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Incidence of Tapeworm Infection in Human Population of Swat, Pakistan: An Occupation Based Study

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WK conceived, designed performed the study and wrote the manuscript. NN reviewed the manuscript and MAN analysed the data statistically.

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ABSTRACT

Diseases caused by tapeworms remain a public health problem in low and middle-income countries including Pakistan. The current study was aimed to assess the prevalence of *Taenia saginata* and *Hymenolepis nana* (tapeworms) infections among farmers, education concerned and shepherds of Swat, Pakistan. A total of 1041 stool samples were examined from January 2006 to December 2008 using direct smear and concentration methods. Two hundred and twenty one (21.2%) participants were found infected with one or more than one intestinal tapeworms. Seventy seven (7.39%) of the participants were infected with single parasite and one hundred forty four (13.8%) with multiple infections. *Taenia saginata* 32.6% (n=146/447), *Ascaris lumbricoides* 20.3% (n=91/447), *Hymenolepis nana* 19.7% (n=88/447), *Trichuris trichura* 14.3% (n=64/447), *Enterobius vermicularis* 6.48% (n=29/447), *Ancylostoma duodenale* 2.90% (n=13/447), *Entamoeba histolytica* 2.68% (n=12/447), and *Giardia lamblia/intestinalis* 0.89%(n=4/447) were detected in order of their prevalence. The individuals below 15 years of age were found marginally more parasitized than above 15 years (0.3856, P<0.05). Males were more infected than females with (0.3157, P<0.05). No significant association was found among the occupational groups and parasitic infection (0.3089, P<0.05). However, shepherds were found more infected than farmers and education concerned. Due to comparative based approach in different occupational groups the present study is of particular interest. Such studies should be continue time to time to know the hazardous of potentially important pathogenic parasitic infections particularly in remote parts of the country.

INTRODUCTION

Tapeworm infection has a global distribution and is endemic in Southeast Asia, including Pakistan. The epidemiology of Taeniasis in Asia suggests the existence of a form of human *Taenia* different from *T. saginata* and *T. solium* (Fan *et al*., 1995). The life cycle of this zoonotic cestode includes the pig and other cattle's as the normal intermediate host and humans as the definitive host. Humans also can be accidental intermediate hosts and develop the larval stages by accidental ingestion of the parasites.

Infection of the gallbladder with *T. saginata* causing cholecystitis has been reported, but *T. solium* associated pancreatic-biliary disease is rare (Ozbek *et al*., 1999). Neurocysticercosis (NC) is the most frequent parasitic disease of the Central Nervous System and the most frequent cause of epilepsy worldwide (Anonymous, 1994; Garcia *et al*., 1999; Del Brutto *et al*., 1998). It is endemic in many regions of the world, and certain part of the United States particularly the southwestern states of California and New Mexico. NC represents a major cause of morbidity among the immigrant Hispanic population. However, as the number of immigrants expanded, especially those from endemic areas, there has also been a progressive increase in the cases of NC in other parts of the country, in the past ten years (Chen and Mott, 1990). Infection with *T. saginata* is also increasingly diagnosed in industrialized countries because of immigration from endemic areas, with over 1,000 cases per year in the United States (White, 1997). Although taeniasis or cysticercosis has been included in one of the short listed

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diseases considered to be eradicable in the short term, no sustainable eradication has been achieved. Whereas endemic taeniasis and cysticercosis occurs in very different scenarios (highlands, tropics, arid coast, etc.), and at different intensities of prevalence (Schantz *et al*., 1993).

Hymenolepis nana has been described as a rare cause of diarrhoea in humans (Beaver *et al*., 1984). This species was first recognized in the small intestine of a boy in Cairo in 1851 by Bilharz. The two species of genus infecting man, namely *H. nana* and *H. diminuta,* cause diarrhea and abdominal pain only in hosts with heavy infection. *H. nana* is the commoner of the two but both species have a cosmopolitan distribution. It is directly transmitted from person to person. *H. nana* may cause epidemics in children. It has also been shown that, *H. nana* infection in mice is strongly influenced by immunosuppression, caused by T-cell deprivation or by induced steroid treatment, results in increased multiplication of abnormal cysticercoids in viscera (WHO, 1981).

In the hilly areas of Pakistan, the prevalence of infection with *T. saginata* has been reported to be 12.8%. Swat district in northwestern Pakistan has been known as a highly endemic area for taeniasis (Khan *et al*., 2015). It is also found that the overall tapeworm infection rate was as high as 7.1% in Lahore, hospital patients (Akhtar *et al*., 1993).

