In Turkey , cysts were encountered in the liver of 96.2% , 26.9% in the lungs , and 3.85% in the spleen (Fakher and Sadjjadi , 2007) . But lungs are the most location in study of Oromia in Ethiopia .

Fertility of cysts was reported in many studies to be : In Saudi Arabia (47.67%) (Ibrahim , 2010), Libya (79.2%) , (Al-Khalidi, 1998), Kenya (70.5%) (Calum, 1985). In Iran the fertility rates of hepatic cyst of sheep and cattle were 47.1% and 1.4% respectively and the fertility rates of pulmonary cyst of sheep and cattle were 39.4% and 8.1% respectively . In the sheep , the fertility rates of hepatic cysts in the liver was higher than that at lungs , but in the cattle the fertility of cysts in lungs was higher than liver . The viability of protoscoleces of fertile cysts for sheep and cattle were about 76.9% and 82.5% respectively (Daryani et al., 2009). In another study in Urugusy the prevalence of ovine hydatidosis was 41.6% and 8.5% in 1991-1992 and 1999, the prevalence of fertile cysts in sheep more than 4 years old was 7.3% and 2.3% in 1991-1992 and 1999, respectively (Fakhar and Sadjjadi, 2007).

1-6 Prevalence of echinococcosis in the Sudan:

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

Recently survey of sheep hydatidosis in khartoum state from march to April 2015 were present in 3.1% (Faisal , 2015).

1-7 Epidemiology:

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

importance in determining the epidemiology of the parasite (Gemmell *et al*., 2001). Its customary to consider the epidemiology as being based on two cycle , the dog is always involved , being infected by feeding on ruminants , offals containing hydatid cysts. The domestic intermediate host will vary according to the local husbandry . This cycle is the primary source of human hydatidosis , the infection being by accidental ingestion of oncospheres from coats of dogs or from water contaminated by dog faeces .

The sylvatic cycle occur in wild canids and wild ungulates and is based on predation or carrion feeding . This cycle is less important as a source of human infection , except in hunting communities where the infection may be introduced to domestic dogs by the feeding of infected viscera of wild ruminants (Schants and Schwabe, 1969). At any time the parasite population consists of 3 sub –population :Adult in the definitive host , larvae in the intermediate host , and eggs in the environment .

1-8 The larva in the intermediate host:

The intensity , infectivity and availability of the eggs in the environment , local circumstances of livestock husbandry , feeding behaviour of the intermediate host , and the slaughter policy together determine the number of infective organism entering the host (Gemmell , 1976). However , the number of these eggs that become established was strictly controlled by the

host natural and acquired resistance to infection. They reported that hydatid cyst may only produce a low level of antigenic stimulation , perhaps insufficient to induce a host response adverse to cyst survival, but strong immunity was induced following parentral (intramusclar) and ingestion in lambs artificially activated embryos of the parasite and significant reduction in the total cyst counts and absence of viable cysts from the challenge infection was observed .

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

1-9 Domestic intermediate hosts:

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

Countries with known hyperendemic infections in Sub-Saharan Africa include Kenya, Nigeria, Somalia, Sudan, Swaziland and Uganda (FAO,1993).

Both susceptibility to infection and cyst fertility rates are essential factors in determining the importance of different intermediate hosts to local maintenance of *E. granulosus* . The susceptibility of cattle to infection is variable (Macpherson *et al*.,1985). Where camels are kept, more than half their population is infected and levels of infection in camels are much higher in relation to other domestic intermediate hosts (Macepherson and Wachira, 1997).

Hydatid cysts in camels, goats, and sheep are usually fertile and the three host appear to be the most important intermediate hosts of *E- granulosus* , in Sub-Saharan Africa Macpherson, 1989 reported that the most cysts encountered in sheep and goats were calcified or semi-calcified .

1-10 Domestic-wildlife interactions:

The introduction of commercial game ranching of wild herbivores in many African countries , mainly to satisfy the appetite of tourists for exotic meats and for the sport of hunting have provided opportunities for dogs to be exposed to hydatid cysts from intermediate host (Schantz and Schwabe,1969).

