

PREVALENCE OF  
*Taenia solium* IN PIGS AND ITS PUBLIC HEALTH IMPORTANCE  
IN KIRTIPUR MUNICIPALITY

A THESIS  
SUBMITTED  
FOR THE PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE  
MASTER'S DEGREE OF SCIENCE  
IN  
PARASITOLOGY

BY  
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KATHMANDU, NEPAL

2009

## DECLARATION

I hereby declare that the work presented in this thesis has been done myself and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by references to the authors or institution.

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\_\_\_\_\_

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## RECOMMENDATION

It is our pleasure to mention here that **Mrs. Meelina shakya** has completed his dissertation work entitled “**PREVALENCE OF *Taenium solium* IN PIGS AND ITS PUBLIC HEALTH IMPORTANCE IN KIRTIPUR MUNICIPALITY**” under our supervision and guidance. It is his original work and brings out useful results and findings in the concerned field.

We strongly recommend this dissertation for approval for the partial fulfillment of the requirements for the Master's Degree of Science in Zoology with special paper **Parasitology**.

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## LETTER OF APPROVAL

On the recommendation of supervisor **Mr. Janak Raj Subedi** and Co-supervisor **Dr. Durga Datt Joshi**, this dissertation of **Mrs. Meelina shakya** is approved for examination and is submitted to the Tribhuvan University in partial fulfillment of the requirements for Master's Degree of Science in Zoology (**Parasitology**).

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## APPROVAL

This dissertation presented by Meelina Shakya entitled “**PREVALENCE OF *Taenia solium* IN PIGS AND ITS PUBLIC HEALTH IMPORTANCE IN KIRTIPUR MUNICIPALITY**” has been approved for the partial fulfillment of the requirements for the Master’s Degree in Zoology with Parasitology as specialization paper.

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## ACKNOWLEDGEMENT

I would like to express my enormous gratitude to my honourable supervisor **Mr. Janak Raj Subedi, Lecturer**, Central Department of Zoology, T.U. and Co-supervisor **Dr. Durga Datt Joshi**, Executive Chairman of National Zoonosis and Food Hygiene Research Centre, for their guidance, support and encouragement.

I am thankful to Prof **Dr. Vasanta Kumar Thapa**, head of the Central Department of Zoology for his valuable suggestion and cooperation.

I express my deep sense of gratitude to my honourable teacher to **Mr. Pitamber Dhakal** and **Mr. Ashok Bahadur Bum**, for his valuable ideas, suggestions and I am thankful to all the staffs of CDZ, T.U.

This thesis work has been supported by National Zoonoses and Food Hygiene Research Center (NZFHRC). I would once again like to thank **Dr. Durga Datt Joshi**, Executive Chairman of National Zoonosis and Food Hygiene Research Centre for providing laboratory facilities with equipment and providing books to prepare this thesis. I would like to acknowledge my gratitude to all the staff of NZFHRC.

I am thankful to Prof. **Dr. Bharat Muni Pokharel** and **Mr. Amul Basnet** for providing me hostipital datas.

I am thankful to my intimate friends, **Bipin Shakya, Pabitra Muni Bajracharya, Bimla Kumari Bashir, Reenu Maiya Maharjan, Anju Shrestha, Sabina Shrestha Vima Thapa** and **Krishna Prasad Dhakal** for helping me on the collection of cysts and questionnaire.

Last but not at least, I owe a debt of gratitude to my family members for their support and constant encouragement in the academic work.

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## **ACRONYMS AND ABBREVIATIONS**

CBS	:	Central Bureau of Statistics
CD	:	Central Department of Zoology
CI	:	Confidence interval
CTVM	:	Centre for Tropical Veterinary Medicine
d.f.	:	Degree of Freedom
DFID	:	Department for International Development
DLS	:	Department of Livestock Services
Ed	:	Edition
EITB	:	Electroimmuno – transfer blot
ELISA	:	Enzyme Linked Immunosorbent Assay
FAO	:	Food and Agriculture Organization of the United Nations
FSIS	:	Food safety and inspection
GDP	:	Gross Domestic Product
MRI	:	Magnetic resonance imaging
NZFHRC	:	National Zoonosis and Food Hygiene Research Centre
OR	:	Odds ratio
PI	:	Post immunoculation
Spp.	:	Species
TU	:	Tribhuvan University
VDC	:	Village Development Committee
WHO	:	World Health Organization

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## ABSTRACT

During the study period from November 2007 to August 2008, a total of 150 pigs slaughtered for meat were examined for *Taenia* cyst. The surveyed found only a single pig slaughtering place in the Kirtipur municipality. The butchers and the meat consumer were found to have no knowledge about the zoonotic diseases caused by *Taenia* sp. The slaughtered animals were observed categorizing them into male, female, adult and calves. Out of total examined hosts, 6 pigs (4.00%) were found positive for *Taenia* cysts. Among these 6 positive samples, sexwise prevalence rate of infection were 3.33% in males and 4.44% in females but the difference were not found significant statistically ( $\chi^2_{0.05, 1d.f} = 0.080$ ). The results revealed that females were infected more often than the males. Again adults (4.16%) were found infected more than the young ones (3.33%) which were not found statistically significant as well ( $\chi^2_{0.05, 1d.f} = 0.043$ ). Out of total examined samples, 6 (4.00%) pigs were found positive for *Taenia* cysts. 5 (83.33%) of them had cysts distributed throughout the whole body. 1(16.66%) animal had cysts of the *Taenia* only in the neck region. Out of 708 total cases recorded from Teaching hospital during 2060-2065, 98 patients were confirmed with *cysticercosis*. Among the 98 infected patients 33 were females, while 65 were males. The results revealed that males were infected more than females. The study also include the recommendation to overcome the diseases caused by *Taenia* cysts which include the practice of hygienic condition, preventing pigs from consuming the human excreta and proper cooking of the meat of host.

# INTRODUCTION

## BACKGROUND

Meat is an indispensable food consumed by most of the people of this universe from very beginning of human civilization till now. The word meat comes from the old English word *mete* which referred to food in general. Meat, in its broadest definition, is animal tissue used as food ([www.wikipedia.org/meat](http://www.wikipedia.org/meat)). Meat is an important source of protein and a valuable commodity in resource-poor communities.

In many developing countries, lack of appropriate slaughtering facilities and unsatisfactory slaughtering techniques are causing unnecessary losses of meat as well as invaluable by-products from animal carcasses. Slaughtering places are frequently contaminated and may not be protected against dogs, rodents and insects. Meat products coming from such conditions are often deteriorated due to bacterial infection or contaminated, which may cause food poisoning or diseases in consumers. In many developing countries, regulations concerning meat inspection and/or control are inadequate or non-existent allowing consumers to be exposed to pathogens including zoonotic parasites (Joshi *et al.*, 2003).

Nepal is an agricultural country with poor economy. Agriculture contributes 38% of the nations GDP and livestock contributing almost 11% to GDP (World Bank, 2002). Roughly 70% of households keep some type of livestock, including cows, buffaloes, pigs and chickens (FAO, 2005). Livestock population in Nepal for 2004/2005 was estimated to be 6.99 M cattle, 4.08 M buffaloes, 7.15 M goats, 0.93 M pigs, 0.86 M sheep and 23 M fowls. ([www.moacwto.gov.np.statistics/livestock/pdf](http://www.moacwto.gov.np.statistics/livestock/pdf)).

Meat consumption varies widely while comparing different countries as it depends on factors like socio-economic condition, religious beliefs, cultural practices, etc. (Joshi *et al.*, 2001). In Nepal, buffaloes contribute about 64% of the meat consumed, followed by goat meat (20%), pork (7%), poultry (6%) and mutton (2%). Goat and poultry meat is acceptable to all castes of people while buffalo meat is consumed mainly by the Newar ethnic group. Previously, pork was consumed only by people belonging to

low castes, however, in recent years; the consumption of pork has increased in higher castes as the caste system has become more relaxed (Joshi *et al.*, 2003).

## **TAENIASIS**

"Those diseases and infections which are naturally transmitted between vertebrate animals and man" have been defined as Zoonotic diseases by World Health Organization. An infection due to an adult *Taenia*, in man or animals, is referred to as taeniasis. (Smyth, 1996). Taeniasis is one of the zoonotic diseases caused by various species of tapeworms belonging to the genus *Taenia*. 3 *Taenia* spp. are known to infect human that include *T. saginata*, *T. asiatica*, and *T. solium*. The natural intermediate hosts are cattle and buffaloes for *T. saginata* and pigs for *T. asiatica*, and *T. solium*. (Naefie *et al.*, 2000).

### ***Taenia solium***

*Taenia solium*, also called the pork tapeworm, is a cyclophyllid cestode in the family Taeniidae. It infects pigs and humans in Asia, Africa, South America, parts of Southern Europe, and pockets of N. America ([www.wikipedia.org/wiki/pork\\_tapeworm](http://www.wikipedia.org/wiki/pork_tapeworm)). Humans are the only definitive hosts for *Taenia solium*, the intermediate host being pigs. Man can also become the accidental intermediate hosts for *T. solium*. (<http://www.dpd.cdc.gov/DPDX/Taeniasis>).

*Taenia solium* (pork tapeworm) causes intestinal infection with the adult tapeworm and somatic infections with the larvae (cysticerci), the conditions producing taeniasis and cysticercosis respectively. (<http://www.health.vic.gov.au/taeniasis>).

### **Morphology**

**Adult worm:** Adult *Taenia solium* are 2 to 7 m long. The scolex is globular, quadrangular, and about 1 mm in diameter. Crowned by a rostellum armed with a double row of large and small hooklets, the scolex resembles a traditional portrayal of the sun, hence the species name *solium*. There are 22 to 36 hooklets measuring 100 to 150  $\mu\text{m}$  and large hooklets 140 to 200  $\mu\text{m}$ . four large (0.5mm), deeply cupped suckers decorate the sides of the scolex. A short, narrow neck precedes the chain of proglottids that usually numbers less than 1000. Gravid proglottids are longer than broad (11 by 5 mm)

and have 7 to 13 lateral sides. Each gravid proglottid has a single genital pore located on a lateral side. Gravid terminal proglottids are quite muscular, enabling them to migrate out of the anus and onto adjacent skin. They usually appear in feces in a chain of 5 to 6 segments. Each gravid proglottid may contain 30,000 to 50,000 eggs (Naefie *et al.*, 2000).