Reports from different parts of Pakistan shows differences in the prevalence rate of taeniasis and hymenolepiasis as: 0.2 and 2.1% (Farooqi, 1964), 0.5 and 1.6% (Haleem *et al*., 1965), 0 and 21.6% (Pal and Malik, 1979), 0 and 18% (Siddiqi and Bano, 1979), 0.2 and 2.32% (Bilqees *et al*., 1982), 0.7 and 1.5% , 0.3 and 3.3% (Baqai and Zuberi, 1986), 3.5 and 6.6% (Pal and Subhani, 1989), 1.7 and 7.0% (Ali, 1993), 7.1 and 17.2% (Akhtar *et al*., 1993), 0.8 and 4.9 % (Qureshi, 1995), 2.6 and 7.2% (Jamil, 1999), 0.53 and 21.55 (Shaikh *et al*., 2000), 0.83 and 20.9% (Shaikh *et al*., 2003), 1.0 and 1.7% (Chaudhry *et al*., 2004), 7.35 and 3.26% (Maqbool *et al*., 2007), 0.4 and 5.6%, 0.9 and 7.3% (Sajjad *et al*., 2009), 16.4 and 6.98% (Noor-un-Nisa *et al*., 2012), 12.8 and 10.1% (Khan *et al*., 2015), 25 and 0% (Khan *et al*., 2017a) and 8.98 and 9.36% (Khan *et al*., 2017b).

To date, most studies have focused more on intestinal parasitic infections among humans population of Pakistan. However, data on the prevalence of tapeworms infections are still lacking and this information remains scanty in Pakistan. Hence, this study was conducted to determine the prevalence of tapeworms' infection in farmers, education concerned and shepherd of Swat, Pakistan. The establishment of such data may shed some light on the topic for public health authorities as they can rectify the effectiveness of current control programs and for the planning of control strategies to reduce the prevalence of tapeworms' infection in humans.

MATERIALS AND METHODS

Study area and population

The study was conducted in Swat region from January 2006 to December 2008. Swat is located in Northwestern parts of Pakistan (34°34° to 35° 55° North and 72° 08° to 72° 50° East), characterized by a temperate climate with pleasant summers (average high temperature 33°C) and cool winters (average low temperature -2°C). The highest mountains altitude (18000 m above mean sea level: mountainous range and 6000 m plain areas) with an annual recorded rain-fall 242 mm. No gastro-intestinal complaint was reported during the collection.

Socioeconomic status of the inhabitants

Swat valley is famous for a wide diversity of fauna and flora. The residential settings are built of bricks and blocks in lower parts and with mud and wood in upper parts of the district. The population has low socio-economic status. People use untreated or surface tap-water for drinking purposes. Health practices are also very low, in rural areas people use open fields for defecation. During rainy seasons the surface of water runoff and waste water from the agricultural field's ingress in to channels, which is the major source of drinking water. The use of such contaminated water are the main sources of gastrointestinal parasitic infections in the people of Swat and adjoining areas.

Data collection

Faecal samples were collected from the hospitals, schools and basic health units (BHUs) of the study area. Specimens were collected in sterile plastic containers and carefully labeled. The occupational groups' farmers, education concerned and shepherds were included. The collected samples were brought to Medical Zoology Laboratory, Vertebrate pest control institute (VPCI), Southern Agricultural Research Centre (SARC), Karachi, Pakistan Agricultural research Council (PARC), for microscopic examination.

Stool examination

The faecal specimens were examined 1st by naked eyes for the detection of adult or any segmental stage of parasite. The specimens were then subjected for examination under the microscope, through normal saline and Lugol's iodine solutions (Wet Mount Techniques).

The formol-ether concentration was also applied for the confirmation of negative cases to be positive. About 3g of faeces was emulsified in 3 drops of normal saline (0.9%) or Lugol's iodine solution. One drop of the suspension was placed on the center of the slide via wooden applicator and a cover-slip was placed. The slide was examined under the microscope first under low 10× and then high 40× power objectives. Saline direct smear was also used for the detection of tapeworm eggs. After completion of direct stool examination, one gram of each sample was emulsified in 10% formalin solution and formol– ether concentration technique was performed as described elsewhere in order to increase the chance of detecting parasites (WHO, 1991).

Statistical analysis

The overall prevalence of infections was calculated from the total number of individual infected divided by the total examined. The prevalence of each parasite reported was calculated by the number of parasitic infection divided by the total number of parasitic infections. Collected data were analyzed using the graph pad version 5, the statistical software. Statistical association of the parasitic infection prevalence with occupation, gender and ages was analyzed. A statistically significant association between variables is considered to exist if $P < 0.05$.