Dogs infected with the domestic stains of *E-granulosus* may contaminate the grasslands and range land that livestock and wildlife share , particularly in East Africa .

In this region transhumance postoralits live in close proximity to wild animals that share the same habitat with domestic ones, thereby facilitating the transmission of a large number of disease

including echinococcosis (Macpherson, 1994). More than six species of carnivores have been found infected with *E-granulosus* (Macepherson 1986). Its believed that the source of infection to wild carnivores is from predation or the scavenged carcasses of infected domestic livestock (Macpherson, et al ., 1984).

1-11 The eggs in the environment:

The crowding of animals during grazing on contaminated soil and the extent to which soil is contaminated by dogs faeces are important environment factors (FAO/UNEP/WHO, 1981). Desiccation is lethal and the end points of temperature are the order of +4 degree to -70 degree (Gemmell, 1990). The eggs of *E-granulosus* survived for more than 200 days at 7 degree , 50 days at 21 degree , but less than a week at 40 degree (Gemmel,1976). Agent responsible for egg dispersion into the environment have not yet been fully identified but suggested agent include : wind, rainfall, arthropods and earthworms , as well as animal feet (Gemmell, 1997).

1-12 Dynamic of transmission:

The perpetuation of echinococcosis depends upon the common presence of the parasite and the definitive and intermediate hosts. The continued existence of host and parasite populations depends upon the fine balance of various interacting regulatory forces (Anderson and May,1978). Studies on dynamics of host, parasite systems had indicated that such characteristics as over

dispersion of parasite numbers within the host population and the development of host immunity act as important stabilizing factors (Anderson and May , 1978). Factors contributing to the dynamics of transmmision include: extrinsic and socio-ecological factors (Roberts *et al* ., 1986).

1-13 Diagnosis:

1-13-1 Parasitological methods

In cattle, diagnosis of cystic echinococcosis is mainly through post-mortem finding during meat inspection . The presence of hydatid cysts in internal organs is a very important tool of diagnosis in that 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).

1-13-2 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 Macepherson (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 .In doubtful cases , drop of 0.1% aqueous eosin solution was added to equal volume of 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 (Pedro and Bories,2001) .

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(Macepherson1985).

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 scariasis , indirect hemagglutination of 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 positive(Miheret *et al*.,2011). Only ELISA gave false positive . 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 positive , more recent reports compared ELISA with antigen electrotransfer and attributed an 82% specificity to ELISA and a 94% to 97% specificity to transfer test . More recently, the polymerase chain reaction

(PCR) has also been used to detect nucleic acids from the parasite in patients blood streams (Pedro and Bories, 2001).

1-14 Treatment:

Hydatid cyst is difficult to treat and, even more so, because there are number of reasons. The disease is complex and dynamic with an envolving phase and quietly growing cysts.

Clinical management of hepatic cysts includes Albendazole or mebendazole therapy in combination with either surgical resection or the PAIR procedure.

Larger cysts (diameter >10 cm) preferably undergo surgical resection (Bek/cci *et al*., 2012). During 1984 – 1986, the World Health Organization took an early initiative and established two multicenter studies in Europe to directly compare Albendazole and Mebendazole, using a single standard protocol.

Mebendazole and Albendazole are the two most commonly used drugs to treat infection with hydatid cysts. Multiple studies have shown Albendazole to be superior to Mebendazole in efficacy. A small prospective study has shown that combining Albendazole with percutaneous draining results is better outcomes (Bek/cci *et al*., 2012).

In animal experiments, it has been shown Albendazole efficacy of Mebendazole against *Echinococcus* metacestode was positively correlated with drug concentratin in the serum and duration of treatment, Albendazole was given orally to sheep with naturally occurring live pulmonary and hepatic cysts .

The viability of pulmonary cysts was established before treatment by thoracotomy and needle puncture .

