بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Prevalence of Ovine Hydatidosis among Body Condition, Location of Cyst, and Volume of Cyst in Sheep Slaughtered in Alkadarow Slaughterhouse -Khartoum State- Sudan

معدل انتشار مرض الأكياس العدارية من خلال حالة الجسم و موقع و حجم الكيس في الضأن المذبوح في مسلخ الكدرو- ولاية الخرطوم- السودان

A thesis Submitted to the College of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Preventive Veterinary Medicine (MPVM)

By

Mawahib Mahil Eltahir Ali

B.V.M. College of Veterinary Medicine, University of Nyala

(2003)

Supervisor:

D: Mubarak Mustafa Abdelrahman

Tropical Medicine Research Institute

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بسم الله الرحمن الرحيم

الايـــــة

قَالَ تَعَالَىٰ:

﴿ وَعَلَّمَ ءَادَمَ ٱلْأَسْمَآءَ كُلَّهَا ثُمَّ عَرَضَهُمْ عَلَى ٱلْمَلَٰٓئِكَةِ فَقَالَ أَنۢبِـُٔونِى بِأَسْمَآءِ هَٰٓؤُلَآءِ إِن كُنتُمْ صَٰدِقِينَ ﴿٣١﴾ قَالُوا۟ سُبْحَٰنَكَ لَا عِلْمَ لَنَآ إِلَّا مَا عَلَّمْتَنَآ ۖ إِنَّكَ أَنتَ ٱلْعَلِيمُ ٱلْحَكِيمُ ﴿٣٢﴾ ﴾

(صدق الله العظيم)

سورة البقرة: الايه(٣١ – ٣٢)

Dedication

To my father and mother

To my brothers and sisters

To my sons, daughters and husband

To all who inspired me to face the ups and downs of life.

Acknowledgment

Firstly, praise to almighty Allah for giving me knowledge, strength, and support to complete this study. With a great touch of pleasure and gratitude, I would like to express thanks to my supervisor Dr. Mubarak Mustafa Abdel Rahman, for his guidance, help and support in revising the text and giving valuable advices through different stages of this study.

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Abstract

This study was conducted at Alkadarow slaughterhouse, Khartoum State, Sudan, during the period from March to April 2021 to estimate the prevalence of hydatid cyst in slaughtered sheep.

Routine meat inspection procedure was employed to detect the prevalence of hydatid cysts in visceral organs (liver, lung, heart and spleen). For 260 sheep examined on slaughtered house originated from four areas: ALkhowei Wad-alnial, Algadarif and Aldamazin. The age of this animals between eight month to one and half years. And the breed of these examined sheep were (Hammary, Kabashy, and Cross breed).

The study revealed on overall prevalence of 9.6% of hydatid cyst infection among studied population.

Location of cysts in body the liver was the most infected organ 11 cysts, while 7 cysts were found in the lung, and 7o cyst was found in the mesentery. No cyst was found in heart or spleen.

As for volume of the cyst the prevalence was (52%) in large cyst (<5ml) and (48%) in small cyst (>5ml).

The results of the univariate analysis by using the Chi-square for the body condition (p-value = 0.987), location of cyst (p-value = 0.000) and volume of cyst (p-value =0.000).

The location of cyst and volume of cyst were found to be significantly associated with hydatid cyst infection.

ملخص البحث

اجري البحث علي 260 راس من الضان المذبوح افي مسلخ الكدروشمال بحري في ولاية الخرطوم –السودان. خلال الفترة من مارس الي ابريل 2021 وكان الهدف هو تقدير معدل انتشار مرض الاكياس العدارية في الضان. تم اجراء التفتيش الروتيني لللحوم للكشف عن وجود الاكياس العدارية في الاحشاء الداخلية. كان مصدر الضان المختار من اربعة مناطق هي (الخوي ود النيل القضارف والدمازين) وتنحدر تحت ثلاثة سلالات هى: (الحمرى والكباشى وسلالة مختلطة) وكانت اعمار الحيوانات بين ثمانية شهور وسنة ونصف السنة.

كان معدل انتشار المرض في كل الحيوانات(9.6%) .

واظهرت الدراسة ان الكبد هو العضو الاكثر اصابة بوجود(11) كيس بنسبة(44%) بينما الرئة بوجود(7 اكياس) بنسبة(28%) وايضا وجود(7 اكياس) في المساريقا بنسبة (28%) ولايوجد كيس في القلب والطحال.

اما بالنسبة لحجم الكيس كان معدل الانتشار13 كيس بنسبة(52%) في الاكياس الكبيرة(اكبر من 5 مل) و(48%) في الكياس الصغيرة (اقل من 5 مل).