Table I.- Prevalence of intestinal tapeworms' parasitic infections according to the occupational groups, genders and ages.

Factor	No. examined	No. infected	Prevalence
Occupational groups			
Farmers	365	78	21.3
Education community	420	79	18.0
Shepherds	256	64	25
Genders			
Male	651	142	21.8
Female	390	79	20.2
Ages			
<15 years	466	106	22.7
>15 years	575	115	20.0

RESULTS

In total, 1041 patients participated in this study. Among them 40.3% were education related, 35 % were farmers and 24.5% were shepherds. Regarding the gender, 62.5% were males and 37.5% were females (Table I). The overall prevalence of intestinal parasitic infection among these individuals was determined to be 21.2%. It was 21.3%, 18.0 and 25% among farmers, educated community, and shepherd, respectively (Table I). The prevalence of infection with intestinal parasites was not significantly different among these three groups ($P = 0.3089$). However, males were found to have a higher percentage of infection (21.8%) compared to the female group (20.2%). The association between the gender and parasitic infection was statistically non-significant ($P = 0.3157$). Regarding ages below 15 years were slightly more infected (22.7%) than above 15 years of age (20.0%). The association between the ages and parasitic infection was also statistically non-significant ($P = 0.3856$).

Out of the 1041 individuals examined, 21.2% were found infected with single or multiple infections either with tapeworms or mixed with helminths and protozoans. Of the infected individuals 7.39% were found to be infected with single species of intestinal tapeworms either *T. saginata* or *H. nana* and the other 13.8% had mixed infection both with helminths and protozoans (Table II).

Regarding the number of parasites species detected in each sample, 7.39% were infected with a single parasite species with a single tapeworms (n = 77/1041), two parasite species 7.49% (n = 78/1041); three parasite species 4.80% (n=50/1041) and four parasite species 1.53% (n= 16/1041) were detected (Table I). *T. saginata* was frequently associated with other helminth and protozoan parasites in 14.6% (n=152/1041) while *H .nana* was reported mixed with helminths in 6.62% of the participants (Tables I and II). Regarding prevalence of intestinal tapeworm infection, *T. saginata* (32.6%) was the most predominant protozoa identified from stool of the studied participants followed by *H. nana* (19.7%). Among nematodes: the roundworms *A. lumbricoides* 20.3.0%, whipworms *T. trichura* 14.3%, pin worm *E. vermicularis* 6.48%, hookworms *A. duodenale* 2.90% and in protozoans *E. histolytica/dispar* 2.68% and *G. lamblia/intestinalis* 0.89% were detected in order of their prevalence (Table III).

DISCUSSION

In Pakistan, the prevalence of *T. saginata* ranges from 0.2% (Bilqees *et al*., 1982) to 12.8% (Khan *et al*., 2015), similarly, the prevalence of *H. nana* ranges from 1.1% (Farooqi, 1964) to 21.5% (Shaikh *et al*., 2000). These two cestodes remain the most common intestinal parasitic pathogens in the studied population. The transmission of these tapeworms occurs by ingestion of raw and semi-cooked beef and accidental ingestion of the intermediate hosts and development of the larval stages.

Table II.- Proportion of mono-parasitism and poly parasitism of intestinal tapeworms parasitic infections in different occupational groups of Swat, Pakistan.

Type of infection	No. of species	Species associated	Cases %
Mono-parasitism	1 species (n=77)	*Taenia saginata*	57
		Hymenolepis nana	20
Total mono-parasitism			77 (7.39)
Poly-parasitism	2 species (n=78)	*A.lumbricoides+T.saginata*	28
		T.trichura + T.saginata	7
		A.duodenale+T.saginata	5
		A.duodenale+H.nana	3
		T.saginata+H.nana	4
		A.lumbricoides+H.nana	7
		T.trichura+H.nana	16
		E.vermicularis+T.saginata	2
		E.vermicularis+H.nana	6
Total poly-parasitism			78(7.49)
	3 species (n=50)	*A.lumbricoides+T.trichura+T.saginata*	13
		E.vermicularis +H.nana+E.histolytica	3
		A.lumbricoides+E.vermicularis+H.nana	8
		A.lumbricoides+E.vermicularis+T.saginata	4
		T.trichura+T.saginata+H.nana	1
		A.lumbricoides+T.trichura+H.nana	10
		T.trichura+A.duodenale+H.nana	1
		A.lumbricoides+T.saginata+ H.nana	3
		A.lumbricoides+T.saginata+E.histolytica	3
		T.trichura+T.saginata+G.lamblia/intestinalis	4
			50(4.80)
	4 species (n=16)	*A.lumbricoides+T.trichura +E.vermicularis+T.saginata*	4
		A.lumbricoides+E.vermicularis+T.saginata+H.nana	1
		A.lumbricoides+T.trichura+T.saginata+E.histolytica	5
		A.lumbricoides+A.duodenale +T.saginata+ H.nana	3
		A.lumbricoides+E.vermicularis+T.saginata+E.histolytica	1
		T.trichura+E.vermicularis+T.saginata+H.nana	1
		A.lumbricoides+A.duodenale +T.trichura + H.nana	1
			16(1.53)
Total poly-parasitism			144(13.8)
Total of infected individuals			221 (21.2)
Total No. examined			1041

