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Ascaris, ascariasis and its present scenario in Nepal

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ABSTRACT

Ascaris **(also known as roundworm) is a common human intestinal parasite (Nematoda) known to be existed since 1500 BC. There are two species of *Ascaris* - *A. lumbricoides* (in human) and A. *suum* (in swine), but, cross-infections reportedly occur. It is a large worm (with separate sex) and is prevalent mainly in developing countries with tropical and sub-tropical climate implicating as one of the major causes of morbidity and mortality. The prevalence of ascariasis approaches one hundred percent in certain areas in developing countries. In Nepal, *Ascaris* has remained as a leading human parasite (known as "*juka* " locally). In some rural areas, over seventy-five percent people are infected with this parasite. A hospital-based study carried out in the capital city of Kathmandu over a period of one decade has shown a static annual prevalence with a mean of approximately thirty-five percent. Investigators have shown a significant impact of ascariasis on various nutritional parameters among Nepalese. *A. lumbricoides*, therefore, appears to constitute one of the major causes of public health problem in Nepal though the extent of ascariasis-associated morbidity and mortality has not been investigated yet.**

Keywords: Ascaris; ascariasis; health problem; Nepal.

INTRODUCTION

Ascaris lumbricoides, also called roundworm, has been known to human since 1500 BC as described in Egyptian medical papyri usually referred as the "*Papyrus Ebers*", the works of Hippocrates (460-375 BC), the Chinese writings of the 2nd and 3rd century BC and subsequently in the text of other Greek and Roman physicians (namely, Celsus, 25 BC - AD 50; Gallen, AD 129-200; Aegineta, 625-690), and Arabic physicians such as Avicenna (981-1037).[8] *Ascaris* eggs

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have been detected in the human remains from 800 BC. The detail anatomy of the worm was described by Tyson (1683) and Redi (1684). The name *Ascaris lumbricoides* was given by Linnaeus (1758). The mode of infection, however, became clear only in the 19th century from the work of Grassi (1881). The whole life-cycle, however, was worked out only in the first quarter of this century by Koino (1922). And, *A. lumbricoides* for many centuries has been the most common parasite of man all over the world.

A. lumbricoides has separate sex. Female worms are relatively larger and longer (20-40 cm) than male worms (15-30 cm) and live in the small intestine of man. The worm has a life span of approximately one year. The worm does not require any intermediate host to complete its life-cycle. A mature female worm can lay up to two-hundred thousands eggs per day which are released in the faeces of infected individuals. Eggs are of two types - fertilized (c: 70x50 µm) and unfertilized (c: 90x50 µm) and have a typical golden-brown colour. Fertilized eggshell has a inner lipid (ascaroside) layer responsible for selective permeability, a chitin-protein layer for structural strength and an outer vitelline layer. Embryonation of fertilized eggs in the environment takes place in about twelve days at 31^{o}C and can survive for up to fifteen years.[10] First moulting of larva takes place inside the eggshell in the environment. Infection in human occurs by ingestion of embryonated eggs. The larva (c: 250 µm in length), escaped in the duodenum or upper jejunum, however, do not grow into adult worm directly, instead, penetrate the intestinal wall, enter the liver and then the lungs. Inside the lungs, the larva (c: 500 µm in length) moults twice and travels through trachea to the larynx and swallowed once again. Upon arriving into the small intestine the second time, the larva undergoes the fourth moulting and then grows into the adult worm. This process is completed in about 60-70 days. *A. lumbricoides* differs from *A. suum* in the type of denticles present in three well-developed lips.

HUMAN INFECTION

Infection with *A. lumbricoides* usually occurs through ingestion of embryonated eggs, through contaminated foods, drinks and vegetables particularly the salads. In highly endemic area, an air-borne infection is also possible. Flies also play an important role in the spread of infection. Further, migrating larva can also pass through the placenta occasionally resulting into a congenital ascariasis.[12,31] Human beings can also be infected with swine *Ascaris - A. suum.* Genetic analysis of *Ascaris* population recovered from both human and pigs, have shown an evidence of cross-infection.[1] The pigs in North America have been incriminated as the source of human ascariasis.