**Egg:** Eggs are spherical, 6-hooked containing larvae inside and are covered with egg shell.

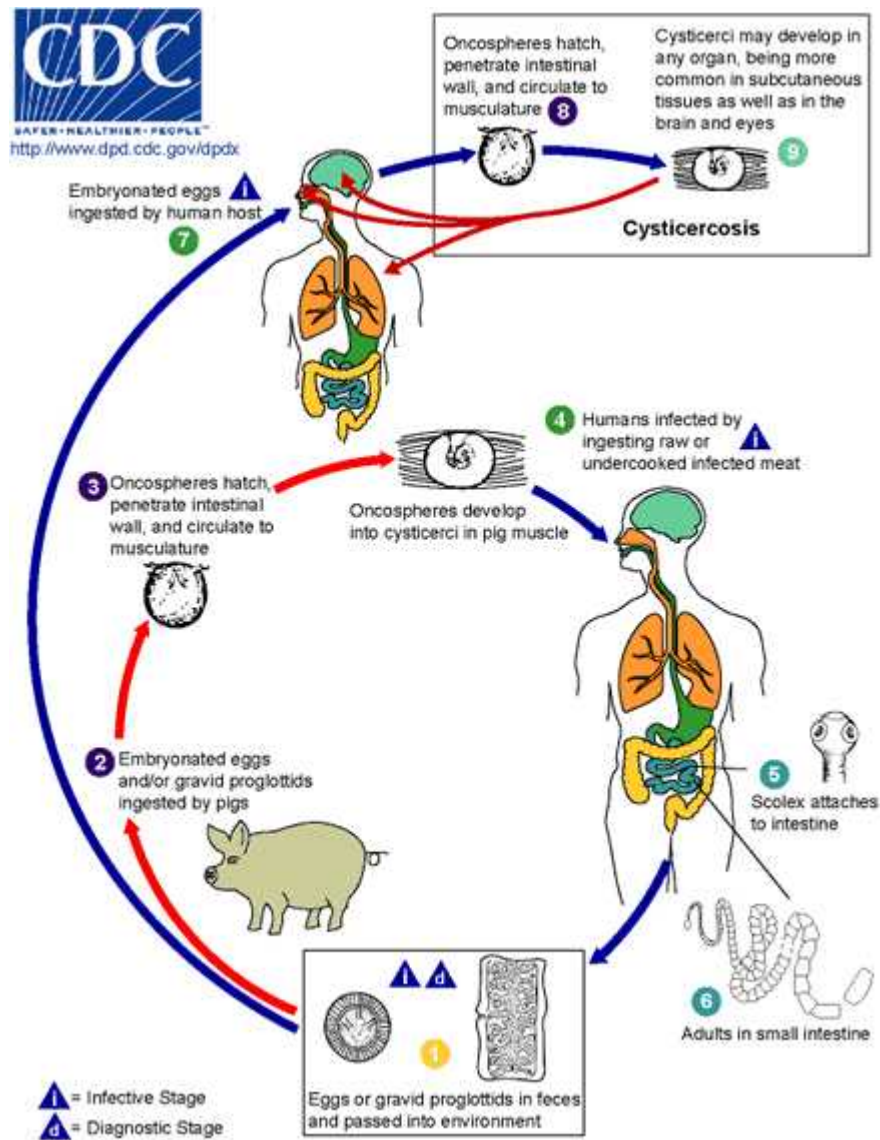
**Larvae:** The larvae of *T. solium* are known as *Cysticercus cellulosae*. These small cysticerci are approximately 6- 18mm wide by 4 - 6mm in length when found in the muscles or subcutaneous tissues of their intermediate host (generally, pigs). The cysticerci may however be found in other tissues such as those of the central nervous system where they may grow much larger, up to several cm in diameter. (<http://www.stanford.edu/class/humbio103/parasites2001/taeniasis>).

### **Life cycle**

*Taenia solium* pass their life cycles in two hosts. Adult worms are found in the small intestine of man. Eggs or gravid proglottids are passed with faeces; the eggs can survive for days to months in the environment. Pigs, the intermediate host for the cestode, become infected by ingesting vegetation contaminated with eggs or gravid proglottids. In the animal's intestine, they hatch, invade the intestinal wall, and migrate to the muscles, where they develop into cysticerci. A cysticercus can survive for several years in the animal. Humans become infected by ingesting raw or undercooked infected meat. In the human intestine, the cysticercus develops over 2 months into an adult tapeworm, which can survive for years. The adult tapeworms attach to the small intestine by their scolex and reside in the small intestine. Length of the adult worms is usually 2 to 7 metres. The adults produce proglottids which mature, become gravid, detach from the tapeworm, and migrate to the anus or are passed in the stool (approximately 6 per day). *T. solium* adults have an average of 1,000 proglottids. The eggs contained in the gravid proglottids are released after the proglottids are passed with the faeces. *T. solium* may produce 50,000 eggs per proglottid respectively. (<http://www.doctorndtv.com/Taeniasis>).



Humans can also be infected by ingestion of food contaminated with feces containing eggs, or by autoinfection. In the latter case, a human infected with adult *T. solium* can ingest eggs produced by that tapeworm, either through fecal contamination or, possibly, from proglottids carried into the stomach by reverse peristalsis. Once eggs are ingested, oncospheres hatch in the intestine, invade the intestinal wall, and migrate to striated muscles, as well as the brain, liver, and other tissues, where they develop into cysticerci. In humans, cysts can cause serious [sequelae](#) if they localize in the [brain](#), resulting in [neurocysticercosis](#). The parasite life cycle is completed, resulting in human tapeworm infection, when humans ingest undercooked pork containing cysticerci. (www.wikipedia.org/wiki/pork\_tapeworm).



**Life cycle of *T. solium***

## **Distribution**

*Taenia solium* has worldwide distribution. Approximately 50 million cases related to *T. solium* infection are believed to occur world-wide annually. It is mainly found in the countries where *Sus* spp. are raised for human consumption and endemic in the human population where people eat raw or inadequately cooked pork. The infection is common in low socioeconomic and poor sanitary areas of Central and Southern Mexico and Central and Southern America. The infection is also present in India, Pakistan, North China, Thailand and Nepal. The frequency however has decreased in developed countries owing to stricter meat inspection, better hygiene and better sanitary facilities. The distribution of cysticercosis coincides with the distribution of *T. solium*. In Ethiopia, Kenya and the Democratic Republic of Congo around 10% of the population is infected, in Madagascar even 16%. (<http://www.who.int/zoonoses/diseases/taeniasis>). Taeniasis and cysticercosis are very rare in Muslim countries. (<http://www.stanford.edu/class/humbio103/parasites2001/taeniasis>).

## **Significances**

### **In human**

#### **Cysticercosis**

*T. solium* eggs can also infect humans and cause cysticercosis (larval cysts in lung, liver, eye and brain) resulting in blindness and neurological disorders. The incidence of cerebral cysticercosis can be as high 1 per 1000 population and may account for up to 20% of neurological case in some countries (e.g., Mexico); cysticercosis ocular involvement occurs in about 2.5% of patients and muscular involvement is as high as 10% (India). (<http://pathmivro.med.sc.edu/book/parasitology/cestodes>). For patients with cysticercosis, devastating effects may occur as the larvae develop in the skeletal/cardiac muscles and the brain. The presence of cysticerci (neurocysticercosis) is the most common parasitic infection of the human brain. It is known to cause adult-set epilepsy, seizures, abnormal behavior changes, and lesions in the brain. Cysticerci in the eye can cause permanent blindness. Also, the racemose or proliferating form of cysticercus can cause tumor like growths. (<http://www.stanford.edu/class/humbio103/parasites2001/taeniasis>).

## **Taeniasis**

The presence of *T. solium* worms in the human intestines usually does not cause major problems. Diarrhea, constipation, indigestion, and other mild stomach symptoms are common. Proglottids may also crawl out of the anus and cause some discomfort or embarrassment. (<http://www.stanford.edu/class/humbio103/parasites2001/taeniasis>).

## **In animals**

Cysticercosis doesn't usually manifest itself clinically in animals. Experimentally infection of pig with a high dose of *T. solium* eggs can produce fever, debility, diarrhoea, anorexia, and muscular stiffness. Death may occur as a result of degenerative myocarditis. In isolation cases, infected *Sus* spp. may experience hypersensitivity of the snout, paralysis of the tongue, and epileptiform convulsions, but the useful life of *Sus* spp. is usually too short for neurologic manifestation to appear. (Pedro, 1980).

## **Control measures**

### **Preventive measures**

The public should be advised to avoid faecal contamination of soil, and human and animal food; avoid the use of raw sewage for irrigation of pasture soil; and to cook beef and pork thoroughly.

Beef and pork, should be adequately cooked, for example at 60°C for five minutes.

Freezing meat below -5°C for more than four days will kill cysticerci.

Meat should be routinely inspected for evidence of taeniasis at slaughter.

### **Control of case**

Praziquantel or niclosamide are used for treatment of beef and pork tapeworm infections. Consult the current version of Therapeutic guidelines: antibiotic (Therapeutic Guidelines Limited).

Persons harbouring adult *T. solium* should be immediately identified and treated to prevent human cysticercosis. For cysticercosis surgical intervention may relieve symptoms. For CNS cysticercosis, praziquantel or albendazole may be used, with corticosteroids if indicated.

Isolation is not required. The case and relevant caregivers should be advised that the case's faeces may be infectious and advised on sanitary disposal of wastes.

### **Control of contacts**

Symptomatic patients exposed to a suspected source of infection should be evaluated for evidence of taeniasis.

### **Control of environment**

If the history is consistent with local infection the source of the infection should be investigated, often with the assistance of the local government.

(<http://www.health.vic.gov.au/taeniasis>).

## **Justification of the study**

Though major ethnic group contributes to Newars (CBS 2001), in the Kirtipur municipality, the number of people of other castes is found ever increasing due to migration which definitely contributes to increase in pork consumption. Previously, pork was consumed only by people belonging to low castes, however, in recent years; the consumption of pork has increased in higher castes as the caste system has become more relaxed. The number and distribution of pig slaughter house and the pork shops is unknown in this area. No data are available. The infrastructure and facilities present in them has not been surveyed as well. More importantly, the prevalence of cysticercosis and taeniasis which has ever increasing economic and public health significances has never been worked out in this municipality.

The present study is an endeavor to document sufficient data to improve the facilities in the slaughtering places and meat shops, to improve or bring the awareness among all the people dealing with animals and pork and ultimately improve the health condition of the people.

The present study is also hoped to awake the related authorities to develop an effective meat inspection system and to implement 'The Slaughterhouse and Meat Inspection Act 1998'.

## **Limitation of the study**

The present study bears following limitations.

- ) Data were collected for only few months.
- ) As the pig slaughter house was located in the remote area of the municipality, data were collected by visiting it only once in a week.
- ) Since the butchers have to deliver the carcass of the slaughtered animals to the meat shops at very early morning, time spent on observing the carcass was limited and if not always, sometimes, rapid observations of the carcass have to be made.

## **OBJECTIVES**

### **General**

The general objective of the study is to survey the pig slaughtering places and pork shops to observe the hygienic condition of the meat and observe the cysts (*Cysticercus cellusae*) occurring in the meat

### **Specific**

- I. To observe the distribution of pig slaughtering places pork shops occurring in Kirtipur.
- II. To observe the hygienic condition in and around the slaughtering area.
- III. To study the incidence of Cysticercosis in pigs slaughtered for meat.
- IV. To create awareness among butchers, meat sellers and consumers about meat hygiene.
- V. To recommend the way to get the best hygienic meat.

### III

## LITERATURE REVIEW

### LITERATURE REVIEW IN CONTEXT TO THE WORLD

Aluja *et al.*, (1996), studied in Mexico, infected pigs with taeniid eggs to study the susceptibility to infection and reinfection of the animals of mixed breeds and of different ages, the viability and death of the metacestodes in the host tissue, and the antibody response which accompanies these events. Sixteen pigs were infected with *Taenia solium* eggs for this purpose. At necropsy metacestodes were counted in 2 kg of shoulder muscles and classified as vesicular or caseous, and all the metacestodes in brains were counted and classified. The results showed that pigs inoculated at 49 and 60 days of age became infected to different degrees and reacted differently to the presence of parasites. In the brain the metacestodes remain viable for longer periods than in muscles. Enzyme-linked immunosorbent assay (ELISA) showed a significant rise in antibodies after infection, which started to decrease 92 days post-infection. The results suggested that older animals are more resistant to the infection.

Newelle *et al.*, (1997) examined 103 epileptics and 72 control subjects from the same households for cysticercosis in the province of Bururi in Burundi. Antigen was detected by enzyme-linked immunosorbent assay in 4.9% of epileptic persons and in 4.2% of controls. Antibody was detected by enzyme-linked electroimmuno-transfer blot assay (EITB) in 11.7% of epileptics and in 2.8% of controls. Neither difference was statistically significant, nor was a history of taeniasis significantly more frequent in epileptics than in controls. However, cysticercosis was significantly more frequently diagnosed by EITB in people with a history of taeniasis than in those without such a history. The prevalence of taeniasis in schoolchildren ranged between 0 and 1.0%. Meat inspection detected cysticercosis in 2% and 39% of pigs in 2 localities, respectively.