وعندما تم تحليل عوامل الخطر بواسطة التحليل الاحادي وباستخدام مربع كاي لتحليل قيمة الخطر وجد ان موقع الكيس وحجمه كان له علاقة معنوية بانتشار المرض.

وباستخدام مربع كاي لتحليل قيمة الخطر وجد ان موقع الكيس وحجمه كان له علاقة معنوية بانتشار المرض.

INTRODUCTION

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 .Sheep 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 (Ethar *et al*.2015) .

Hydatidosis occurs in all breeds, sex, and ages of sheep but animals of 3 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 (Ethar *et al*.2015).

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 Taeniida and is also referred to as echinococcosis (Ethar *et al*.2015).

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).

In Khartoum state, Hydatidosis may be one of the major infectious zoonotic diseases because most abattoirs in Khartoum state 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 everywhere, 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 Hydatidosis Since the animals share the same life cycle as man, therefore determination of the prevalence of the disease in Khartoum state is very important in order to explore the size of the problem which helps to control the disease (Ethar *et al*., 2015).

Objectives:

The objectives of this study were:

1/ Estimate the prevalence of Hydatidosis in slaughtered sheep in Alkadarow slaughter house Khartoum State and studies risk factors associated with Hydatidosis infection in sheep in Alkadarow slaughter house.

2/ Determine the location of cysts in the sheep carcasses.

3/ Measure the volume of cysts.

CHAPTER I

LITERATURE REVIEW

1.1 Classification:

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

Kingdom: Animalia

Phylum: Platy helminthes

Class: Eucestoda

Order: Taenidea

Family: Taenidae

Genus: *Echinococcus*

Species: *E. granulosus*

Subspecies: *E. gr.granulosus*

E. gr.canadesis

1.2 Etiology*:*

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

1.2.1 Morphology of Echinococcus:

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

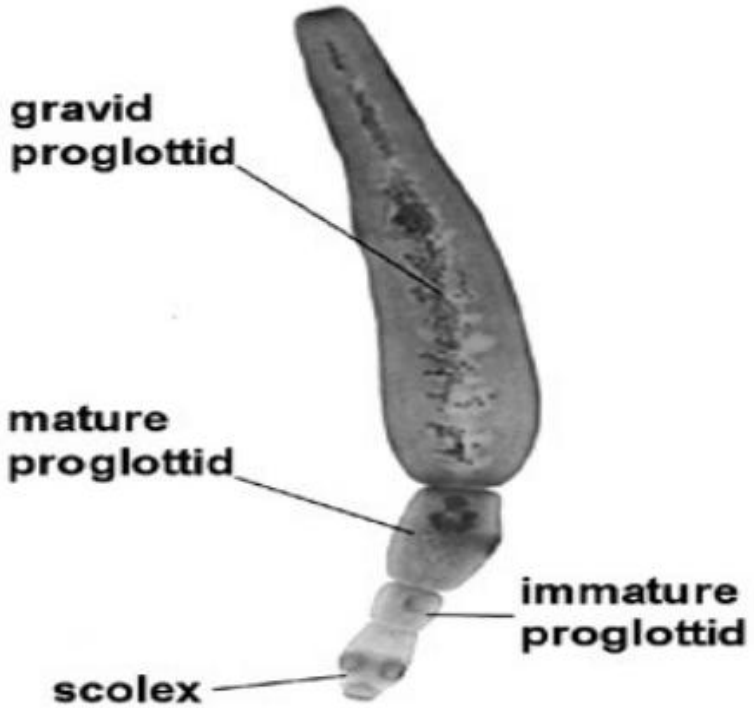

Figure (1.1) Morphology of a mature adult worm of *E. granulosus* (source MTCR).

1.2.2 Morphology of Echinococcus egg:

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

1.2.3 Morphology of cyst:

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

Larval form of *E. granulosus* typically consists of single cavity (unlocular). 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 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 host 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).