Both 10 and 20 mg/kg btw/day doses were found effective in that no viable protoscoloces were found after six weeks, treatment in either group while untreated control still had viable cysts . In addition , treated animals showed macroscopic changes. However, bone marrow toxicity had probably occurred in two sheep (Morris et al., 1985).

1-15 Control of *Echinococcus granulosus*:

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

Options for control include horizontal and vertical approaches . The former emphasizes long – term primary healthcare (education, sanitation and upgrading of meat inspection) with the aim to reduce disease transmission .

The vertical approach is targeted to the reduction of the parasite biomass by reducing the tapeworm population (dog-dosing) or reducing the dog population . The vertical approach can be divided into phases : planning , attack, consolidation and maintenance of eradication (Gemmell *et al* ., 2001).

1-15-1 The control in dogs:

The reduction of the total parasite biomass through 6 weekly mass dog dosing with Praziquantel , eradication of unwanted and stray dogs , immunization of dogs against *E- granulosus* , and the regular programme to spay bitches will reduce the infection pressure to humans and livestock . Macpherson and Wachira, (1997) had shown a significant suppression of egg production in dogs immunized , the infection with secretory antigens derived from adult *E. granulosus* grown in vitro.

1-15-2 Safe meat hygiene practices:

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

1-15-3 Health education:

Health education is a basic component of any programme for control of *Echinococcus granulosus* and cystic echinococcosis . It requires the motivation and participation of various population groups and has to take into consideration the beliefs, perceptions, behaviours, expectations, traditional habits, cultural and religious traditions, customs and need of the people.

The educational material should address local problems in order to be effective and have the needed impact on governmental officials, political decision-makers, managers, farmers health professionals, butchers, abattoir workers, dog owners, school-age and other educationally deprived children , field and laboratory workers and every one involved directly or indirectly in a control programme of echinococcosis . The full socio-economic impact which may be considerable in endemic areas has to be brought out clearly in order to alert the community on the need for control . The educational materials include audio-visual aids (video films, television programmes), Mass media , posters , pamphlets, picture, brochures, colouring books and preserved adult *E.granulosus* and hydatid cysts (Macpherson and Wachira, 1997, Gemmell *et al* 2001).

1-16 Vaccination:

A vaccine , based on a single polypeptide antigen derived from oncospheres and produsedin *Echerichia coli* using recombinat DNA technology has been successfully developed for using against *T. ovis* in sheep . This technology has now been successfully applied to *E. granulosus* (Lightowlers *et al* ., 2004). Trials using the recombinant oncosphere antigen vaccine EG95 gave 96-98% protection against experimental challenge of sheep with *E. granulosus* . Protection may last up to 12 months and can be transferred to lambs via colostrum . Trials with natural challenge of vaccinated lambs resulted in similar level of

protection. EG95 vaccine for *E. granulosus* can now be mass produced and has to potential to significantly reduce the time for the take phase of hydatid control programmes (WHO/OIE, 2001). While considerable research has been undertaken with crude antigens to protect dogs from echinococcosis , no success has been demonstrated so far . Basic research on canine mucosal immunology and *Echinococcus* infection is required for progress(Carlos *et al*., 2006).

Chapter two

Materials and methods

2- Materials and methods

2-1-1 Study area:

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 longitude 21-24 East with length of 250 k and a total area of 20,736 km² 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 worm to cold dry winter . Rain fall ranges between 100-200 mm at the North Eastern part to 200-300 mm at the Southern parts with 10-100 mm at the North western parts.

Temperature in summer ranges between 25-40C° during the months of April to June and between 20-35C° during July – October period. Temperature degree continue to fall during the winter period between November – March to the level of 15-25C° .

Khartoum state divided into three cluster (cities) , built at the convergence of the Blue and White Niles : Omdurman to the north west across the White Nile , North Khartoum and Khartoum (0mer 1999).

This study was done in west Omdurman (Ombada) in slaughter of Al-Baraka.