Saini *et al.*, (1997) studied food safety and regulatory aspect of cattle and *Sus* spp. cysticercosis using slaughter disposition data maintained by the food safety and inspection (FSIS) of the US Department of Agriculture. Prevalence of cattle cysticercosis (*Cysticercus bovis*) for 10 years period from 1985 through 1994 was reported. Out of an annual average of approximately 33 million slaughtered cattle, about 6,200 carcasses

were identified with *Cysticercus* lesion. In the five FSIS inspection region in the United States namely Western, South-Western, North-Eastern, South- Eastern and North-Central, an average cattle cysticercosis prevalence of 0.0697, 0.0085, 0.0012, 0.0004 and 0.003 respectively was reported. Out of a total of approximately 80 million swine slaughtered annually in the United State, the number of carcasses identified with *Cysticercus* lesion (*Cysticercus cellulosae*) is extremely low, ranging from 1 through 44 during each of the 10 years. Swine cysticercosis, with man being an alternate intermediate host, posses' serious public health concerns with sometime fatal consequences manifested through neurocysticercosis.

D'-Souza (1998) studied the prevalence of *C. cellulosae* (*T. solium*) infection in 1416 pigs in four districts of Andhra Pradesh, India. The rates of infection at Chitoor, Krishna, West Godavari and Guntur districts were 8.66, 8.00, 6.00 and 43.3 per cent, respectively. Prevalence was found to be 5.36 per cent a bacon factory in Gannavaram. Rates of infection in relation to age, sex and breed were not statistically significant. Moderate, light and heavy infections were observed in 40, 31.11 and 28.88 % of the infected pigs, respectively. The overall prevalence of 6.35 % is considered to be significant in view of the economic loss to farmers and the high public health importance of this parasite.

Gracia *et al.*, (1998) surveyed two different populations in Saylla, a Peruvian village near Cusco, known for chicharrones, a local pork dish, by serology and stool examination to determine the prevalence and epidemiologic characteristics of *Taenia solium* infection. Group I (n =43), the chicharroneros, were members of families professionally devoted to the making and selling of chicharrones, and Group II (n 5 102) was a sample of the general population of the same village. Unlike people in Group I, general villagers only occasionally prepare or sell this food product, and then only to their neighbors or relatives. The prevalence of taeniasis was extremely high (8.6%) for the chicharroneros and 3% for the general villagers. Seroprevalence for cysticercosis by immunoblot was similarly high in both groups (23.3% and 23.8%, respectively).

Garcia *et al.*, (1999) performed a serological survey using the enzyme linked immuno electrotransfer blot (EITB) in a village in a highlands of Peru where there are 3 distinct but close neighborhoods to determine if there is a distinct relationship between human and porcine *T. solium* infection. 108 out of 365 individuals were sampled, and 14 were seropositive (human seoprevalance 13%). Most seropositive individual were



neurologically asymptomatic. 38 out of 89 sampled pigs (43%) were seropositive. There was a clear geographical clustering of cases, and positive correlation between human and porcine seroprevalence was found when the 3 neighbourhoods was compared.

Haridy *et al.*, (1999) observed a total of 6,434,093 slaughtered cattle, buffaloes and pigs to study human taeniasis and cysticercosis in Egypt. The study showed 0.72% cysticercosis (*bovis* and *cellulosae*) infections. Individual animal species infection was 0.23% in native breed cattle, 7.25% in imported cattle, 0.14% in buffaloes and 0.09% in pigs.

Rodriguez *et al.*, (1999) conducted an epidemiological survey in a community in Yucatan State, Mexico, an area endemic for *T. solium* to detect human taeniasis and cysticercosis. Information of the environmental, demographic and risk factors associated with transmission of *T. solium* within the community was recorded on questionnaires. Although no *Taenia* eggs or proglottid were found in the initial fecal samples collected from each of the 475 subjects, the result of the capture ELISA for *T. solium* coproantigen were positive for 10 of the subjects of both genders and various ages. After treatment with niclosamide, proglottids were detected in purge samples from 7 of the 10 subjects. The prevalence of parasitologically confined taeniasis was therefore 1.5% (7 in 475).

Sanchez *et al.*, (1999) conducted an epidemiological study in a Honduran rural community in 1991 to determine the local prevalence and associated risk factors of *Taenia solium* infection. The seroprevalance of anticysticercus antibodies, investigated by ELISA (N=526), was found to be 30%. The prevalence of intestinal infection with *Taenia* and other parasite was investigated by formal ether concentration of 3 stool samples from each subjects (N=536). Almost all (96%) of the subjects carried at least one of the 17 species of intestinal parasites identified, 11 (2%) of them (9 of them female) being found to be infected with *Taenia* sp.

Sutisna *et al.*, (1999) carried out an immuno epidemiological investigation of 3 rural communities in Bali, Indonesia to study community prevalence of taeniasis and cysticercosis which revealed a taeniasis prevalence of 0.72 (3/415). One of the 3 cases was due to *T. solium*; the other two were due to *T. saginata*. A further 9 cases of *Taenia* infection were identified from patients from villagers surrounding the chosen communities, suggesting the higher prevalence in other areas. Seroprevalence of human cysticercosis by immunoblot was 1.65% (6/363) though all cases were detected within a single community (6/115, prevalence 5.22%).

Sarma *et al.*, (2000) investigated the prevalence of *C. cellulosae* in 279 pigs slaughtered at different abattoirs in Greater Guwahati, (Assam) India and it was found to be 3.22%..

Santamaria *et al.*, (2002) experimentally inoculated *Taenia solium* eggs know about the immune response and efficiency of establishment in pigs. Three of 4 pigs inoculated with 10 eggs of *Taenia solium* became infected. In those pigs infected with larger numbers of eggs, all became infected. Specific antibodies against the metacestodes were found in serum at day 30 postinoculation (PI) in animals that received 1,000 or more eggs and at day 60 in those that received 10 or 100 eggs. All pigs infected with 1,000 or more eggs developed antibodies, but only 40% and 75% of pigs that received 10 and 100 eggs, respectively, developed antibodies. Metacestodes were found in the muscles of 23 of the 27 infected animals. In 35.7% of the pigs that received 1,000 or more eggs, metacestodes were also found in the brain. Most of the metacestodes found in pigs infected with 10 or 100 eggs were caseous, whereas in pigs infected with 1,000 or more eggs the majority of metacestodes were vesicular. This study showed that the severity of *T. solium* infection and the possible regulation of the immune system–evasion mechanisms depend on the number of meta cestodes that succeed in establishing themselves and remain vesicular.

Avapal *et al.*, (2003) reported prevalence rate of 1.70 per cent in Ludhiana city of Punjab state, India on post-mortem examination of the pigs.

Prasad *et al.*, (2003) examined 72 members of a pig farming community and 50 slaughtered pigs in Uttar Pradesh, India between November 2000 and June 2001 for *Taenia solium* infection. 27 of the human subjects (38%) had intestinal taeniasis and 7 (9.7%) had reported seizures. All 3 of the latter who were examined had

Moro *et al.*, (2003) conducted an epidemiological study in a highland, rural community in Peru, to determine the seroprevalences of human and porcine infection with *Taenia solium* and the risk factors associated with human infection. The seroprevalences, determined using an assay based on enzyme-linked-immuno-electrotransfer blots (EITB), were 21% (66/316) in the humans and 65% (32/49) in the pigs. The human subjects aged <30 years were more likely to be positive for anti-*T. solium* antibodies than the older subjects ( $P < 0.001$ ). The risk factors associated with human seropositivity were lack of education beyond the elementary level [odds ratio (OR) =2.69; 95% confidence interval (CI) =1.09-6.65] and pig-raising (OR=1.68; CI=0.96-2.92). Curiously, sheep-raising was inversely associated with human *T. solium* infection (OR=0.50; CI=0.28-0.90).

Rajshekhar *et al.*, (2003) studied *Taenia solium* taeniosis/cysticercosis in Asia: its epidemiology, impact and issues. They found that Cysticercosis is the cause of epilepsy in up to 50% of Indian patients presenting with partial seizures (Indonesia), Vietnam and possibly China and Nepal. Seroprevalence studies indicate high rates of exposure to the parasite in several countries (Vietnam, China, Korea and Bali (Indonesia)) with rates ranging from 0.02 to 12.6%. Rates of taeniasis, as determined by stool examination for ova, have also been reported to range between 0.1 and 6% in the community in India, Vietnam, China, and Bali (Indonesia). An astonishingly high rate of taeniasis of 50% was reported from an area in Nepal populated by pig rearing farmers. In addition to poor sanitation, unhealthy pig rearing practices, low hygienic standards, and unusual customs such as consumption of raw pork is an additional factor contributing to the spread of the disease in some communities of Asia.

Rodríguez-Hidalgo *et al.*, (2003) carried out the epidemiological study of the taeniasis/cysticercosis complex in Ecuador. The data were compiled on the infection of both tapeworms in man and animals in Pichincha and Imbabura provinces in the Andean region, north of Quito. On post mortem inspection 3 out of 806 (0.37%) carcasses had *T. saginata* metacestodes, however, 35 sera out of 869 (4.03%) showed circulating antigen in a monoclonal antibody-based sandwich ELISA (Ag-ELISA). Porcine cysticercosis was detected in 15 out of 2896 (0.52%) carcasses and 93 out of 1032 serum samples (9.01%) were positive in Ag-ELISA. In humans, 4.99% (215 out of 4306) cases of antigen positives were found, whereas coprological examination of 1935 stools resulted in 30 positive cases (1.55%). The limited number of adult tapeworms (29) that were

collected does not allow firm conclusions on the proportion of each species, but in total 21 specimens were identified as *T. saginata* and 8 as *T. solium*. These data have been discussed in view of the epidemiology of human cysticercosis.

Sharma (2003) reported 6.35 per cent prevalence rate in Ludhiana city of Punjab state, India on post mortem examination of 236 pigs. Age wise prevalence was more (6.48%) in pigs under one year of age than those aged more than one year (6.25%). Prevalence rate was found to be 8.82 per cent in males and 4.48 per cent in females. *C. cellulosae* infection was found to be independent of age and sex of pigs whereas it had significant statistical correlation between the infection and the breed and managerial practices. Prevalence of cysticercosis was found to be maximum (13.46%) in post monsoon and minimum in pre monsoon season and it was found that disease was independent of season statistically. Most common predilection sites were found to be thigh muscles (100%), forequarter (100%), neck muscles (100%) followed masseter muscles (73.39%), tongue (53.34%), heart (36.36%), diaphragm (36.36%), liver (36.36%), oesophagus (6.67%) and kidney (6.67%).

DeGiorgio *et al.*, (2005) studied the sero-prevalence of *T. solium* Cysticercosis and *T. solium* Taeniasis in an at-risk community in the USA, specifically rural Southern California. The result showed that the sero-prevalence of *T. solium* Cysticercosis was 1.8% and the sero-prevalence of *T. solium* Taeniasis by serum immunoblot was 1.1%. *Taenia solium* Cysticercosis and *T. solium* Taeniasis antibodies were not detected in children. The sero-prevalence of *T. solium* Taeniasis was highest in the migrant farm worker community. Handwashing frequency was correlated with *T. solium* Taeniasis sero-positivity.

Jolanta *et al.*, (2006), during the period 1993–2004, found cysticercosis caused by *Cysticercus cellulosae* in only a few pigs (18 cases – 0.0025% of 7,018,273 examined pigs) in Lublin province, Poland.

