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Epidemiological analysis of human fascioliasis in northeastern Punjab, Pakistan

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ABSTRACT

A coprological study was performed to assess human fascioliasis in 7200 subjects inhabiting rural communities of localities close to the capital city of Lahore in the northeastern part of the very highly populated Punjab province, Pakistan, a country where human infection had never been reported before 2005. The analysis of 1200 subjects including 50 subjects/month throughout a two-year study in each of six localities surveyed provided an overall prevalence of 1.18%, with a range between 0.67% and 1.75% according to localities. Infection rates did not differ according to gender, excepting a higher rate in females (1.13% vs 0.77%) in one locality. Prevalences according to age groups proved to be higher in 11–20 years with 1.57%, followed by 1.18% in 0–10 years and 0.47% in 21–30 years, while no infection above 30 years. Seasonal prevalences proved to be significantly different when comparing summer and autumn with winter and spring. Monthly prevalences showed two peaks, the highest in August (4.67%) and another in January (2.17%). Correlation studies of monthly prevalences with temperature, humidity, rainfall, and pan evaporation showed significant results only with humidity. Despite prevalences being low, the very high number of inhabitants and population densities of the areas surveyed suggest a wide public health problem potentially infecting up to 150,000 rural people, children included, only in the respective districts. Additionally, the situation becomes of more concern when considering the present climate change trend affecting the Punjab, which indicates a progressively increasing fascioliasis transmission risk in that animal endemic area in the near future.

1. Introduction

Trematodiases in general have become a priority due to recent modifications in prevalences, intensities and geographical distribution, as a consequence of effects of climate change and global change (Boissier et al., 2015). Food-borne trematodiases have especially being emphasised in the recent WHO Roadmap for neglected tropical diseases 2015–2020 (World Health Organization, 2013). Among food-borne trematodiases, fascioliasis merits a particular focus due to its worldwide distribution in livestock and the estimates of up to 17 million people infected in many countries of Europe, Africa, Asia, the Americas and Oceania (Mas-Coma et al., 2009a),

This liver fluke disease is emerging in many countries, with progressive detection of new human endemic areas and an increasing number of human case reports, in an emergence phenomenon which has partly been related to climate change (Mas-Coma et al., 2008) and also global change aspects such as anthropogenic modifications of the environment (Afshan et al., 2014), travelling (Ashrafi et al., 2014) and import/export of livestock (Mas-Coma et al., 2009a). These changes appear to be related to the high dependence of both fasciolid larval stages and their freshwater lymnaeid snail vectors on climatic and environmental characteristics (Fuentes et al., 1999, 2001; Mas-Coma et al., 2009b).

The increasing importance of human fascioliasis also relies on results recently obtained in studies on pathogenicity and immunity, according to which this disease appears to be pronouncedly complicated including diagnosis difficulties (Mas-Coma et al., 2014a) and a great morbidity impact on children in long-term infection, such as in human fascioliasis endemic areas (Valero et al., 2003, 2006, 2008; Girones et al., 2007). The complexity of the clinical picture, and the symptoms and syndromes due to the capacity of the flukes to affect vital organs other than the liver, giving rise to important sequelae and even death (Mas-Coma et al., 2014b), adds concern about a disease whose high morbidity in humans had already been

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Table 1
Monthly prevalences (%) of human fascioliasis found in the two-year coprological surveys performed on a total of 7200 subjects including 1200 subjects (50 subjects/months from April 2003 to March 2005) analysed from each one of six rural localities of northeastern Punjab province, Pakistan.

	Sheikhupura			Gujranwala			Kamoke		
	Infected/total (%)		Mean ± S.E. (%)	Infected/total (%)		Mean ± S.E. (%)	Infected/total (%)		Mean ± S.E. (%)
	Year 1	Year 2		Year 1	Year 2		Year 1	Year 2	
April	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0
May	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0
June	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0±0.0
July	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0
Aug	1/50 (2.0)	2/50 (4.0)	3.0 ± 1.0	1/50 (2.0)	1/50 (2.0)	2.0 ± 0.0	2/50 (4.0)	5/50 (10.0)	7.0 ± 3.0
Sep	0/50 (0.0)	2/50 (4.0)	2.0 ± 2.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	4/50 (8.0)	2/50 (4.0)	6.0 ± 2.0
Oct	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	1/50 (2.0)	1/50 (2.0)	2.0 ± 0.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0
Nov	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
Dec	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0
Jan	1/50 (2.0)	1/50 (2.0)	2.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	2/50 (4.0)	1/50 (2.0)	3.0 ± 1.0
Feb	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
March	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
Total	3/600 (0.5)	5/600 (0.83)	0.67 ± 0.2	4/600 (0.67)	6/600 (1.0)	0.83 ± 0.2	11/600 (1.83)	10/600 (1.67)	1.75 ± 0.08