2-1-2 Al-Baraka Abattior :

This abattior is located in the west of Omdurman , Khartoum State . It consists of administrative building , Veterinary Services Department, The health of the environment . Sheep and Goats are slaughtered on the top floor . The capacity of slaughter house is 1500 head of sheep per day . Electric bus is used to move the carcass . It provides services for carcass 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). Across-sectional study was conducted at Albaraka abattior on three randomly days . This 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 make ante-mortem examination for animals to be slaughtered animals. A total of 332 sheep were examined in Albaraka abattior during the survey period which extended from February to March 2019 during the antemortem inspection, the age, sex, breed, origin and

body condition of each animals were recorded. The age of animals was determined by incisors of animal teeth . Body condition of each individual animal was assessed and recorded depending on their body condition score were ranked as poor or good. Animals origin or their location was also recorded .

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 , spleen , kidneys and heart . In parallel , the following data were recorded : serial number , date , infection, infected organ, number of cyst , and size of cyst . Infected organs were collected in polyethene pags and taken to parasitoloy laboratory to conduct cyst count , cyst size , fertility and viability of protoscoleces .

2-5 Laboratory examination:

2-5-1 Examination of cyst:

Infected organs were transported to the laboratory for further analysis to determine the state of cysts. The fertility of cyst were examined microscopically . Each cyst was cut-opened with scissor and the content of the cyst was poured into a clean petri dish . Adrop from the fluid of the cyst was put in a clean slide and then examined under the microscope (40x) for the presence of protoscolices . The viability of protoscolices was determined by flame cell motility . The cyst which contained no protoscolosis as well as suppurative , calcified , or degenerated

were concidered as unfertile cyst . Wherever the cyst were persent, they were removed and incised . The shrunk, evacuated , pus formatted cysts were classified as degenerated cysts, while the solid and sand 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 the syringe and the volume of cyst was estimated by measuring this fluid by using syringe .

2-6 Sample size:

The expected prevalence of sheep hydatidosis for calculation of sample size was taken from the study in Sudan(Sheep Hydatidosis 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

$$N = \frac{4 \times P \times Q}{L^2}$$

Where :

n = Required Sample Size

P = Expected prevalence = 10.7

Q = 1- P = 1-10.7

L= Allowable error = (0.05)

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

0.0025

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

2-7 Statistical analysis:

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

Cross – tabulation of hydatidosis cyst per according to potential risk factors was made .

Univariate anyalysis for risk factors associated with sheep Hydatidosis 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 less than or equal 0.25 in the univariate model . The significant level in the multivariate analysis was less than or equal 0.05 .

Chapter Three

Results

3-Results:

From 332 sheep inspected, only 15(4.5%)animals were positive, and the rest were negative for hydatidosis (Table

3.1).

Table 3.1: Distribution of hydatidosis infection among 332 sheep examined at Al-Baraka Modern slaughterhouse:

	Frequency	Percent	Valid Percent %	Cumulative Percent %
Valid 0	317	95.5	95.5	95.5
1	15	4.5	4.5	100.0
Total	332	100.0	Abstract 100.0	

Risk factors associated with hydatidosis

3-1: Age of animals:

Three hundred and thirty two sheep of various ages were examined in this study. The presence of hydatid cyst in various organs was investigated. Table 1 showed 195sheep were old and 137were young . Infection was high in animals which were old(5.64%) but in young animals the infection rate was(2.91%)

The chi-square test showed no significant association between infection and age of animal (p-value 0.240) (Table 3:4)

3-2: Sex of animals:

The sex of animals and the presence of hydatid cyst had been investigated 143 of sheep were female and 189 were males . Infection rate was high in male animals (5.3%), but in female animals the infection rate was (3.5%)

The chi-square test showed no significant association between hydatid cyst and sex of animals (p-value 0.436) (Table 3-4).

3-3 Area (State)or origin:

From 332 sheep inspected, 10(4.5%) animals were positive for sheep hydatidosis . The highest rate of infection was in Omdurman(5.4%), North Kordofan had infected rate higher (5%) than the less rate of infection was in Algadarif (2.46%).