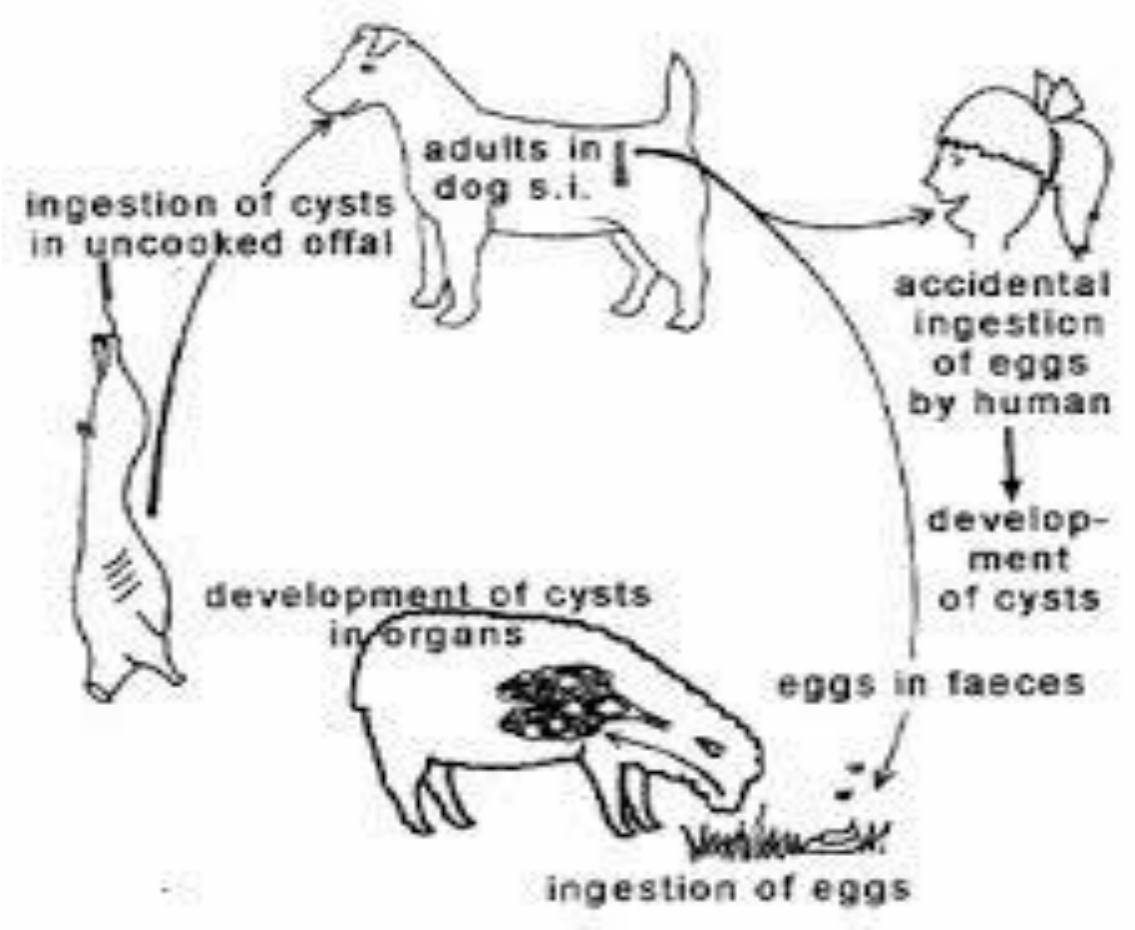

Figure (1.2): Life cycle of Echinococcus species.

www.farmstyle.com.au

1.4 Geographic distribution and prevalence of Hydatidosis 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. (Omer, 2013).