The migrating larva in the lungs cause pneumonitis (also known as *Ascaris* pneumonia or Loffler's syndrome). A small number of adult worms in the intestine usually cause no symptoms. A moderate and large number of worms, however, cause various kinds of symptoms (such as nausea,

vomiting, diarrhoea, fever, urticaria) including intestinal obstruction. In general, worm population of 50 to 500 is found to be associated with severe complications.[10] However, as many as 1,842 worm have also been recovered from a young obstructed woman in Western Africa.[7] The wandering worm sometimes invade the liver, pancreas, appendix, pulmonary artery, trachea and bronchioles, maxillary sinus, bulbar conjunctiva, auditory canal and urinary tract causing related distressful ectopic symptoms. Interestingly, very small babies (less than two months old) obstructed with *Ascaris* adult worms have also been reported.[12,31] In a series of studies on patients admitted to hospital due to ascariasis, intestinal obstruction has been found to be the commonest complication accounting for 38-87% of all complications.[13] In a review of 2,234 cases of ascariasis with complications recorded during 1980-1985 in China, cholecystic ascariasis was found to be the most common (64.5%) followed by intussusception (21.5%) and pneumonitis (11.9%).[44] The surgical complications due to wandering *Ascaris*, however, remarkably decrease with the decrease of national *Ascaris* prevalence as has been observed in Korea.[3]

Protein-energy malnutrition is another important aspect of *A. lumbricoides* infections. The effect of malnutrition is more prominent in growing children. In one study, 72% of the children had stunted growth, 61% were underweight and 6% were wasted.[21] A significant increase in blood haemoglobin and serum protein level in Nepalese children (less than 15 years of age) infected with *Ascaris* and other soil-transmitted helminths (STH) after one month of deworming (with single dose of albendazole) has been observed previously.[30] A significant association between a low vitamin A status and the STH (mainly *Ascaris*) infection in children has also been observed.[31] *Ascaris*-associated vitamin A deficiency has been found to cause xerophthalmia[11,39] and thereby with vision loss as well as death.[18] Lai *et al* [22], however, found no contribution of *Ascaris* (and *Trichuris*) in the growth retardation among primary school children in Malaysia..

PREVALENCE AND ECONOMIC LOSS

Worldwide

A. lumbricoides is a cosmopolitan intestinal parasite with a high prevalence in developing countries in tropic and sub-tropic areas of Asia, Africa and Latin America and is more common in children. Presently, the prevalence of *Ascaris* infection in the world range from less than one percent[3,5,44] to over ninety percent[17,21,42] in developing countries. Most of the reports from elsewhere in the world have shown *A. lumbricoides* as the leading intestinal parasite. No change in the worldwide prevalence of *Ascaris* infection during a period of fourty years (29% in 1935-1945 and 28% in 1975-1985) has been observed.[34] At present, in spite of so much development achieved, approximately 250 million people have been estimated to be infected with *Ascaris* globally.[43] According to a recent estimate, *A. lumbricoides* infections are responsible for 120 million to 215 million

cases of morbidity[4] and 60,000 deaths annually.[43]

Many studies, carried out in developing countries with high endemicity, have revealed *A. lumbricoides* eggs as most important contaminant of soil and environment.[23,36,40,41] Peng *et al* [24] in China found a relatively stable soil-contamination rate with *Ascaris* eggs. In one study, the prevalence of soil-contamination with *Ascaris* eggs was found to range from 34.4% to 94.7% in some economically disadvantaged rural areas in China.[46] A survey of the soil of three areas in Bangladesh, has also shown one hundred percent contamination of households including court yard, near latrine, kitchen area, garbage area, garden area, water source area with a very high intensity near latrine area.[23] *Ascaris* eggs have also been found to be adhering to cooking and eating utensils, fruit, vegetables, furniture, door handles, money and fingers.[19] Geophagy has also been reported to increase the chances of re-infection with *Ascaris* significantly. In one study, Geissler *et al* [15] found re-infection with *Ascaris* twice as common significantly. In one study, Geissler *et al* [15] found re-infection with *Ascaris* twice as common among geophagous children than in non-geophagous children.

In Nepal

As shown by various reports, *A. lumbricoides* has remained as the most leading intestinal parasite in Nepal.[6,11,16,26,27-29,33,37] The reported prevalence rate ranged from less than 15.0% to over 75.0%.[26,27,33] *Ascaris* infection was more prevalent in rural areas. However, reports showing relatively low prevalence of ascariasis in rural areas were also available.[14,16] A hospital-based study with a mean number of 6,837 faecal samples per year conducted in the capital city of Kathmandu over a period of one decade, have revealed a static prevalence of ascariasis with an average of approximately 35% (Fig. 1).[29]

Fig. 1: Annual Rate of *Ascaris* Infection in Nepal

This static status was in agreement with the worldwide static prevalence of *Ascaris* infection reported by Rogers (29% during 1935-1945 and 28% during 1975-1985).[34] *A. lumbricoides* (known as "*Juka* " in Nepal) is the most known intestinal parasite among Nepalese because of its big size as well as abundance. However, occasional reports showing worms other than *A. lumbricoides* topping the list of intestinal parasites were also available.[14]