The result of study showed that there is no significant association between hydatid cyst infection and origin of animal (p-value 0.590).

3-4: Body condition:

The body condition of animals and the presence of hydatid cyst had been investigated. Thirty one of sheep were found in poor condition and rate of infection was (9.67%) followed by 301 of sheep were found to be in good condition and rate of infection was 3.98%.

Chi square test showed no significant association between the infection and body condition(p-value 0.146) (Table 1.4).

3-5: 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 (6.12%), but the infection was low where dog were absent(3.24%).

The chi square test showed no significant association between infection and presence of dogs (p-value 0.210) (Table 3-4).

3-6: Breed of animals:

The total number of Hamary was181 animals, among these 181 animals 8 were found infected and the rate of infection was(4.4%). Total number number of Balady breed examined were 64 , among these there was 4 infections with rate 6.25%. Total number of Kabashy breed examined were 87 , among these 3 cases was infection (3.44%).

The chi square test showed there is no significant association between the hydatid cyst and infection and breeds (p-value 0.712).

3-7: Grazing:

The grazing and presence of hydatid cyst infection had been investigated. The total number of infection was higher in open grazing (7.4%) more than infection were the grazing closed (1.73%).

The chi square test showed there is significant association between the hydatid cyst infection and grazing (p value 0.006) (Table 3-4).

3-8: Location of cyst:

The location of cyst in different organs was investigated. The results showed the liver was the most infected organ with hydatidosis and found in 9 cases.While 4 cases of the cystes were found in the lung. Also 2 cases showed the cysts on the muscles. (Table 3-4).

Chi square test showed significant association between the infection and location of cyst (p-value 0.000) (Table 3-4).

Figure(3) Hydatid cyst in lung , liver and muscle.

3-9: Size of cysts (volume):

Distribution of small cyst less than 5 ml , was found in 4 cases , and 5 to 10 ml was found in 11 cases (Table 3-2).

Chi square test showed significant association between the infection and the size of cysts.

3-10: Fertility of cysts:

Macroscopic examination of the cysts revealed a total of 15 cysts, 3 cysts in three cases were fertile viable and 12 cysts were sterile(Table 3- 2).

Chi sqaure test showed significant association between the infection and fertility of cyst(p-value= 0.000) (Table 3-4).

Table 3:2:Summary of frequency tables for potential risk factors of hydatidosis in 332 sheep examined at Al-Baraka Modern slaughterhouse:

Risk Factors	**Frequency**	**Relative Frequency %**	**Cumulative Frequency %**
Age			
Old	195	58.5	58.5
Young	137	41.3	100
Sex			
Female	143	43.1	43.1
Male	189	56.9	100
Source			
North Kordofan	177	53.3	53.3
Omdurman	74	22.3	75.6
Algadarif	81	24.4	100

Table 3-2 : continued

Risk Factors	Frequency	Relative Frequency %	Cumulative Frequency %
Breed			
Hamary	181	54.5	54.5
Balady	64	19.3	73.8
Kabashy	87	26.2	100
Grazing			
Close	196	59.0	59.0
Open	136	41.0	100
Body condition			
Poor	31	9.3	9.3
Good	301	90.7	100
Present of dog			
Yes	147	44.3	44.3
No	185	55.7	100

Location			
Liver	9	2.7	2.7
Lung	4	1.2	3.9
Muscle	2	0.6	4.5
No cyst	317	95.5	100
Volume			
< 5ml	4	1.2	1.2
5-10ml	11	3.3	4.5
No cyst	317	95.5	100
Fertility			
Fertile	3	0.9	0.9
Sterile	12	3.6	4.5
No cyst	317	95.5	100

Table 3:3: Summary of cross tabulation for potential risk factors of hydatidosis in 332 sheep examined at Al-Baraka Modern slaughterhouse :-