	Muridke			Shahdara			Kasur		
	Infected/total (%)		Mean ± S.E. (%)	Infected/total (%)		Mean ± S.E. (%)	Infected/total (%)		Mean ± S.E. (%)
	Year 1	Year 2		Year 1	Year 2		Year 1	Year 2	
April	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
May	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
June	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0
July	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
Aug	3/50 (6.0)	2/50 (4.0)	5.0 ± 1.0	2/50 (4.0)	3/50 (6.0)	5.0 ± 1.0	1/50 (2.0)	1/50 (2.0)	2.0 ± 0.0
Sep	1/50 (2.0)	3/50 (6.0)	4.0 ± 2.0	3/50 (6.0)	1/50 (2.0)	4.0 ± 2.0	2/50 (4.0)	2/50 (4.0)	4.0 ± 0.0
Oct	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	2/50 (4.0)	2/50 (4.0)	4.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0
Nov	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
Dec	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	1/50 (2.0)	0/50 (0.0)	1.0 ± 1.0
Jan	1/50 (2.0)	1/50 (2.0)	2.0 ± 0.0	1/50 (2.0)	2/50 (4.0)	3.0 ± 1.0	2/50 (4.0)	0/50 (0.0)	2.0 ± 2.0
Feb	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	1/50 (2.0)	1.0 ± 1.0	0/ 50 (0.0)	0/50 (0.0)	0.0 ± 0.0
March	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0	0/50 (0.0)	0/50 (0.0)	0.0 ± 0.0
Total	7/600 (1.17)	9/600 (1.5)	1.3 ± 0.2	9/600 (1.5)	10/600 (1.67)	1.58 ± 0.58	6/600 (1.0)	5/600 (0.83)	0.92 ± 0.25

highlighted several years before by the World Health Organization (Chen and Mott, 1990).

With regard to geographical distribution, the lymnaeid snail specificity explains the present distribution of both fasciolid species. Whereas *Fasciola hepatica* was able to spread from its European origin to all the five continents, *Fasciola gigantica* has always been restricted to Africa and Asia (plus Hawaii), a biogeographical phenomenon which appears to parallel the inability thus far of the *Radix* group to expand and colonise continents other than those two. The ecological requirements of the respective lymnaeid vectors also explain why *F. hepatica* is more prevalent in temperate zones and therefore prevalent throughout Europe, the Americas and Oceania, while *F. gigantica* is environmentally adapted to the tropical and humid zones that are predominant in Africa and Asia (Mas-Coma et al., 2009a).

In southern Asia, human infection by *Fasciola* has never been hitherto considered of extensive public health concern, although the increasing number of human reports in recent years may need a re-conderation of the present situation. Indeed, in the south-western part of Asia, human fascioliasis in Iran appears to be concentrated mainly in the northern part of the country, namely in Guilan and neighbouring provinces (Moghaddam et al., 2004; Ashrafi and Mas-Coma, 2014; Ashrafi et al., 2015), in India only very scattered individual cases have been reported (Ramachandran et al., 2012), similarly as in Thailand (Parichatikanond and Sarasas, 1984; Chamadol et al., 2010), Laos (Quang et al., 2008) and Taiwan (Yen et al., 2011) and Indonesia islands (Norizuki et al., 2015; Figtree et al., 2015) in southeastern Asia, with the exception of the numerous cases in Vietnam (De et al., 2006; Le et al., 2008). Thus, both Afghanistan and Pakistan appear free from human infection in the recent WHO map (World Health Organization, 2015), this absence being traditionally explained by the extreme aridity and high temperatures of the lowland areas inhabited by people.

In Pakistan, however, fascioliasis patients have been recently reported from the northeastern part of the Punjab province (Qureshi et al., 2005; Qureshi and Tanveer, 2009). These unexpected human infection reports motivated a wide and deep environmental study which demonstrated an overlapped impact of both climate change and global change, represented by the man-made extensive irrigation systems, on the fascioliasis transmission risk in the area where human infection was detected (Afshan et al., 2014).

The aim of the present article is to analyse the results of a two-year coprological survey of humans inhabiting different localities throughout a wide zone in the northeastern part of Punjab, to assess the extent and epidemiological characteristics of human fascioliasis outside the area of Lahore city where human infection by the liver fluke was first detected (Qureshi et al., 2005) and in localities where preliminary serological studies by means of an indirect haemagglutination (IHA) test enabled for the detection of human infection (Qureshi and Tanveer, 2009). Coprological data of fascioliasis infection are analysed from the points of view of their relationships with geographical distribution, sex, age and seasonality. Finally, the present and future epidemiological situation is considered taking into account the present evolving trends of climate and global changes.

2. Materials and methods

2.1. Study area

The surveys were conducted in six rural communities of different localities located in the northeastern part of the Punjab province, namely along a wide zone surrounding Lahore city. The localities surveyed were (from north to south): (A) Gujranwala and (B) Kamoke (Gujranwala district: area of 3,622 km^2;