Prasad *et al.*, (2006) described clinical signs in swine indicative of brain involvement by cysticerci. The signs were excessive salivation, excessive blinking and tearing, and subconjunctival nodule. A total of 30 swine (18 with 2 or all 3 clinical signs and 12 without any sign) underwent magnetic resonance imaging (MRI). All 18 swine with above signs had NCC on MRI along with variable involvement of other organs that were

subsequently confirmed by ex vivo MRI, necropsy and histopathology, while none of the 12 animals without any sign had NCC.

Suroso *et al.*, (2006) reported Taeniasis/cysticercosis from several provinces of Indonesia: Papua (=former Irian Jaya), Bali, North Sumatra, East Nusa Tenggara, South East Sulawesi, Lampung, North Sulawesi, Jakarta, West Kalimantan, and East Java. The highest level of endemicity of taeniasis/cysticercosis has been found in Papua. Recent surveys in Jayawijaya District of Papua in 2000 and 2001 showed that 5 of 58 local people (8.6%) harbored the adult tapeworm, *Taenia solium*, whereas 44 of 96 people (45.8%), 50 of 71 pigs (70.4%), and 7 of 64 local dogs (10.9%) were seropositive for *T. solium* cysticercosis. Current surveys in Bali and Samosir District, North Sumatra during 2002-2005 revealed that *Taenia saginata* taeniasis has increased in incidence whereas *T. solium* cysticercosis is now rather rare compared to one-two decades ago in Bali. *Taenia asiatica* taeniasis is still common in Samosir District.

Wandra *et al.*, (2006) carried out an epidemiological survey of taeniasis/cysticercosis in one semi-urban and two urban villages in three districts of Bali, Indonesia in 2002 and 2004. In total, 398 local people from 247 families were diagnosed by anamnesis and clinical examinations, and 60 residents were suspected to be taeniasis carriers. Among 60 suspected carriers, 56 persons expelled a total of 61 taeniid adult worms after praziquantel treatment. From 398 residents, 252 stool samples were available for analysis of taeniid eggs, coproantigens or copro-DNA for identification of taeniid species, and 311 serum samples were available for detection of antibodies against *Taenia solium* cysticercosis. Taeniasis prevalences were highly variable among three villages (1.1-27.5%), and only one case of cysticercosis due to *T. solium* infection was detected. All expelled tapeworms were confirmed to be *Taenia saginata* by mtDNA analysis. There was no *Taenia asiatica* human case in Bali.

Chummy *et al.*, (2007) studied the prevalence of *Taenia solium* porcine cysticercosis in free-range pigs in selected districts of Eastern, Southern and Western provinces of Zambia by Tongue examination and detection of circulating antigen (Ag-ELISA). A total of 1691 pigs were examined out of which 183 (10.8%) were positive on tongue examination. Ag-ELISA gave a sero-prevalence of 23.3%. When considering the factors in a logistic regression analysis, only breed type was significantly associated with porcine cysticercosis (OR = 0.72; 95%CI = 0.63–0.81). The crossbred pigs were 72%

more likely to have had cysticercosis than the Nsenga (dwarf local) breed as determined by Ag-ELISA. The result that crossbred pigs had a higher prevalence of *T. solium* cysticercosis suggests that pig breeds may display different susceptibility to cysticercosis. The limited use of latrines in these areas implies that people use the nearby bush for defecation, resulting in pigs having access to human faeces.

Krecek (2007) carried out study on porcine cysticercosis in areas of South Africa including Eastern Cape Province. Lingual examination (tongue palpation) in live pigs, two enzyme-linked immunosorbent assays (ELISAs), which detect parasite antigen (B158/B60 Ag-ELISA and HP10 Ag-ELISA) and an enzyme immuno-transfer blot (EITB) assay, which detects antiparasite antibody, were used to verify endemicity and estimate apparent prevalence. In the absence of a gold standard true prevalence was obtained, using a Bayesian approach, with a model that uses both available data and prior information. Results indicate that the parasite is indeed present in the study villages and that true prevalence was 64.6%. The apparent prevalences as measured by each of the four tests were: 11.9% for lingual examination, 54.8% for B158/B60 Ag-ELISA, 40.6% for HP10 Ag-ELISA and 33.3% for EITB. This base-line knowledge of the prevalence of *T. solium* in pigs provides information essential to the design and monitoring of sustainable and appropriate interventions for cysticercosis prevention and control.

Lescano *et al.*, (2007) estimated the *Taenia solium* swine cysticercosis risk gradient surrounding tapeworm carriers in seven rural communities in Peru. At baseline, the prevalences of taeniasis by microscopy and swine cysticercosis by serology were 1.2% (11 of 898) and 30.8% (280 of 908), respectively. The four-month cumulative seroincidence was 9.8% (30 of 307). The unadjusted swine seroprevalence and seroincidence rates increased exponentially by 12.0% (95% confidence [CI] = 9.7–14.3%) and 32.8% (95% CI = 25.0–41.0%), respectively when distance to carriers decreased by half. Swine seroprevalence was 18.4% at > 500 meters from a carrier, 36.5% between 51 and 500 meters, and 68.9% within 50 meters ( $P < 0.001$ ). Swine seroincidence also displayed a strong gradient near tapeworm carriers (3.8%, 12.2%, and 44.0%;  $P < 0.001$ ). Within 50 meters, swine seroprevalence appeared unaffected if the owners harbored tapeworms, although pigs owned by a tapeworm carrier had a four times higher seroincidence compared with other pigs ( $P = 0.005$ ).

Barton *et al.*, (2008) conducted the first population-based study to estimate the prevalence of human infection with *Taenia* tapeworms along the Texas-Mexico border. Households were interviewed in the Texan city of El Paso and in the neighbouring Ciudad Juarez, in Mexico. Faecal samples from household members were then checked for *Taenia* eggs by flotation and/or for *Taenia* copro-antigens in an ELISA. The overall prevalence of taeniasis in this border region was found to be 3% but, compared with the residents of Juarez, El Paso residents were 8.6-fold more likely to be tapeworm carriers. The interviews revealed some important differences between the two study sites, particularly the more frequent use of anthelmintic drugs on the Mexican side of the border.

Prasad *et al.*, (2008) conducted a study in a rural pig farming community of north India to estimate the prevalence of *T. solium* taeniasis and associated factors. Demographic, clinical and epidemiological data were collected from 1181 subjects in 210 households in 30 villages. Stool specimens from 924 subjects were examined for eggs of *Taenia* and other parasites. Identification of *T. solium* was confirmed by morphological features of segments and species-specific DNA detection from segments and stool. The prevalence of *T. solium* taeniasis was 18.6% (172/924); factors associated with taeniasis on multivariate analysis were age above 15 years, history of passage of *Taenia* segments in stool, undercooked pork consumption and poor hand hygiene (hand-washing with clay/water after defecation). Seventy-eight subjects (6.6%) with epilepsy were identified. The study showed alarmingly high rates of epilepsy and *T. solium* taeniasis in the study community; it highlights the need for large-scale imaging-based surveys to identify the factors associated with epilepsy including neurocysticercosis.

## **LITERATURE REVIEW IN CONTEXT OF NEPAL**

No literature regarding the topic of the present thesis of the Kirtipur area was found, however, similar such type of works had been performed by different authors at different parts of Nepal. In this connection some relevant literatures are given below.

Joshi (1973) observed *Taenia* cysts in pig meat slaughtered in Kangeswari, Kathmandu.

Poudyal (1998) studied on prevalence of *T. solium* in pigs and its public health importance in Kathmandu and Dharan. Out of 250 slaughtered pigs examined, 34 (13.6%) were found positive for cysticercosis. Further out of 196 slaughtered pigs examined in Kathmandu, 28 (14.28%) were found positive, whereas in Dharan, 54.6 (11.11%) were found positive.

Amatya *et al.*, (1999) confirmed sixty two patients with cysticercosis, out of 23,402 biopsy cases detected at Patan hospital, Lalitpur in the following 5 years. Forty cases were identified from the Kathmandu valley and the rest from outside Kathmandu. Most patients were younger than 30 years of age (mean,  $21 \pm 11$  years). Statistically, there was no difference between males (0.28%) and females (0.24%). The average size of cysticercosis was 19 mm in diameter.

Maharjan *et al.*, (2002) studied the prevalence of porcine cysticercosis among Magar community of Syangja district. A total of 419 slaughtered pigs were examined. 32.5% were examined from Tindabate VDC and Walling Municipality. 43.7% were observed in Tulsibhanjgang VDC and rest in Jagatradevi VDC. The knowledge on cysticercosis as a disease was found completely all among Magar ethnic group. But most of them have noticed the cyst during slaughtering and pork consumption for which they commonly called “chamley” and believe nothing as a disease but observe when pigs were fed rice water. This risk factors associated with the transmission of porcine cysticercosis includes living condition, absence of latrine and animal husbandry system.

Joshi *et al.*, (2003) found 14% (34/250) of pigs positive for cysticercosis on Postmortem surveys of pigs at slaughter establishments in Kathmandu and Dharan municipality. Antemortem detection of *T. solium* infection of pigs in a Syangja District community indicated 32% (136/419) of pigs positive by lingual examination while 24% (48/201) was serologically positive by Enzyme-linked Immuno-electro Transfer Blot (EITB) and 6% (12/201) showed evidence of old infection or exposure with 42 kDa and 50 kDa. A human helminthological survey in Syangja District in central Nepal indicated a very high prevalence of taeniasis, with 43% positive (77/180), while in Tanahun District 18% were positive (28/152). Human cysticercosis cases were reviewed on the basis of hospital-based data. During the past five years, records from Patan Hospital, Bir Hospital, and Kanti Children's Hospital reported 62, 4, and 11 cysticercosis cases in Kathmandu, respectively.



Karki (2003) studied on an epidemiological survey on intestinal helminthes among Magar communities in Barangdi VDC, Palpa with special references to *Taenia* spp. He found the overall prevalence of *Taenia* spp. to be 8.28% in that community. The highest prevalence rate of taeniasis was observed in the 21-30 yrs of age group. Nearly similar prevalence rate was recorded in both sexes. Taeniasis prevalence was found to be very less among children and old people since the disease is associated with the frequently pork eating habit.

Sharma (2006) surveyed about 437 households and pig farming area in three VDCs i.e. Tindobate VDCs, Thumpokhara VDC, Jagatradevi VDC and Walling Municipality in Syangja district. From the study, it was found out that the contamination of soil and water contributes greatly for the parasitic infestation of both pig and human. Most of the pigs were kept inside the house at night and were fed on kitchen wastes and excreta. That was the important factor that was co-related with the high prevalence of parasitic infestations like Taeniasis in pigs and humans.

## CHAPTER – IV

### MATERIALS AND METHODS

#### STUDY AREA

Nepal, a small landlocked country, lying between India and the Tibetan Autonomous Region of China is geographically located at 80° 4' East to 88° 12' East longitude and 26° 22' North to 30° 27' North latitude. Kirtipur is one of the recently urbanized cities of Kathmandu valley, the capital city of the country, located some 8 kms. south-west of the central Kathmandu. It is declared as municipality in 2053 and is divided into 19 wards. It extends from 27° 41' 36" – 27° 38' 37" N to 85° 18' 00" – 85° 14' 64" E and is surrounded by the Bagmati River in the east, Tinthana and Machchhegaon VDC in the west, ward no. 14 of the Kathmandu Metropolitan in the north and Chalnakhel VDC and Shesnarayan VDC in the south. The shape of the municipality resembles almost a square, the area being 14.76 sq.km (Nepal Gazettes part III 2053) and the study area covers an all over area of the municipality.