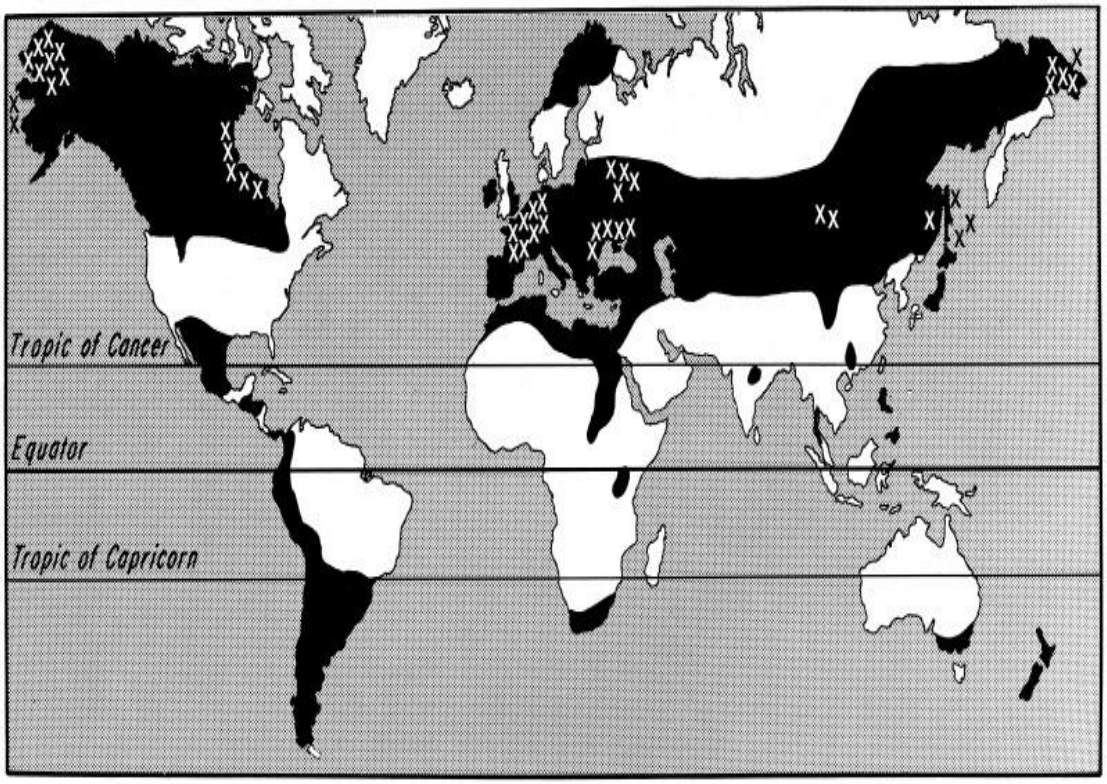

Figure (1.3) Global distribution of *E. granulosus* (black) and *E. multilocularis* (x)

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

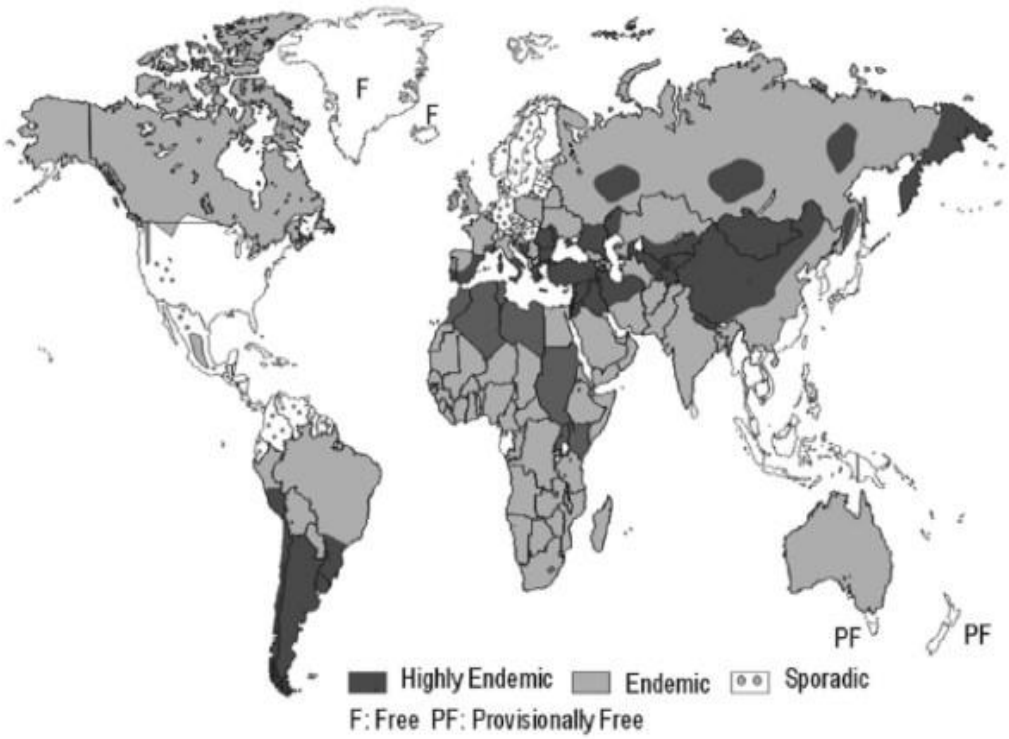

Figure :(1.4) World distribution of *Echinococcus*. (Eckert *et al*., 2011).

1.4.1 Prevalence of Hydatidosis 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). 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 years (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).

1.4.2 Prevalence of Hydatidosis in Sudan:

A study was conducted to estimate the infection rate of Hydatidosis caused by *E. granulosus* in cattle and sheep as intermediate hosts in slaughter houses of Khartoum State. An abattoir survey was carried out in 849 cattle and 3850 sheep slaughtered in the study area during January 2010 to June 2010. The highest infection rate (2.8%), was found in cattle followed by sheep (1.4%). The most affected organs in cattle were the lung and liver (37.5% for each). In sheep, the liver was the most infected organ (65.2%), followed by mesentery (21.7%). The records of abattoirs in Khartoum state indicated that Hydatidosis was one of the most frequently encountered parasites during the last six months in Khartoum State (Mohamadin and Abdelgadir, 2011).