Risk Factors	No. inspected	No. affected(%)
Age		
Old	195	11(5.64)
Young	137	4(2.91)
Sex		
Female	143	5(3.5)
Male	189	10(5.3)
Body condition		
Poor	31	3(9.67)
Good	301	12(3.98)
Source		
North Kordofan	177	9(5)
Omdurman	74	4(5.4)
Algadarif	81	2(2.46)

Table 3:3: Continued

Risk Factors	No. inspected	No. affected(%)
Present of dog		
Yes	147	9(6.12)
No	185	6(3.24)
Breed		
Hamary	181	8(4.41)
Balady	64	4(6.25)
Kabashy	87	3(3.44)
Grazing		
Open	196	14(7.14)
Close	136	1(0.73)

Table 3: Summary of univariate analysis for potential risk factors of hydatidosi in 332 sheep examined at A-Baraka Modern slaughterhouseusing the chi-square test:

Risk Factors	**No. inspected**	**No. affected (%)**	**Df**	**x2**	**P- value**
Age			1	1.381	0.240
Old	159	11(5.64)			
Young	137	4(2.9)			
Sex			1	0.608	0.436
Female	143	5(3.5)			
Male	189	10(5.3)			
Origin			2	1.055	0.590
North Kordofan	177	9(5)			
Omdurman	74	4(5.4)			
Algadarif	81	2(2.46)			

Body Condition			1	2.110	0.146
Poor	31	3(9.67)			
Good	301	12(3.98)			
Presence of dog			1	1.574	0.210
Yes	147	9(6.12)			
No	185	6(3.24)			
Breed			2	0.680	0.712
Hammary	181	8(4.4)			
Balady	64	4(6.25)			
Kabashy	87	3(3.44)			
Grazing			1	7.641	0.006
Open	196	14(7.14)			
Close	136	1(0.73)			

Significant association was observed in univariate analysis between hydatidosis and the grazing of animals (p-value 0.006).

Table 4: Summary of multivariate analysis for potential risk factors of hydatidosis in 332 sheep examined at Al-Baraka Modern slaughterhouse using the Exp(p):

Risk factors	No .inspected	No .affected	DF	Exp(P)	P- value	95% CI for EXP (P)	
						Lower	Upper
Age Old Young	 195 137	 11(5.64) 4(2.9)	1	0.000	0.999	0.000	_
Sex Female Male	 143 189	 5(3.5) 10(5.3)	1	0.000	0.998	0.000	_
Origin North Kordofan Omdurman Algadarif	 177 74 81	 9(5) 4(5.4) 2(2.46)	1	2.565	0.524	0.141	46.564

Body Condition **Poor** **Good**	**31** **301**	**3(9.67)** **12(3.98)**	**1**	**4.958**	**0.046**	**0.030**	**23.866**
Presence of dog **Yes** **No**	**147** **185**	**9(6.12)** **6(3.24)**	**1**	**2.713**	**0.998**	**0.000**	**_**
Breed **Hammary** **Balady** **Kabashy**	**181** **64** **87**	**8(4.4)** **4(6.25)** **3(3.44)**	**2**	**0.507**	**0.643**	**0.029**	**8.913**
Grazing **Open** **Close**	**196** **136**	**14(7.14)** **1(0.73)**	**1**	**1.052**	**0.998**	**0.000**	**_**

Multivariate analysis showed no significant association between hydatidosis and any of the investigate risk factors.

For the location of hydatid cyst in carcass organs, the liver was found to be the the most affected organ(2.7%).

Chapter Four

Disscussion

4- Discussion

In the present study the prevalence of hydatidosis in sheep Slaughtered in Al-Baraka Modern slaughterhouse, West Omdurman, Khartoum state, Sudan was 4.5%. This result is in agreement with the results of another study (Formsa and Jobre, 2011) carried out in Ethiopia in which the rate of infection was 4.9%.