The total population of the municipality is 40835 and the total number of households is 9487 (National Census 2001). All of the ethnic people are Newars in this municipality and they are in majority followed by Chhetris, Brahmans, Tamangs, Magars, Mijars, etc. Nayabazar is the central market and busy.

#### STUDY POPULATION AND SAMPLING

In Kirtipur area only one pig slaughtering place was found and was surveyed. However to meet the demand of pork, the meat seller was found bring the pork also from Talchikhel of Lalitpur district. During the survey from November 2007 to August 2008 i.e. over the period of 10 months, 150 samples of slaughtered pigs were observed. Out of them 90 were females and 60 were males. Among 150 sampled animals, 6 cases were found positive for the cyst of *Taenia*. The cysts mostly occur at sites/organs like underpart of tongue, neck muscles, muscles of shoulder, etc.

## **MATERIALS**

### **Equipment**

- ) Microscope
- ) Refrigerator
- ) Scissors
- ) Forceps
- ) Petri dishes
- ) Tray
- ) Sampling bottles
- ) Gloves
- ) Camera
- ) Disposal vials

### **Chemicals**

- ) Formalin
- ) Alcohol
- ) Detergent
- ) Soap

## **METHODS**

150 pork samples were collected from the Kirtipur Municipality were examined during the study period 2007 /2008.

## **DATA COLLECTION**

Field observation and surveillance study among butchers, meat sellers and pork consumers were the source of most of the data collected.

### **Data collection through field observation**

Field observations were responsible for the collected data like age and sex of the slaughtered animal. It was also responsible for finding out the prevalence of the *Taenia* cyst which was the main goal of the study.

### **Data collection through surveillance**

Butchers, pork sellers and consumers were surveyed during the research through separate questionnaires. During which, different questions were put on to them and formal and informal interviews were carried out to get the true and relevant data as much as possible.

### **Butchers surveillance study**

6 butchers were questioned during the study to know mainly about

1/ the number of animal they slaughter each day

2/the place from where they bring the animal

3/ the way they slaughter the animal

4/ the type of water they use to clean the slaughter animal

5/ the place where they deposit the waste produced from the slaughtered animal

6/ their knowledge about the cyst and the parasite

7/ facilities present in the slaughtering place

### **Meat seller surveillance study**

In the study area only a single pork selling was identified which was run by the main butcher of the slaughter place itself. He was questioned to know about the facilities present in his shop like facilities of refrigeration, water supply, etc and his dealing with the cyst if any found occurring.

### **Consumers' surveillance study**

100 pork consumers were surveyed during the study, among them most, in fact 90 were outsiders, and only 10 were found to be local residents of the area. They were asked to know about their frequency of pork consuming, their knowledge about the cyst and *Taenia*.

### **LABOARTORY WORK**

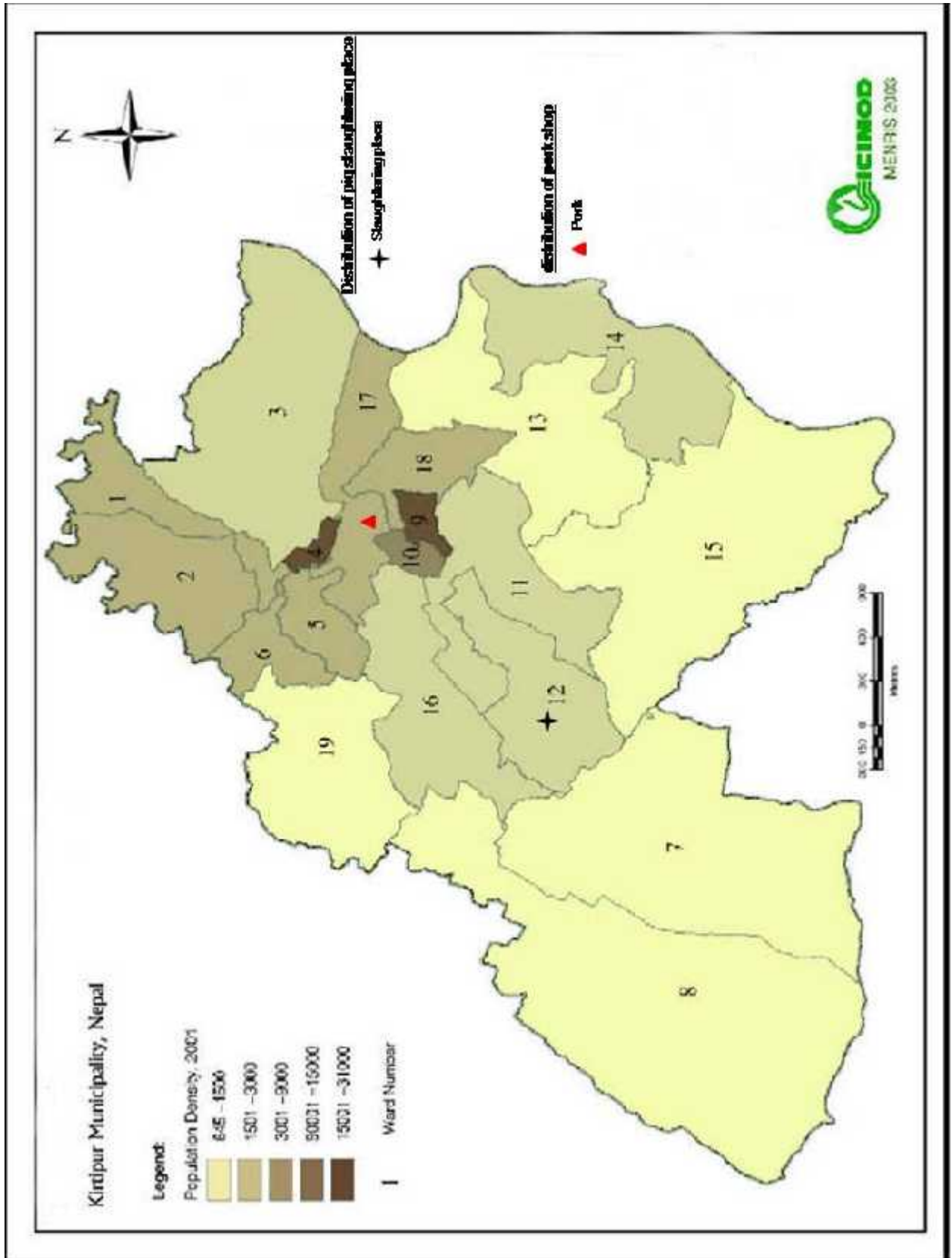
The cysts found during the survey were bought to the lab. of NZFHRC along with the attached muscles. These cysts were then carefully and gently separated from the attached muscles with the help of scissors and blunt forceps. The separated cysts were finally preserved in 90% alcohol in the sample bottles.

### **DATA ANALYSIS**

Data collected from the field observations and surveillance studies were then classified, tabulated and presented in figures with the help of supervisor and co-supervisor for the final result.









## V

### RESULTS

#### **Butchers' Survey Result**

The survey found only a single pig slaughtering place was observed in the Kirtipur area. It was located in ward no. 12 of the municipality, in the place called Jakha.

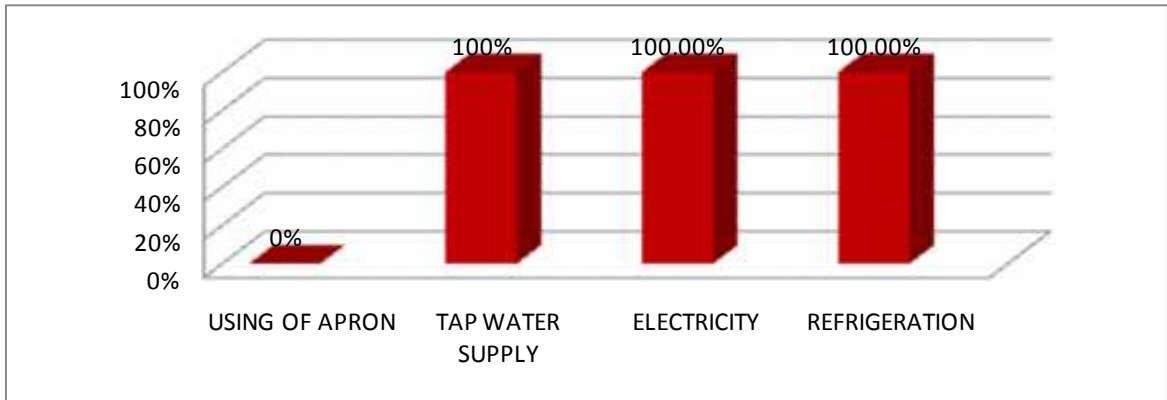
Though a single slaughtering place was observed. The butcher used to bring the pork from Talchikhel area of Lalitpur district to fulfill the demand of pork during non-slaughtering days. No. of animals slaughtered in that area were 8-10 per week. So, altogether two slaughtering places were studied. 7 butchers of these 2 slaughtering places were questioned and following information were obtained.

The pigs were found brought from Dharan on the vehicle to the slaughtering places.

The butchers had their own slaughter shed or sty for the pigs to keep prior to slaughter, near by their home. The method of killing the pig was found very inhumane. They used to strike or pinch the pig with the pointed instrument (rod) made of metal to kill the pig. The dead body was found then dipped into the boiling water pots for a few minute. The hairy bristles were then removed with knife and get washed with cold water. Then the carcasses were dressed accordingly and get delivered to the meat shops. The limbs and even tongue were found separately sold.

At Kirtipur, the pigs were found slaughtered on the cemented ground while at Talchikhel, the animal were found slaughter on the table.

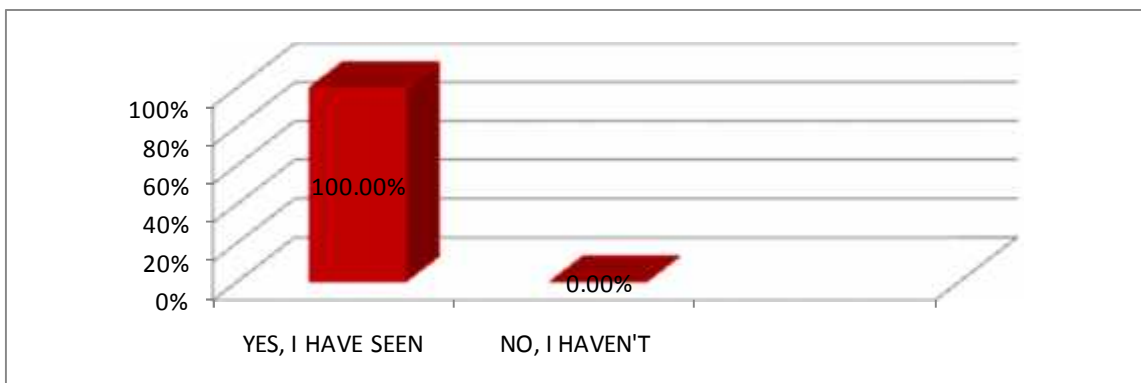
For cleaning up the carcass, all the butchers or slaughtering places were found using the tap water. The slaughtering places were found to have facilities for electricity as well as refrigeration. No extra clothing (boots, apron, etc) were found used by butchers during slaughter.



**Fig. 1:** SANITARY CONDITION & FACILITIES PRESENT IN THE SLAUGHTER HOUSE

The waste materials produced during the slaughtering were found used properly. They were dumped to generate bio- fuel/gas.

When the butchers were asked about their seeing of any tumor like growth or small rice grains like structure in the pork, all of them replied that they've seen such things but such cases were rare. They also revealed that sell such meat or pork.