Another study was conducted for determination of the prevalence, parasitological status and genetic identification of hydatid cysts from sheep in different parts of the Sudan. It was concluded that, sheep play a marginal role in the transmission cycle of the disease

in Sudan. This fact is different from data obtained from other regions in Africa as well as parts from southern Sudan, where sheep are heavily involved in the transmission cycle of the disease. Both, the prevalence and fertility rates of the disease in sheep in Western Sudan were higher (11.9% and 19% respectively) comparing to those reported in other investigated areas in Sudan. (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 Hydatidosis was: 3.0% in male and 1.2% in female.

Also prevalence between Hydatidosis and presence of dogs was: 2.8% in presence of dogs and 1.4% in absence of dogs. The prevalence between Hydatidosis and breed of animals was: 8.3% in fuga, 2.5% in Baggara and 0.0% in Kenana. Also distribution of Hydatidosis when carcasses not disposed was 2.9% and 0.0% when carcasses disposed. The study showed that the lung was the most infected organ 83.31 and 16.7% were in liver. No cyst in heart and peritoneum, microscopic examination of the 13 cysts revealed that, 12 cysts (92.3%) were sterile, one cyst (7.7%) were calcified cysts, no fertile cysts were found. The cyst in male were localized in lung, but in female were localized in liver (Nasr Eldin, 2011).

An abattoir survey was conducted on 248 sheep slaughtered at El-obied abattoir, North Kordofan State, Sudan, during the period extended from April to August 2013. 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 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 year 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 condition and 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 cattle suggests that these animals clearly have an important role in the continuation of the *Echinococcus granulosus* life cycle in Sudan (Shadia and Abdelrahim, 2014).

1.5 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 cosmopolitan 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 hosts, the external environment and socio- ecological factors (Nousiba *et al*., 2019)

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, offal's 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 (Nousiba *et al.*, 2019).

The sylvatic cycle occurs 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 (Nousiba *et a*l., 2019).

1.6 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 Ma, 1978). Factors contributing to the dynamics of transmission include: extrinsic and socio-ecological factors (Roberts *et al.*, 1986).

1.6.1 The eggs in the environment:

The crowding of animals during grazing on contaminated soil and the extent to which soil is contaminated by dog's 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 degrees, 50 days at 21 degrees, but less than a week at 40 degrees (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).

1.6.2 The larva in the intermediate host:

The intensity, infectivity and availability of the eggs in the environment, local circumstances of livestock husbandry, and feeding behavior 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 averse to cyst survival, but strong immunity was induced following parenteral (intramuscular) 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 (Nousiba *et al*., 2019).

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 john stone, 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).

1.6.3 Domestic intermediate hosts:

In many parts of the world, *E. granulosus*, is perpetuated predominantly 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 hyper endemic 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 (MacPherson 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.

1.6.4 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 pastoralist 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* (MacPherson 1986). It's believed that the source of infection to wild carnivores is from predation or the scavenged carcasses of infected domestic livestock (Macpherson, *et al*., 1984).

1.7 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 (Eddi *et al*., 2004)

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 Ma, 1978). Factors contributing to the dynamics of transmission include: extrinsic and socio-ecological factors (Roberts *et al.*, 1986).

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. 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).

1.8 Diagnosis:

1.8.1 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)

1.8.2 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).

1.9 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).

1.9.1 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).

1.9.2 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).

1.9.3 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). In the 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).

1.10 Control:

Any approach to the control of Hydatidosis should recognize the multiplicity of interacting extrinsic and intrinsic factors as well as the impact of socioecological factors on the dynamics of transmission (Nousiba *et al.*, 2019).

1.10.1 The Control in Dogs:

The established control measures were directed to words 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 (Nousiba *et al*., 2019).

The control of stray dogs and health care of domestic ones will help in eliminating the source of human and livestock infection (Nousiba *et al*., 2019).

Other methods used to reduce the dog and tapeworm population include spaying of bitches, mass killing and mass dog treatment program. Some countries impose restriction on the importation of carnivores from zones endemic with *E. granulosus*, while others require the treatment prior to importation (Nousiba *et al*., 2019).