The study on parasite eggs contamination of soil in the Kathmandu Valley has revealed *Ascaris* eggs as the commonest contaminant during both wet and dry seasons (Rai *et al*, unpublished data). This was in agreement with the higher prevalence of *Ascaris* infection in urban school children in Kathmandu (23.6-47.0% compared with rural school children (15.8-30.7%) in eastern Nepal.[6] However, Shrestha[37] reported a very low contamination rate of soil from kitchen garden and around toilet with STH in a village (12 km away from Kathmandu city). This finding was in contrast to the high prevalence of STH infection

(56.8%) and to the indiscriminate open defecation habit of approximately half of the people (46.6%) living in the same village. The low prevalence of parasite eggs in the soil samples by Shrestha[37] could be due to the difference in the technique employed for the recovery of parasite eggs.

In spite of high prevalence of *Ascaris* infection in Nepal the exact degree of morbidity and mortality associated with ascariasis remains unknown. In one study, a significant increase in a blood haemoglobin and serum protein level among school children (infected with *Ascaris* and other soil-transmitted helminths) after one month of deworming (with a single dose of albendazole) has been reported.[30] Similar trend has also been seen in vitamin A status.[31] These, findings showed a possibility of a significant effect on the nutritional status of Nepalese particularly among children and thereby in the causation of various morbidities and mortality.

Economic loss

The cost of infection by intestinal worms (*Ascaris* and other STH) has been estimated. In late 1970s US $ 4.4 million was lost in Kenya annually by intestinal worm infected people in the form of nutrients wasted as unabsorbed food (*Ascaris* and other STH).[35] As many as 88,804 patients were admitted to hospitals as a result of ascariasis in Kenya in the year 1976 alone.[38]

ASCARIS PREVALENCE: INDICATOR OF DEVELOPMENT

Soil contamination rate with *Ascaris* eggs can be taken as an indicator of environmental hygiene[36] which is changed remarkably with the improvement of living standards of people. This has been seen in some of the Asian countries like in Japan[44], Korea[3], Taiwan[5] as well as in economically sound and big cities in China.[46] For example, in Korea, the *Ascaris* prevalence was over 80% during 1950s which showed a steady decrease - 54.9% in 1971 to 13.0% in 1981, 2.1% in 1986 and subsequently to 0.3% in 1992.[3] Earlier (during sixties and early seventies), similar trend was seen in Japan.[44] In contrast, the prevalence has remained static in poverty-stricken least developed countries. For example, in Nepal - one of the most impoverished countries in the world - annual prevalence of *Ascaris* infection has not been changed for over a period of ten subsequent years.[29] Recent investigation has also revealed a high soil contamination rate with *Ascaris* eggs in both the urban and sub-urban areas of the capital city of Kathmandu and two other neighbouring cities in the Kathmandu Valley (Rai *et al*, unpublished data) indicating the poor sanitary system and probably the impact of migration of infected rural population.[9]

Further, a significantly higher prevalence among children from larger families has also been reported.[20] Kan *et al* [20] found a strong association between the STH prevalence in children and the level of paternal education and occupational skills (lower the fathers' educational and occupational skills higher the prevalence of STH in children). The impact of economic development on *Ascaris* infection has remarkably been seen in China. In the rural areas with poor sanitary condition, the

prevalence of *Ascaris* in human population and soil-contamination with *Ascaris* eggs range from 49.5-70.2% and 34.4-94.7% respectively, while in big cities with economical development, the sanitary condition has been dramatically improved[46] resulting into low prevalence of STH. The prevalence of *Ascaris* infection among recipients of *Gramin* bank loan was lower (66.5%) compared with those of non-recipients of bank loan (72.2%) in Bangladesh and appeared to be associated with an increase in monthly income (monthly income increased almost by 50%).[25]

PREVENTION AND CONTROL

Poverty and its accompanying features such as lack of sanitation, malnutrition, illiteracy and overcrowding are all causes and consequences of *Ascaris* (and most of the parasites of public health importance) infection. Economic hardship in the rural areas in developing countries has stimulated migration of rural people (most of whom are illiterate and are also infected with one or multiple intestinal parasite species) to the fast-growing unplanned towns/cities (slums).[9] As a result, approximately 45% of the world population now live in cities, most of which are slums. Since the problem of *Ascaris* (as well as other STH) is multifacial, the prevention and control programme should be designed accordingly. The important factors to be considered include mass chemotherapy targeted at school children[2] and a comprehensive education of people particularly the school children about their personal hygiene and the environmental sanitation (for example, the construction and use of latrine). And, the fundamental changes in both the individual and community behaviours should then be supported by financial as well as human resources as has been successful in Japan after the World War II[44] as well as in Korea[3] and Taiwan[5] during recent past.

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