**Fig. 2:** CYSTS OBSERVED BY THE BUTCHERS

When asked about visiting by meat inspection team, they all admitted that no one has ever come for pork inspection.

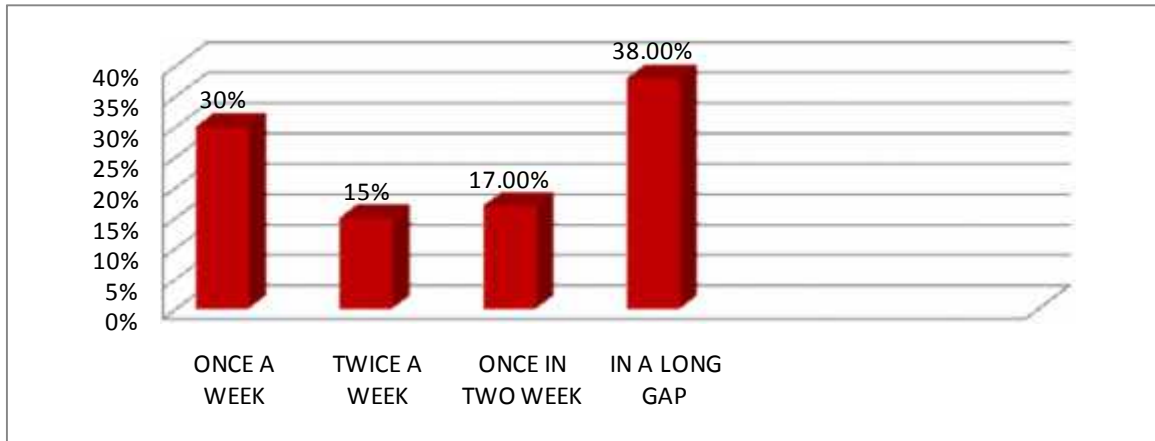
### **Meat Sellers' Survey Result**

Over the entire Kirtipur Municipality, only a single pork selling shop was reported. It was located in Nayabazar site, ward no.17. It was the main market area of the Kirtipur area. The owner of slaughtering place himself was the owner of the meat shop. The meat/pork was found brought from the slaughtering areas on cycle (From Talchikhel+ Jakha) It had got facility of electricity and refrigeration and Tap water used for meat cleaning. Separate clothing or apron was found getting worn during meat selling. He admitted that he had seen the cyst but had got no idea of it being the larval stage of *Taenia solium* (no idea about taeniasis), so sell the meat.

### **Consumers' Survey Result**

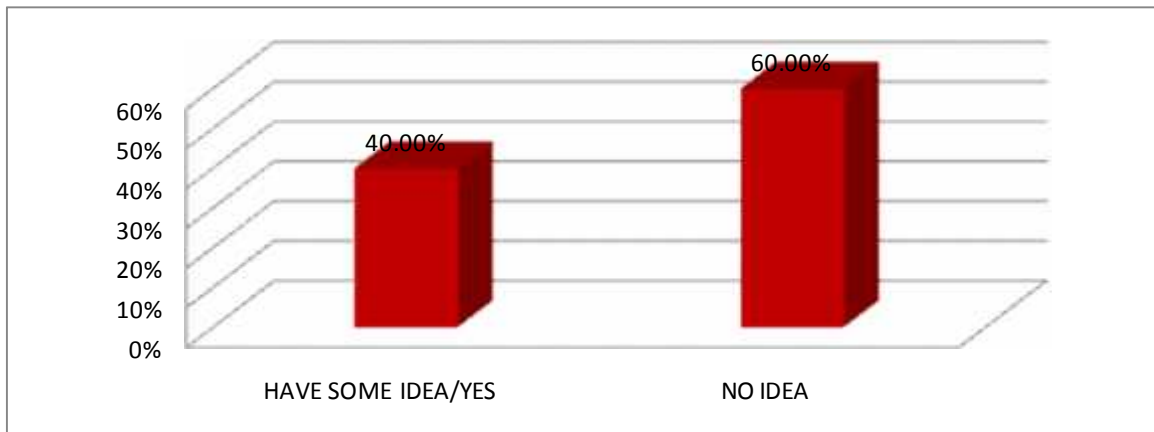
100 pork consumers were surveyed during research. Most of the pork consumers were outsiders. In fact, 90 of them were outsiders and only 10 of them were local residents. Kirtipur being ethnic city of Newars and pork is not generally consumed in Newari community. So, local pork consumers are generally low.

Out of 100 consumers surveyed 30 of them replied that, they consume pork once a week, 15 said, twice a week, 17 said, once in 2 week and rest said in a long gap which is graphically shown below.



**Fig. 3: FREQUENCY OF PORK CONSUMPTION**

40 (40.00%) of them replied that they had idea about taeniasis and 60 (60.00%) replied that they had got no idea of *Taenia* cyst.



**Fig. 4: CONSUMERS' KNOWLEDGE ABOUT TAENIASIS**

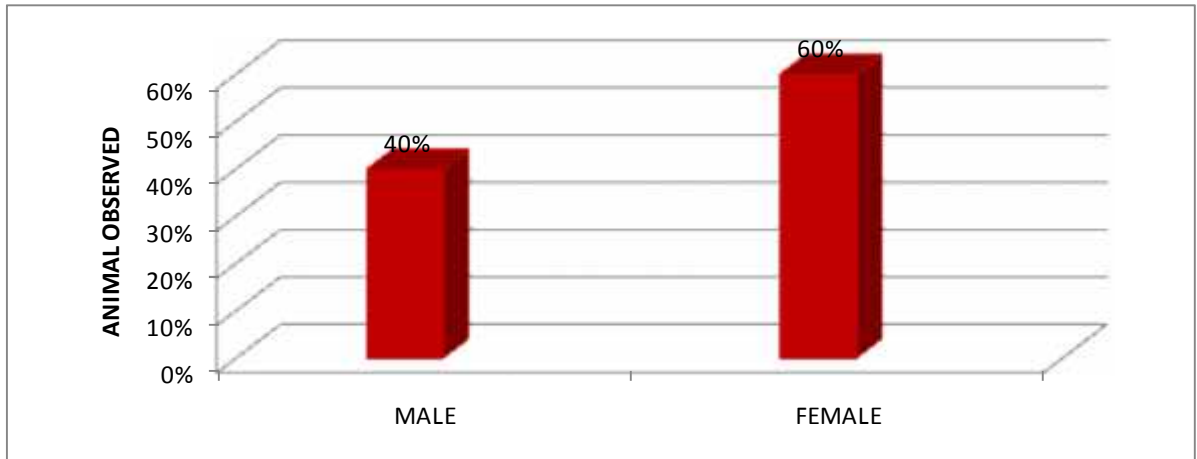
92 of the consumers said that they had never seen *Taenia* cysts in the meat they bought while 8 said they had seen such structure and discarded such meat.

All of them said they were satisfied with the hygienic condition of the.

### **Observation of slaughtered pigs**

#### **Sex-wise observation**

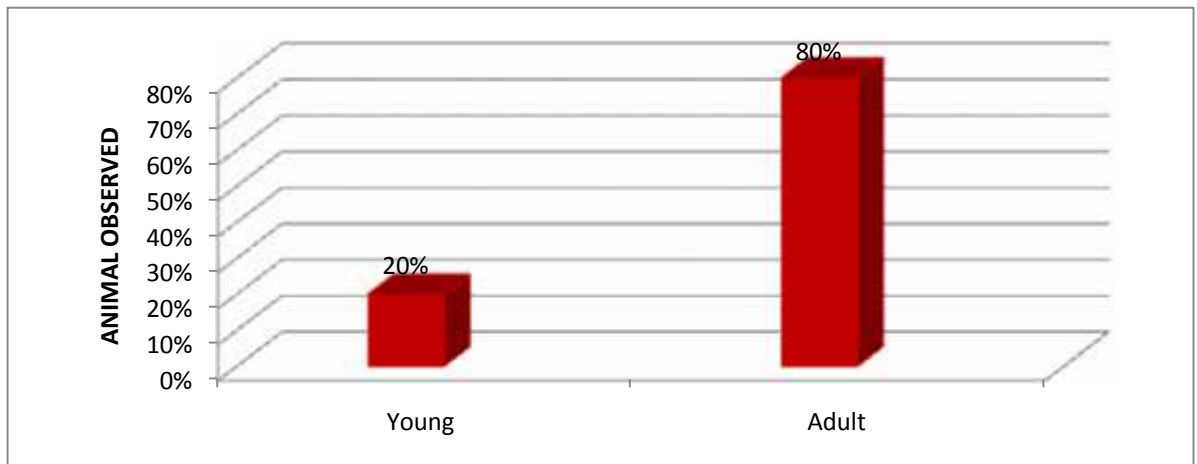
Out of 150 slaughtered animals observed, 60 (40.00%) were males and 90 (60.00%) were females.



**Fig. 5: SEX-WISE OBSERVATION OF SLAUGHTERED PIGS**

**Age- wise observation**

Adult pigs were found slaughtered more often the young ones. 120 (80.00%) observed animals were adult compare to 30 (20.00%) young ones.



**Fig. 6: AGE-WISE OBSERVATIONS OF SLAUGHTERED PIGS**

Sex and age of the slaughtered pigs were determined through questionnaire as well as through the observation.

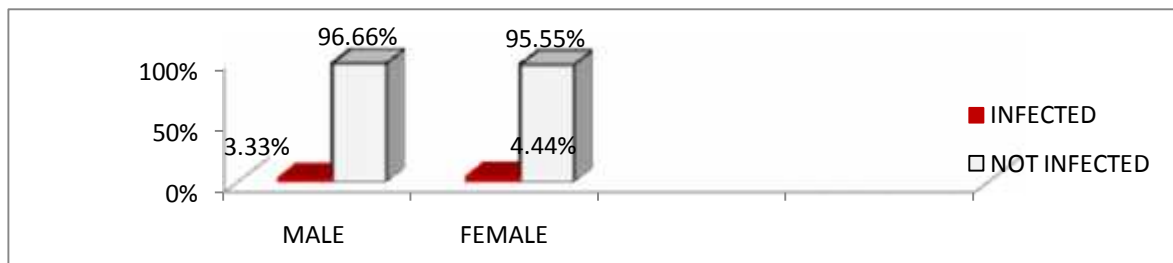
## Prevalence of *Cysticercus cellulosae* (Taenia Cysts)

### General prevalence

Out of 150 slaughtered pigs observed, 6 positive cases (3.33%) of cysticercosis were observed.

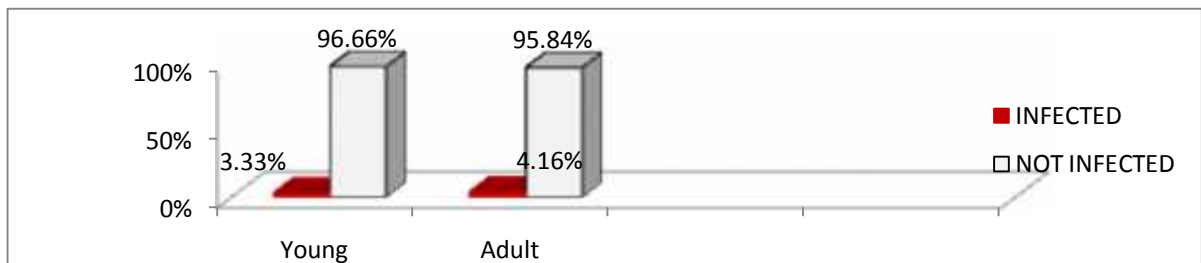
### Sex-wise prevalence

The prevalence of cysticercosis was found slightly higher in females (4.44%) compare to males (3.33%). However, the chi-square test indicated that the season-wise prevalence of cysticercosis was not significant ( $\chi^2_{0.05, 1d.f.} = 0.080$ ).