1.10.2 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 condemned offal's by burning, boiling and deep burial, forms an important part of echinococcosis control. Dogs should be prevented from entering abattoirs. Illegal slaughtering must be prosecuted and special precautions must be taken when home slaughtering is carried out for social ceremonies (Gemmell *et al*., 2001).

1.10.3 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, behaviors, expectations, traditional habits, cultural and religious traditions, customs and need of the people (Nousiba *et al*., 2019).

The educational material should address local problems in order to be effective and have the needed impact on governmental officials, political decision-makers, managers, farmer’s health professionals, butchers, abattoir workers, dog owners, school age and other educationally deprived children, field and laboratory workers and everyone

involved directly or indirectly in a control programme of echinococcosis. The full socioeconomic 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 audiovisual 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).

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).

1.11 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 26 protections. 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 II

MATERIALS AND METHODS

2.1 Study area:

The study was carried out in Khartoum State Alkadarow slaughterhouse 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 and a total area of 20,736 km^2.

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).

Alkadarow slaughterhouse was selected for current study because slaughtered animals originated from different states Alkhowei and Wad nail (North Kordofan State) Algadarif (Algadarif State) Aldamasin (Blue Nile State).and high number of animals are used to be slaughtered on daily regular basis.

2.2 Study design:

Descriptive study to determine the percentage of infested sheep with Hydatidosis was conducted on three regular visit to the slaughterhouse. The animals selected by systematic random sampling method. From each three animals one animal was selected for examination. The study was performed in the period between 1 March 2021 to 30 March 2021 to determine the prevalence and risk factors associated with the disease at a particular period of time.

2.2.1 Ante –mortem examination:

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

2.2.2 Post -mortem examination:

During the post mortem examination, visual inspection, palpation and systemic incision of each visceral organs was performed particularly the liver, lungs, mesentery and other organs. Infested organs were collected in polyethene pages and taken to laboratory to conduct cyst size.

2.2.3. Size 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.

2.2.4 Sample Size:

According to the formula described by Martin (1987).we used the expected prevalence of sheep Hydatidosis was(8.9%) reported by Madiha (2014).with 95% confidence interval and 5% precision value.

Formula;

$n=4\times P\times Q$

$L2$

Where:

N≡ Required Sample Size

P≡ Expected prevalence = 8.9

Q ≡ 1- P = 1-8.9

L≡ Allowable error = (0.05)

n =4×8.9× (1−8.9)

0.0025 =130

Therefore the calculated sample size was 130 and to increase accuracy the sample size was increased to 260 (Thursfield, 2007).

2.3 Study population:

Age of animals in these study between eight month and one bats half years the age determine by dentation. The sex of all these animals were male and originated from different states Alkhowei and Wad nail (North Kordofan State) Algadarif (Algadarif State) Aldamasin (Aldmasin State).

The body condition category to good and moderate according to the cover of fat and tissue one the backbone and the ends of the short ribs.

2.4 Statistical analysis:

Results of the study were analyzed using excel spread sheet and statistical packets for Social Sciences (SPSS).

Univariate analysis for risk factors associated with sheep Hydatidosis in Khartoum state, Sudan were analyzed by the Chi-square test. We used chi-square test to compare observed results with expected results.

CHAPTER III

RESULTS

3.1 Prevalence of Hydatidosis among slaughtered sheep in Alkadarow slaughterhouse Total of the 260 sheep inspected, only 25(9.6%) animals were positive, and the rest were negative for Hydatidosis (table 3.1).

Table 3.1: Distribution of Hydatidosis infection among 260 sheep examined in Alkadarow slaughter house.

Disease	Frequency (%)
+ ve	25 (9.6%)
- ve	235(90.4%)