In comparison to other regions, it was clear that prevalence of hydated cyst recorded in this study had higher rate, for example, the prevalence of hydatidosis recorded in the current study was higher than the prevalence reported from: Egypt: 0.66% (Abo-Elwafe *et al*.,2009), Khartoum: 1.4% (Mohamadain and Abdelgadir,2011), Khartoum: 3.1% (Faisal *et al*., 2015), Sinnar: 0.6%(Ibrahim *et al*., 2010), West Omdurman: 2.8% (Khoulod *et al*.,2015).

On the other hand the prevalence of hydatid cyst recorded during this study is lower than the results in other studies which was 9.2% in Kenya (Abby *et al*.,1996), 9.1% in Palestine (Jehad et al.,2009), 8.4% in Libya (Al-Kalidi, 1998) , 11.1% in Iraq (Saida and Nouraddin, 2011) and 12.61% in Saudi Arabia (Ibrahim,2010).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 tempreatures(OIE,2005). In addition, the different in hydatidosis prevalence rate between countries could be associated with difference 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 condition, 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).

The difference in the prevalence of hydatid cyst infection could be also attributed to the variability of the of the following: origin of animal, mode of grazing, presence of the definitive host(Carnivore) degree of contaminated with the 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 North Kordofan was 5%, in Omdurman was (5.4%) and in Algadarif was 2.46%. There is no significant association between hydatid cyst infection and origin of animal (p-value =0.590).

The rate of hydatid cyst infection in different age groups of sheep, showed that there is no significant association(p-value = 0.240) was observed. Old animals were more affected(5.46%) compared with young animals(2.9%). The difference in infection rate could be attributed mainly to the fact that aged animals have longer exposure time to *E. granulosus* ,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 chance of detecting cyst at meat inspection are higher in aged animals due to the large size of cysts. Also the older animal cyst have more time to enlarge. Beside that an *Echinococcus* eggs, 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 are in agreement with the result of investigations carried out in Northern Iran (Daryani *et al*.,2009), and in Sinnar area, Blue Nile State,Sudan (Ibrahim *et al*.,2011).

The results of the current study showed that the prevalence of hydatid cyst infection within 2 cateogeries of body condition of animals was: 9.67% in poor body condition and 3.98% in good body condition. However , there was no significant association between hydatid cyst infection and body condition of animals (p-value = 0.146) this could be attributed to the fact that hydatid

cyst infection is mild disease which may not affect the general health of the affected animal.

our study showed that male sheep have higher rate of infection than females sheep, the rate of infection in males animals was 5.3%, while in female animals was 3.5%. However, there was no signifecant association between hydatid cyst infection and sex of animals(p-value =0.436) this result in contrast to results in Iran which is 76.1% in female and 24.8% in male sheep (Daryani et al., 2009). There is no significant association was observed between sex and hydatid cyst infection in this study. This could be attributed to the fact that both male and female animals graze together on the same pasture.

The prevalence of hydatid cyst infection as related to breed of animals was 4.4% in Hamary, and 6.25% in Balady, and 3.44% in Kabashy , but there was no significant association between breed and hydatid cyst infection (p-value = 0.712).

The occurrence of hydatid cyst infection in relation to the location of cyst in animals was higher in liver. There was significant association between hydatid cyst infection and location of cyst (p-value =0.00). The liver in the study was the most infected organs. These finding are consistent with the observation reported in Sudan (Mohamadin and Abdelgadir,2011;Ibrahim,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 the organs(Soulsby,1982).

Fertility of cyst is an important factor that can affect stability of *E.granulosus* cycle depending on geografical 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 cyst in this study were sterile (12 cases), and three cyst was fertile (three case).

Conclusions

This study indicates that the overall prevalence was 4.5%.The prevalence of hydatid cysts infection was 3.5% in femals and 5.3% in males. The prevalence of hydatid cyst infection according to the geographical area of sheep was higher in Omdurman (5.4%), followed by North Kordofan(5%) and then Algadarif (2.46%).The prevalence of hydatid cyst infection according to breed was higher in Balady 6.25%, followed by 4.4% in Hamary, and 3.44% in Kabashy. Microscopic examination of hydatid cyst showed that 12 cysts were sterile (3.6%) and three cysts were fertile(0.9%).