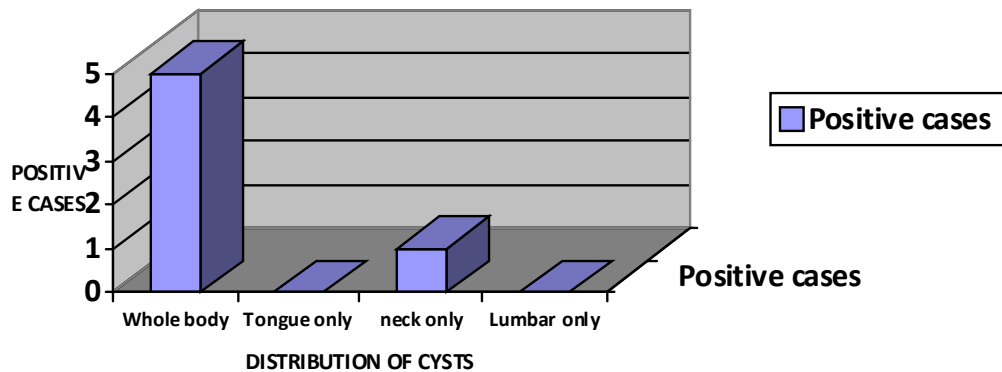
### Age- wise prevalence

Adults (4.16%) were found infected more often than the young ones (3.33%). the chi-square test however indicated that the difference in the age-wise prevalence of cysticercosis was not significant ( $\chi^2_{0.05, 1d.f.} = 0.043$ ).



### Organ-wise prevalence

Out of 6 infected animals observed during the survey, 5 (83.33%) of them had cysts distributed throughout the whole body. 1 (16.66%) animal had cysts of the *Taenia* only in the neck region.



### Public Health Problem

#### *Taenia* cases in Teaching Hospital

During the survey, the positive cases of *Taenia* in individuals as found out by the serological test was also considered and included. The hospital data of 6 years were included.

#### Sex-wise prevalence of Cysticercosis in human

The sex – wise prevalence of cysticercosis study showed the following results. The maximum cases were reported in males (24.10%) in the year 2062 and in female it was recorded maximum (17.7%) in 2063. The highest overall prevalence of cysticercosis was found in the year 2062 with overall 20.19% prevalence. In average prevalence percentage in males was 15.01% and that in females was 12%. In the case of males there is alternaterise and fall in the prevalencepercent while in case of female there is rise in prevalence percentage upto year 2062 and then again there is fall as shown in the table.

**Table: Sex-wise prevalence of Cysticercosis in human**

year	Suspected individuals			Positive cases			Prevalence (%)		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total
2060	81	53	134	11	3	14	13.58	5.66	10.44
2061	72	32	104	5	3	8	6.94	9.37	7.69
2062	62	42	104	15	6	21	24.1	14.2	20.19
2063	67	45	112	10	8	18	14.9	17.7	16.07
2064	62	45	107	9	7	16	14.5	15.5	14.95
2065	89	58	147	15	6	21	16.85	10.34	14.28
<b>Total</b>	<b>433</b>	<b>275</b>	<b>708</b>	<b>65</b>	<b>33</b>	<b>98</b>	<b>15.01</b>	<b>12.00</b>	<b>13.84</b>

**Age-wise prevalence of Cysticercosis in human**

The highest prevalence was seen in the the age group 16 – 30 with the prevalence percentage of 39.55%, 34.61%, 44.23%, 33.03%, 42.99% and 42.17% respectively in the year from 2060 – 2065. The highest prevalence was observed in the year 2062 with 44.23%. Likewise the prevalence was found almost nil in the age – group 76-90 with highest 0.96% in the year 2061 and 2062 respectively and lowest 0.89% in 2063. therefore the study showed fluctuation in the prevalence with sudden increase and decrease in their no. and prevalence percentage. Overall highest prevalence was shown by the age group 16-30(39.54%).



Year	Total	Age group (Prevalence %)					
		0-15	16-30	31-45	46-60	61-75	76-90
2060	134	42(31.34%)	53(39.55%)	26(19.40%)	10(7.40%)	3(2.23%)	0(0.00%)
2061	104	33(31.73%)	36(34.61%)	17(16.34%)	15(14.42%)	2(1.92%)	1(0.96%)
2062	104	26(25.00%)	46(44.23%)	21(20.19%)	8(7.69%)	2(1.92%)	1(0.96%)
2063	112	29(25.80%)	37(33.03%)	26(23.21%)	12(10.71%)	7(6.25%)	1(0.89%)
2064	107	27(25.23%)	46(42.99%)	23(21.49%)	10(9.34%)	1(0.93%)	0(0.00%)
2065	147	33(22.44%)	62(42.17%)	22(14.96%)	19(12.92%)	7(4.76%)	4(0.95%)
<b>total</b>	708	190(26.83%)	280(39.54%)	135(19.06%)	74(10.45%)	22(3.10%)	7(0.06%)

**Table: Age-wise prevalence of Cysticercosis in human**

## V

### DISCUSSION AND CONCLUSION

*Taenia solium* is an important zoonosis in many pork-eating countries and is usually associated with low social and economic development. The prevalence of *T. solium* infection varies greatly according to the regional level of sanitation, pig husbandry practices and eating habits (Dorny *et al.*, 2003).

The clinical effect of cysticercosis on infected animals is generally not significant, however, in addition to the effect on human health, economic losses may be high due to the condemnation of heavily infected carcasses and the necessity to freeze or boil infected meat. Losses may also occur from restriction of exports (Grindle, 1978).

Pork was previously consumed only by people belonging to low castes, however, in recent years; the consumption of pork has increased in higher castes as the caste system has become more relaxed. The pig population in Nepal, especially in smallholder communities taking advantage of the increased demand for pork, has increased dramatically in recent years, from 3, 80,000 in 1981 to 9, 12,530 in 2001. This is equivalent to a 140% increase in the pig population during the past 20 years compared with increases of 1, 45, 38, and 15% of cattle, buffaloes, goats and sheep during the same time period, respectively (FAO, 2002).

As the demand of pork is ever-increasing, the importance and significance of taeniasis and cysticercosis can't be ignored.

During the questioning of butchers and meat sellers two important things came to notice. First one was the lack of meat inspection of any authorities and the second was the lack of knowledge about taeniasis or cysticercosis among the butchers and meat sellers. It was known from their admittance that they had seen the rice grain like structure in the pork, which actually was the cysts of *Taenia* and which however was being sold as well.

The study found 3.33% i.e. 6 out of 150; pigs were found positive for the cysticercosis. The prevalence of cysticercosis in pigs in Nepal has been studied by

Poudyal (1998), Joshi (2003), etc. they have found 13.6% (34/250) and 14% (34/250) prevalence of cysticercosis in pigs in Kathmandu and Dharan respectively.

Females (4.44%) were found infected with the cysticercosis more often than the males (3.33%). Similar findings were observed by Sharma (2003) in Ludhiana city of Punjab state, India on post mortem examination of 236 pigs. He found the Prevalence rate of *C. cellulosae* to be 8.82 percent in males and 4.48 percent in females. Poudyal (1998) found 8.77% males and 24.05% female pigs infected with *C. cellulosae* in various localities on Kathmandu Metropolitan City and Dharan municipality.

The study also found that the prevalence of cysticercosis was found slightly higher in adult pigs (4.16%) compared to the young ones (3.33%). This is just as opposite found by Sharma (2003), in Ludhiana city of Punjab state, India. He, on post mortem examination of 236 pigs found that pigs under one year of age was more infected (6.48%) than those aged more than one year (6.25%).

Higher prevalence in old animals might be due to loss in resistance associated with old age and also might be due to carrying residual infection from previous years. Swarup and Pachauri (1987) in India suggested that the higher prevalence in older female animals is due to relaxation of resistance at parturition or during lactation.

When cysts have been found out, they were at most time found distributed throughout the whole body of the animal. In fact out of 6 infected animals observed during the survey, 5 (83.33%) of them had cysts distributed throughout the whole body and only 1 (16.66%) animal had cysts in the neck region.

From the hospital datas the prevalence percent of males was found more in comparison to the females. The out come of the field study showed the higher prevalence percent in females *Sus* spp. rather than in males *Sus* spp. the higher prevalence in females of *Sus* spp. might be due to relaxation of resistance at parturition or during lactation.

In the present study, the hospital datas showed highest prevalence in the year 2062 with 24.1% in males and 17.7% in 2063 in females. As a whole the prevalence rate was more

in males in comparison to females. The highest prevalence in males might be due to their habit of eating outside i.e. in unhygienic places.

The hospital data on the age- group basis showed the highest prevalence in the age group 16-30 and lowest was among the people of age –group 76-90. The reason behind highest prevalence in 16-30 years age-group might be due to the higher metabolic rate in these age-group as well as due to their highly active earning age. Similar findings were observed by Poudyal (1998) that younger age group, below 30 years age group was considered a vulnerable age group for being infected with *Taenia*.

## **VII**

### **RECOMMENDATION**

From the outcome of the study of my result, following recommendations have been made.

1. To prevent uncontrolled slaughtering of pigs, required number of slaughter house should be established at required places.
2. The butchers and meat sellers should be trained and should be made aware about the taeniasis and cysticercosis.
3. Information regarding meat borne diseases and zoonotic diseases should be introduced at very early in the school.
4. Inspection of meat (pork) should be carried out at regular basis.

## REFERENCE

- Aluja, A.S.D., Villalobos, A.N.M., Plancarte, A., Rodarte, L.F., Hernandez, M. and Sciutto, E. (1996). Experimental *Taenia solium* cysticercosis in pigs: characteristics of the infection and antibody response. *Veterinary Parasitology*, **61**(1-2), January: 49-59.
- Amatya, B.M. and Kimula, Y. (1998). Cysticercosis in Nepal: A Histopathologic Study of Sixty-two Cases. *The American Journal of Surgical Pathology*, **23**(10) October: 1276.
- Avapal, R.S., Sharma, J.K. and Juyal, P.D. (2003). Occurrence of *Cysticercus cellulosae* in pigs in and around Ludhiana city. *Journal of Veterinary Parasitology*, **17**: 69-70.
- Barton, B.C., Mayberry, L.F., Bristol, J.R., Cardenas, V.M., Mena, K.D., Martinez-Ocana, J., Flisser A. and Snowden, K.F. (2008). Population-based survey of taeniasis along the United States-Mexico border. *Annals of Tropical Medicine and Parasitology*, **102**(4) June: 325-33.
- Chummy, S., Sikasunge., Isaac, K.P., Andrew, M.P., Seter, S., Pierre, D. *et al.* (2007). Prevalence of *Taenia solium* porcine cysticercosis in the Eastern, Southern and Western provinces of Zambia. Available online 30 April 2007.  
<http://www.sciencedirect.com/science> .
- D'Souza, P.E. (1998). Studies on porcine cysticercosis with special reference to serodiagnosis. *Journal of Veterinary Parasitology*, **12**: 64.
- DeGiorgio, C., Pietsch-Escueta, S., Tsang, V., Corral-Leyva, G., Ng, L., Medina, M.T. *et al.* (2005). Sero-prevalence of *Taenia solium* cysticercosis and *T. solium* taeniasis in California, USA. *Actaneurologica Scandinavica*, **111**(2):84-88
- Garcia, H.H., Araoz, R., Gilman ,R.H., Valdez, J., Armando, E.G., Cesar, G., Bravo, M.L., Tsang, V.C.W. and Cysticercosis working group in Peru (1998). "Increased prevalence of cysticercosis and taeniasis among professional fried pork vendors and the general population of a village in the Peruvian highlands ". *American society of Tropical medicine and hygiene*, **59**(6) Dec: 902-905.
- Garcia, H.H., Gilman, R.H., Gonzalez Pacheco, R., Verastegni, M. and Tsang, V.C.W. (1999). "Human and Porcine *Taenia solium* infection in a village in the highlands of Cusco. Peru". *Acta Tropica*, **73**(1) May 25:31-36.