Table III.- Intestinal tapeworms and other helminth and protozoan parasitic infections among different occupational groups in Swat, Khyber Pakhtunkhwa, Pakistan (January 2006 to December 2008).

Parasite	Ages		Sex		Occupation			Over all	%
	<15	>15	Male	Female	Farmers	Education concerned	Shepherds		
Cestodes									
Taenia saginata	61	85	96	50	53	46	47	146	32.6
Hymenolepis nana	56	32	60	28	28	40	20	88	19.7
Nematodes									
Ascaris lumbricoides	43	48	55	36	38	27	26	91	20.3
Trichuris trichura	39	25	35	29	21	24	19	64	14.3
Enterobius vermicularis	12	17	13	16	14	5	10	29	6.48
Ancylostoma duodenale	10	3	8	5	6	4	3	13	2.90
Protozoans									
Entamoeba histolytica/dispar	6	6	6	6	4	2	6	12	2.68
Giardia lamblia/intestinalis	2	2	1	3	0	0	4	4	0.89
Total No. of infection	229	216	271	174	164	146	135	447	42.9
Total No. of samples	466	575	661	390	365	420	256	1041	-

Taenia saginata is widely prevalent in the human population of Swat, Pakistan. It is found to be 32.6 % in prevalence in present study. Other studies conducted in Pakistan showed low prevalence rate except Akhtar *et al*. (1993) who recorded the prevalence of infection to be 7.1% in hospital patients at Lahore. Pal and Subhani (1989) described 3.5% of the prevalence was recorded in Dir district. The absence of *T. saginata* from other region of the country is related to the traditional consumption of well cooked meat Ansari and Naru (1968). A very high incidence of this tape worm (25-75%) is found in humans of Africa, Tibet and Syria.

The frequency of occurrence of this cestode infection out of Pakistan is also low in prevalence. Adekunle (2002) investigated 4.3 % in Nigerian children. While Sayasone *et al.* (2009) in Lao PDR hepato-patients recorded 22.8 % infection rate which is the highest rate of infection according to literature available. Although *Taenia* species are recorded comparatively in low prevalence rate of infection even in the world.

The prevalence rate of *Hymenolepis nana* is 19.7% in the present study. In Multan well persons this infection was recorded to be 3.4 % (Farooqi, 1964). In school children of Dir district 6.6 % prevalence was recorded (Pal and Subhani, 1989). In school children of Chitral district 5.98% prevalence was noted. Nearly similar to the present study this similarity may due to same socio-economic level. In a survey in urban and sub-urban areas of Islamabad the rate of infection was 7.2 % as reported by Jamil (1999).

Highest prevalence rates of *H. nana* recorded as 21.6 % in Islamabad (Pal and Malik, 1979), 21.5 % and 20.9 % in Larkana and Shikarpur, respectively (Shaikh *et al*., 2000, 2003), 18.0 % in Peshwar (Siddiqi and Bano, 1979) and 17.2 % in Lahore (Akhtar *et al*., 1993).

This cestode parasite is also present in variable distribution in human population of Pakistan, such as: Bahawalpur 1.1% (Farooqi, 1964), Peshawar 2.1% (Farooqi, 1965), Karachi 1.6% (Haleem *et al*., 1965) and 2.32% (Bilqees *et al*., 1982), 1.5% in Hazara Division in Hospital samples, 2.5% in University students in Faisalabad and 3.3% in Diarrhea patients in Karachi (Baqai and Zuberi, 1986).

Variable prevalence of this intestinal pathogenic tapeworm for different areas might be due to the different ecological, personal habits, cultural and geographical restrictions.

CONCLUSIONS

This research offers new vision into occupation's parasitic infection status among the farmers, education concerned and shepherds of Swat valley, Pakistan. Present study results call for the development of occupational health and rural communities in the area. Health education interventions should be imposed to reduce transmission and reinfection in the studied occupational groups. Current research will serve as a benchmark for successive post-intervention surveys and analysis.

Statement of conflict of interest

Authors have declared no conflict of interest.

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