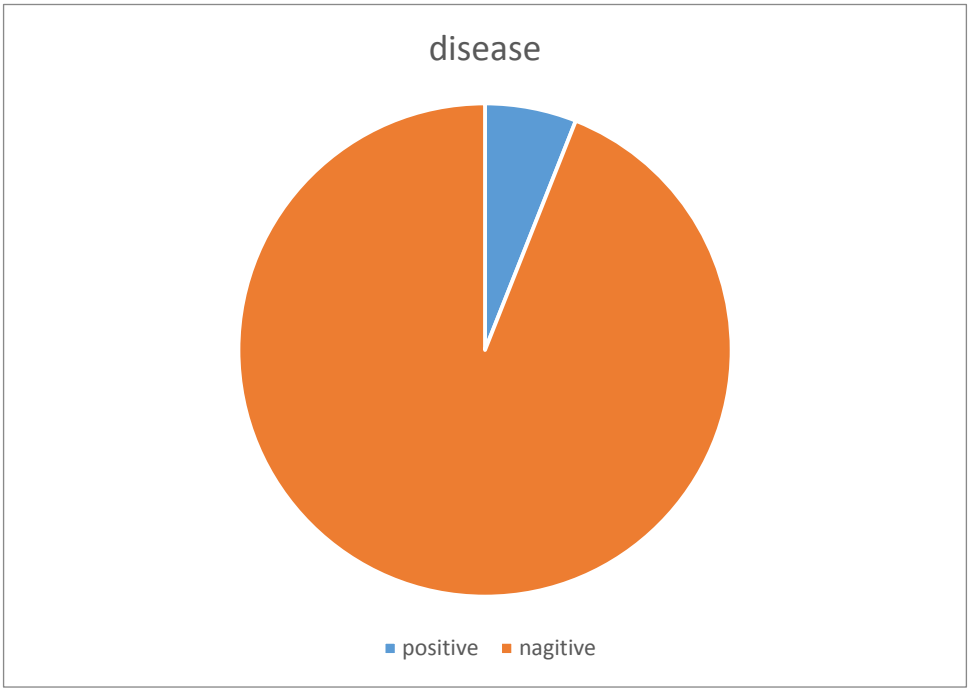

Figure 3.1: summarizes the number of infected animals with Hydatidosis among 260 sheep.

3.2: Risk factors associated with sheep Hydatidosis slaughtered in Alkadarow slaughterhouse

3.2.1 Age of animals:

260 sheep of various ages were examined in this study. The presence of Hydatidosis in various organs was investigated. Table 3.2 shows the age distribution of sheep. 187 of sheep were less than year and 73 of sheep were equal and more than year. Infection was high in animals which were equal or more than one year (19.2%) but in animals less than one year the infection rate was (5.8%).

The chi square test showed significant association between infection and age of animal (P-value 0.001) (Table 3.6).

Table 3.2: Age of animals:

Age of animals	**No infested (%)**
1-3 year	73(19.2%)
<1 year	187(5.8%)
Total	**260**

3.2.2 Area (source) or origin:

Total of the 260 sheep inspected, 25(9.6%) animals were positive for sheep Hydatidosis. Figure (3) summarizes the number of infected animals with Hydatidosis in various states .The highest rate of infection was in ALdamazin (Blue Nile State) had infection rate (11.6%) Wad-nail (North Kordofan State) (10.6%)) Alkhowei (North Kordofan State) had infection rate (10.4%) and the less rate of infection was in Algadarif (Algadarif State) (5.4%).

The Result of study showed that there is no significant association between hydatid infection and origin of animal (*P*-value 0 .723). (Table 3.6)

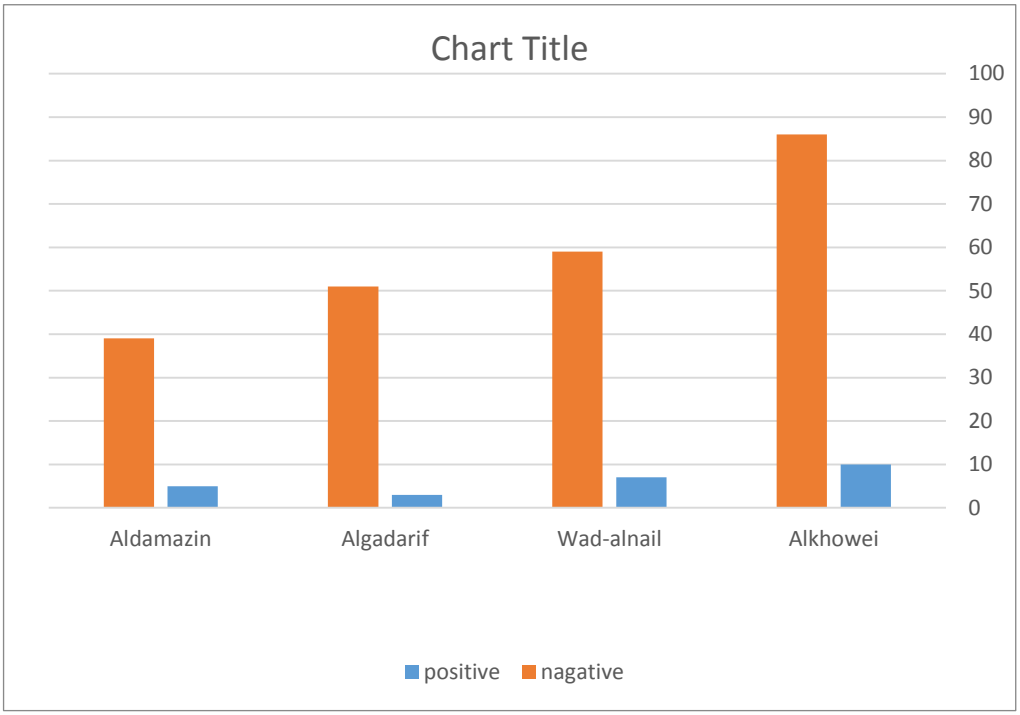

Figure (3.2): summarizes the number of infected animals with Hydatidosis in various states.