Gwan-Puchades, M.T. and Fuentes, M.V. (2000). "The Asian *Taenia* and Possibility of Cysticercosis." *Korean Journal of Parasitology*, **38**(1) March: 1-7.

Haridy, F.M., Ibrahim, B.B., Morry, T.A. and Ramadan, N.H. (1999). Human taeniasis and cysticercosis in slaughtered cattle, buffaloes and pigs in Egypt. *Journal of Egyptian Society of Parasitology*, **29**(2) Aug: 375-394.

HMG Nepal (1997). Nepal gazettes part III.

HMG Nepal (2001). Population Census 2001 of Nepal.

<http://pathmivro.med.sc.edu/book/parasitology/cestodes>

<http://www.doctorndtv.com/Taeniasis>

<http://www.dpd.cdc.gov/DPDX/Taeniasis>

<http://www.health.vic.gov.au/taeniasis>

<http://www.who.int/zoonoses/diseases/taeniasis>

Jolanta, K. and Jolanta, R. (2006). Prevalence of cysticercosis in cattle and pigs in the Lublin province in the years 1993–2004. *Annales Universitatis Mariae Curiae-Skolodowska*, Lublin- Polinia, **61**(17).

Joshi, D.D. (1973). Veterinary Public Health Hazard in Nepal.

Joshi, D.D. (1991). Current Practices of Livestock Slaughtering and Meat Marketing in Kathmandu, lalitpur and Bhaktapur. National Zoonoses and food Hygiene Research Center Chagal, Kathmandu.

Joshi, D.D. (1999). Animal slaughtering and meat marketing practices in Nepal. Kathmandu. National Zoonoses and Food Hygiene Research Center.

Joshi, D.D. and Maharjan, M. (2004). Taeniasis and cysticercosis Situation in Nepal. In: Akira, H.W. and Hiroshi, Y. (Eds). *Taeniasis, Cysticercosis and Echinococcosis in Asia*. The Federation of Asian Parasitologists, 141-153.

Joshi, D.D., Maharjan, M., Johansen, M.V., Willingham, A.L. and Sharma, M. (2003). "Improving Meat in Inspection and Control in Resource – Poor Communities: The Nepal Example." *Acta Tropica*, **87**(1): 119-127.

Joshi, D.D., Maharjan, M., Johansen, M.V., Willingham, A.L., Gaihre, Y. and Sharma, M. (2003). Taeniasis/cysticercosis situation in Nepal. *Southeast Asian journal of tropical medicine and public health*, **35**: 252-258.

Karki, D. (2003). An Epidemiological Survey on Intestinal Helminthes among Magar Communities in Barangdi VDC, Palpa with special reference to *Taenia* spp. M.Sc. dissertation (2003).

Krecek, R.C., Michael, L.M., Schantz, P.M., Ntanjana, L., Smith, M.F., Dorny, P. *et al.* (2007). Prevalence of *Taenia solium* cysticercosis in swine from a community-based study in 21 villages of the Eastern Cape Province, South Africa. *Veterinary Parasitology*, **154**(1-2):38-47.

Lescano, A.G., Hector, H. Garcia, H.H., Gilman, R.H., Guezala, M.C., Tsang, V.C.W *et al.* (2007). Swine Cysticercosis Hotspots Surrounding *Taenia Solium* Tapeworm Carriers. *American Journal of Tropical Medicine and Hygiene*, **76**(2): 376-383.

Lloyd, S. (1998). Cysticercosis and Taeniosis: *Taenia saginata*, *Taenia solium*, and *Asian Taenia*, In: Palmer, S.R., Soulsby, L. and Simpson, D.I.H. eds. *Zoonoses-biology, clinical practice, and public health control*. Oxford: Oxford University Press, 635-649.

Maharjan, D. (1999). Morphology of Kirtipur Municipality. A dissertation of M.Sc presented to Central Department of Geography, T.U.

Maharjan, M. (2002). An epidemiological study of porcine cysticercosis among Magar communities of Syangja district, Nepal. Final report submitted to IFS. National Zoonoses and Food Hygiene Research Center.

Moro, P.L., Lopera, L., Bonifacio, N., Gilman, R.H., Silva, B., Verastegui, M. *et al.* (2003). *Taenia solium* infection in a rural community in the Peruvian Andes. *Annals of Tropical Medicine and Parasitology*, **97**(4), June: 373-379.

Newell, E., Vyungimana, F., Geerts, S., Van Kerckhoven, I., Tsang, V. C. W. and Engels, D. (1997). Prevalence of cysticercosis in epileptics and members of their families in Burundi. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **91**(4):389-391.



- Poudyal, P. M., Joshi, D.D., Jimba, M., Mishra ,P.N., Neave, L.A. and Maharjan, M. (2001). Epidemiological status of *Taenia/cysticercosis* in pigs and humans in Nepal. *Journal of institute of Medicine*, **23**:1-12.
- Poudyal, P.M. (1998). Prevalence of *Taenia solium* in pigs and its Public Health Importance in Kathmandu Metropolitan City and Dharan Municipality, Sunsari District of Nepal. A dissertation of M.Sc presented to Central Department of Zoology, T.U.
- Prasad, K.N., Chawla, S., Jain, D., Pandey, C.M., Pal, L., Pradhan, S. and Gupta, R.K. (2003). Human and porcine *Taenia solium* infection in rural north India. *Trans R Soc Trop Med Hyg*, **96**(5):515-521.
- Prasad, K.N., Chawla, S., Prasad, A., Tripathi, M., Husain, N. and Gupta, R.K. (2006). Clinical signs for identification of neurocysticercosis in swine naturally infected with *Taenia solium*. *Parasitology International*, **55**(2) June: 151-154.
- Prasad, K.N., Prasad, A., Gupta, R.K., Pandey, C.M. and Singh, U. (2008). Prevalence and associated risk factors of *Taenia solium* taeniasis in a rural pig farming community of northern India. Journal article. Pub Med ID: 18440704.
- Rajshekhar, V., Joshi, D.D., Doanh,. N.Q., Van, D.N. and Ziaonong, Z. (2003). *Taenia solium* Taeniasis/ Cysticercosis in Asia: Epidemiology, Impact and Issue. *Acta Trop.* **87**(1) June: 53-60.
- Rodriguez-Hidalgo, R., Benitez-Ortiz, W., Dorny, P., Geerts, S., Geysen, D, Ron-Roman, J., *et al.* (2003). Taeniasis-cysticercosis in man and animals in the Sierra of Northern Ecuador. *Veterinary Parasitology*, **118**(1-2) Dec: 51-60.
- Saini, P.K., Donald, W. and Patrick, C. (1997). Food safely and regulatory aspects of cattle and swine cysticercosis. *Journal of Food Protection*, **60**(4): 447-453.
- Sanchez, A.L., Gomez, O., Allebeck, P., Cosenza, H. and Ljungstrom, I. (1999). "Epidemiological study of *T. solium* infection in rural village in Honduras". *Annals of Tropical Medicine and Parasitology*, **91**(2):163-171.
- Santamaria, E., Plancarte, A. and Aluja, A.S. (2002). The experimental infection of pigs with different numbers of *Taenia solium* eggs: Immune response and efficiency of establishment. *Journal of Parasitology*, **88**(1):69-73.

Sarma, M.D., Deka, D.K. and Borkakoty, M.R. (2000). Occurrence of hydatidosis and porcine cysticercosis in Guwahati city. *Journal of Veterinary Parasitology*, **14**: 173-74.

Sciuto, E., Fragoso, G., Fleury, A., Laclette, J.P., Sorelo, J., Aluja A., Vargas, L. and Larralde, C. (2002). *Taenia solium* diseases in human and pigs: An ancient parasitosis disease rooted in developing countries and emerging as a major health problem of global dimensions. *Microbes and infection*, **2**(15):1875-1890.

Sharma, M. (2006). Socio-Demographic Factors of Pig Farmers Associated in Transmission of Taeniosis/Cysticercosis. *Journal of Institute of Medicine*, **28**(1).

Sharma, R. (2003). Prevalence and immunodiagnosis of *Cysticercus cellulosae* in swine and its public health significance. M.V.Sc. Thesis, Punjab Agricultural University, Ludhiana, India.

Suroso, T., Margono, S.S., Wandra, T. and Ito, A. (2006). Challenges for control of taeniasis/cysticercosis in Indonesia. *Parasitol Int*, **55** Dec: 161-165.

Sutisna, I.P., Fraser, A., Kapti, I.N., Rodriguez-Canul, R., Widjana, D.P., Craig, P.S. and Allan, J.C. (1999). Community prevalence study of taeniasis and cysticercosis in Bali, Indonesia. *Tropical Medicine and International Health*, **4**(4) April: 288-294.

Thapa, R. (2000). Prevalence of intestinal helminth parasites in general, *Taenia* species in detail particularly in Bote and Darai communities in Vyash municipality Tanahun District, Nepal M.Sc. Thesis, Central Department of Zoology, Tribhuvan University, Kathmandu.

Wandra, T., Sutisna, P., Dharmawan, N.S., Margono, S.S., Sudewi, R., Suroso, T., Craig, P.S. and Ito, A. (2006). High prevalence of *Taenia saginata* taeniasis and status of *Taenia solium* cysticercosis in Bali, Indonesia, 2002-2004. *Trans R Soc Trop Med Hyg*, **100**(4) Apr: 346-53.

[www.wikipedia.org/wiki/pork\\_tapeworm](http://www.wikipedia.org/wiki/pork_tapeworm)

## Questionnaires

### Questionnaire for butchers for taeniasis/cysticercosis survey

1. Name:
2. Address:
3. How many pigs are slaughtered per day?
4. How do you slaughter the animal?  
a/stunning    b/electric shock    c/priking with pointed metal rod  
d/other
5. Do u have a slaughter house?  
a/ yes            b/ no
6. How do you dispose your waste?  
a/river site    b/ drainage system    c/ street site    d/ garbage
7. Do you have any idea about meat borne diseases?  
a/ yes            b/ no
8. Have you seen *Taenia* cyst in meat?  
a/ yes            b/ no
9. If *Taenia* cysts are found, what do you do?  
a/ sell it            b/ throw into garbage
- 10: Does any body come for meat inspection?  
a/ yes            b/ no
- 11: In which part is cyst mostly found?  
a/ neck            b/ tongue    c/ lumbar region            d/whole body
12. Where do you bring the water from?  
a/well            b/tap            c/river            d/other

### Questionnaire for meatseller

1. Name:
2. Address
3. Do you have facilities for meat marketing shop?  
a/ yes            b/ no

4. Do you slaughter animals yourself for marketing?  
a/ yes            b/ no
5. How do you transport the meat?  
a/on foot    b/cycle            c/ vehicle
6. Do you have idea about meat borne diseases?  
a/ yes            b/ no
7. Have you seen cyst in meat?  
a/ yes            b/ no
8. Do you sell meat with cyst?  
a/ yes            b/ no

#### **Questionnaire for consumer**

- 1.Name:
- 2.Address:
- 3.Which meat do your family consume?  
a/ buffalo    b/ goat            c/ pig            d/ hen
- 4.Do you have idea about meat borne diseases?  
a/ yes            b/ no
- 5.Have you seen any cysts on the meat?  
a/yes            b/no