Recommendations

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

1- Prevalence of the disease in other states in the different species of farm animals.

2- Enhancement of awareness of people about the economic and puplic health importance of the disease.

3- Further investigation of risk factors associated with ovine hydatidosis.

4- Alert policy makers to design governmental control programes against hydatid cyst infection to minimize the prevalence in Sudan and ensure effective protection not only in animal population but also for humans at risk of contracting the infection.

5- Prevention of the disease in the intermediate host by finding a suitable drug to destroy or render the hydatid cyst sterile, proper methods for destroying stray dogs and wild carnivores and conduct extensive research programs on the best drug to be used for deworming pet dogs.

6- Vaccination of dog with clear identity card and collar for these dogs.

Puplic health education through media and teaching livestock holders and people who are at risk about periodic epidemiologic investigations.

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Appendices

Appendix 1

Details of cross tabulation for potential risk factors of hydatidosis in 332 sheep examined at Al-Baraka Modern slaughterhouse:

Table1: Age

Results	**Old**	**Young**	**Total**
+ve **% of total**	11 5.64%	4 2.9%	15 4.5%
-ve **%of total**	184 94.35%	133 97%	317 95.48%
Total **% of total**	195 100%	137 100%	332 100%

Table 2: Sex:

Results	**Female**	**Male**	**Total**
+ ve **% of total**	5 3.5%	10 5.3%	15 4.5%
-ve **% of total**	138 96.5%	179 94.7%	317 95.48%
Total **% of tatal**	143 100%	189 100%	332 100%

Table 3: Origin(State) :

Results	**North Kordofan**	**Omdurman**	**Algadarif**	**Total**
Yes %	9 5%	4 5.4%	2 2.46%	15 4.5%
No %	168 94.9%	70 94.6%	79 97.5%	317 95.48%
Total % of total	177 100%	74 100%	81 100%	332 100%

Table 4: Body condition:

Results	Poor	Good	Total
+ ve % of total	3 9.67%	12 3.98%	15 4.5%
- ve % of total	28 90.3%	289 96%	317 95.48%
Total % of total	31 100%	301 100%	332 100%

Table5: Present of dog

Result	**Yes**	**No**	**Total**
+ ve **%**	9 6.12%	6 3.24%	15 4.5%
-ve **%**	138 93.87%	179 96.75%	317 95.48%
Total **% of total**	147 100%	185 100%	332 100%

Table6: Breed:

Results	**Balady**	**Hamary**	**Kabashy**	Total
+ ve **%**	4 6.25%	8 4.4%	3 3.44%	**15** **4.5%**
-ve **%**	60 93.75%	173 95.58%	84 96.55%	**317** **95.48%**
Total **% of total**	64 100%	181 100%	87 100%	**332** **100%**

Table 7: Grazing:

Results	Open	Close	Total
+ ve **%**	14 7.14%	1 0.73%	15 4.5%
-ve **%**	182 92.85%	135 99.26%	317 95.48%
Total **% of total**	196 100%	136 100%	332 100%

Appendix 2

Table 1: Summary of univariate analysis for potential risk factors of hydatidosis in 332 sheep examined at Al-Baraka Modern slaughterhouse using the Odds Ratio(OR):

Risk Factor	. No Inspected	No.affected (%)	Df	OddsRatio (OR)	P. value	95% CI for EXP (P)	
						Lower	Upper
Age			1	1.98	0.240	0.619	6.378
Old	**195**	**11(5.64)**					
Young	**137**	**4(2.9)**					
Body condition			1	2.58	0.146	0.687	9.691
Poor	**31**	**3(9.67)**					
Good	**301**	**12(3.98)**					
Presence of dog			1	1.94	0.210	0.676	5.597
Yes	**147**	**9(6.12)**					
No	**185**	**6(3.24)**					
Grazing			1	10.38	0.006	1.349	79.99
Open	**196**	**14(7.14)**					89
Close	**136**	**1(0.73)**					