3.2.3 Body condition:

The body condition of animals and the presence of Hydatidosis had been investigated. 166 of sheep were found to be in good condition and rate of infection was (9.6%) followed by 94 of sheep were found to be in moderate condition and rate of infection also was (9.6 %).

Chi square test showed no significant association between the infection and body Condition (p – value 0.987) (Table 3.6).

Table (3.3) Body condition

Body condition	No infested (%)
Good	166(9.6%)
Moderate	94(9.6%)

3.3 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 11 cases, the cysts were found in the livers, and 7 cases was found in the lung . Also 7 cases were found on mesentery. (Table 3.4).

(Table 3.6).

Table (3.4) Location of cyst:

Location of cyst	No infested (%)
Liver	11 (44%)
Lung	7 (28%)
Mesentery	7 (28%)
Total	25

3.4 Size of cysts (volume):

Distribution of small cyst than 5ml, equal or more than 5 ml in organs was listed in (Table 3.5). Equal or more than 5 ml size cysts was found in 12 cases and small than 5 ml cysts was found in four cases (Table 3.6).

Table (3.5): Size of cyst:

Size of cyst	No infested (%)
Small (<5ml)	13 (52%)
Large (>5ml)	12 (48%)
Total	25

Table (3.6): Summary of univariate analysis for potential risk factors of Hydatidosis in 260 sheep examined at Alkadaro slaughterhouse using the Chi-square test:-

Risk factors	No. examined	No. infested (%)	DF	X^2	*P*-value
Age					
1-3 year	73	14 (19.2)	1	10.68	0.001
<1 year	187	11 (5.9)			
Origin					
ALkhowei	96	10 (10.4)	3	1.324	0.723
Wad-AL nail	66	7 (10.6)			
ALgadarif	54	3 (5.6)			
ALdamazin	44	5 (11.4)			
Body condition					
Good	166	16 (9.6)	1	0.000	0.987
Moderate	94	6 (9.6)			

CHAPTER IV

4.1 DISCUSSION

The real magnitude of the disease in domestic animals, wild animals and man in the Sudan still needs further investigation. Slaughtered animals may pass through several owners on their way to the slaughterhouse; this may create difficulty to trace infected animals.

In the present study the prevalence of Hydatid cyst infection in sheep slaughtered in Alkadarow slaughterhouse, Khartoum State, Sudan was 9.6%. This result is higher than the result of another study carried out in west Darfur State in which the rate of infection was 8.9% (Madiha, 2014).

The prevalence of hydatid cyst in this study (9.6%), 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).

On the other hand, the prevalence of hydatid cyst recorded during this study is lower than the results in other studies which was 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 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 hydatid cyst infection 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, and 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 results of the current study showed that the prevalence of hydatid cyst

Infection within 2 categories of body condition of the animals was: (166) in good

Body condition and (94) in moderate body condition. However, there was no significant association between hydatid cyst infection and body condition of animals (*P*-value = 0.987).

The occurrence 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 =0.000).

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), 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).

4.2 CONCLUSIONS AND RECOMMENDATIONS

1. The overall prevalence of hydatid cyst in this study was (9.6%).
2. The prevalence of the disease was higher in animals with good body condition (64%) comparing with the animal with moderate condition (36%).
3. The liver was found to be the most infected organ (44%) compared with infected lung and mesentery (28%) of examined sheep.
4. Control program for sheep Hydatidosis must:

A. Control the (offal's) especially livers of sheep in slaughterhouses.

B. Awareness of all worker in slaughterhouses.

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APPENDICES

Appendix (A)

Sample collection form:

Address:

Location:

Sheet list:

Date:

1/ Animal NO:

2/ Body condition:

1- Good 2- moderate

3/ Location of cyst:

1-liver 2- lung 3/mesentery

4/ size of cyst:

> 5ml < 5ml

Appendix (B)

(A) **(B)**

Figure 2: Hydatid cysts in lung (A) and liver (B) El-Ibrahim, 2009)