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Potential risk of fish-borne nematode infections in humans in Brazil – Current status based on a literature review

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ABSTRACT

A literature survey identified a variety of potentially zoonotic fish-borne nematode species in both marine and freshwater hosts which are common throughout Brazil. The few cases of fish-borne zoonotic nematodioses reported in humans in Brazil are summarized, and the possible routes of infection are discussed, such as the importance of restaurants specialized in dishes containing raw or undercooked fish. The difficulties of diagnosing of human infections with fish-borne nematodes in Brazil are reviewed. Requirements for an integrated approach to avoid the infection are discussed. It is concluded that, a) human fish-borne nematodiosis may constitute a problem of public health in Brazil; b) effective regulations to prevent the infection should be adopted; c) people must refrain from eating raw or undercooked fish dishes; and d) an intensive campaign alerting people about the feeding risk behaviors shoul be undertaken.

1. Introduction

Fish borne nematodes infections in humans are common in countries where people have a traditional custom of consuming live, raw, smoked, lightly cooked or marinated fish and/or squid. This assumes that, i) the fish or squid must harbor infective stages of nematodes and, ii) they must be ingested in such conditions that live worms can reach the digestive tract of humans. Not only live worms but also dead worms can cause allergic reaction, sometimes with serious consequences including anaphylactic shock (Audicana et al., 2002).

Several species of fish-borne nematodes are recognized as causative agents for human diseases: in the family Anisakidae; *Anisakis*, *Pseudoterranova*, *Contracaecum* and *Hysterothylacium* spp. are well known as human pathogens. In the family Gnathostomatidae, several *Gnathostoma* spp. are known to be infective to humans. In the family Capillariidae, *Capillaria philippinensis* is a fish-borne pathogen cappable of causing severe, sometimes fatal, diarrhea in the Philippines and Thailand, and sporadic cases have been reported from Taiwan, Japan and Korea (Cross and Belizario, 2007). In the family Dioctophymatidae, *Eustrongylides* spp. and *Dioctophyme renale* are fish-borne zoonotic nematodes rarely causing human disease.

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Among those fish-borne nematodes, the most common species causing human infections are *Anisakis* spp., *Pseudoterranova* spp. and *Gnathostoma* spp., which are distributed worldwide (Arizono et al., 2011; Herman and Chiodini, 2009; Lamothe-Argumedo, 2006; Nawa et al., 2010; Torres et al., 2007). Infections with *Hysterothylacium* spp., *Contracaecum* spp., *Eustrongylides* spp. and *Dioctophyme renale* occur rarely and only a few cases have been described worldwide (Agrawal et al., 2014; Eberhard and Ruiz-Tiben, 2014; Ignatovic et al., 2003; Nagasawa, 2012; Yagi et al., 1996).

In Brazil, little is known regarding human infections with fish-borne nematodes. Some publications discussed this issue by pointing out the possible risk of ingesting raw or undercooked fish (Cardia and Bresciani, 2012; Knoff et al., 2013; Lima dos Santos, 2010; Masson and Pinto, 1998; Okamura et al., 1999), or even dried or salted fish containing dead nematodes (Pereira et al., 2000; Prado and Capuano, 2006). Only few papers reported human infections with fish-borne nematodes (Amato Neto et al., 2007; Chaves et al., 2016; Dani et al., 2009; Eiras et al., 2015; Lisboa, 1945; Rosa da Cruz et al., 2010; Vargas et al., 2012).

The fish diversity in Brazil, including both freshwater and marine species, is one of the richest in the world, especially concerning freshwater fish. According to Levêque et al. (2008), the Neotropical region has about 4050 species of fish, the majority of which are found in Brazil. Of marine fish, at least 1297 different species are distributed along the approximately 8500 km of Brazil's coastline (Menezes et al., 2003). The fish diversity is not a risk factor by itself for fish-borne nematode infections, and probably not all the species serve as hosts. However, the greater the number of fish species infected, especially in the case of economically important species, the greater the risk for humans of ingesting fish-infected nematodes. Taking into account these factors it is surprising that only a few cases of human infections with fish-borne nematodes have so far been reported in Brazil. This fact led the authors to produce the present study in order to clarify i) the existence of fish-borne nematodes with zoonotic potential in Brazil and the risk of infection with them, ii) the quantification of human infections known to date in Brazil, iii) the ability of physicians to diagnose human fishborne nematode infections and, iv) the general importance of this problem in the country, including the need for the adoption of effective prophylactic measures.

2. Materials and methods

The data presented here are based on a thorough bibliographical search. All the available faunistic lists were examined (Eiras et al., 2010; Luque et al., 2011; Moravec, 1998; Vicente et al., 1985; Vicente and Pinto, 1999) in order to detect reported fish infected with potentially zoonotic nematode species. Moreover, an electronic extensive bibliographical search was performed using several key words (fish nematodes, zoonosis, human health, Brazil, etc.) and several databases were searched (*Web of Knowledge*, *Biological Abstracts and Helminthological Abstracts*, *Aquatic Science and Fisheries Abstracts*). We successfully retrieve a large number of papers as shown in the results. These papers were too numerous to cite them all in the present work. The potential fish-borne zoonotic nematode species, the hosts (both freshwater and marine) and the sampling localities of the hosts are presented in Table 1. In addition, we extensively searched for the reports of human infection with fish-borne nematodes in Brazil. To the best of our knowledge, we identified all reported human cases of fish-borne nematode infections in Brazil.

3. Results

Fish-borne nematode parasites of zoonotic importance and respective fish hosts in Brazil are indicated in Table 1. *Anisakis* spp. were reported from 44 different host species, *Pseudoterranova* spp. from 16 hosts, *Hysterothylacium* spp. from 57 hosts, *Eustrongylides* spp. from 46 hosts, *Contracaecum* spp. from 89 hosts, *Gnathostoma* spp. from 2 hosts, and *Dioctophyme renale* from 3 hosts. The geographical distribution of the fish hosts species in both freshwater and marine environment is widely spread through the country's coastline and rivers belonging to almost all the hydrological basins. Moreover, the hosts include nearly all the economically important marine fish (*Thunus thynus*, *Engraulis anchoita*, *Micropogonias furnieri*, *Pagrus pagrus*, *Scomber japonicus*, *Katsuwonus pelamis*, *Pomatomus saltatrix*, etc.) and freshwater fish species (*Pseudoplatystoma corruscans*, *P. fasciatum*, *Plagioscion squamosissimus*, *Salminus brasiliensis*, *Arapaima gigas*, *Cichla ocellaris*, *Piaractus mesopotamicus*, etc.).

Despite the infection of a large number of fish species with zoonotic nematodes the public health significance of this fact was not assessed. To reach definitive conclusions it would be necessary to take into account the intensity and prevalence of the infection for each species. However, the collected data demonstrate that zoonotic nematodes are not rare, as they occur in a large number of fish species. Therefore, it seems reasonable to classify infection of fish with zoonotic nematodes as “common” in Brazil.

To date only a few cases fish-borne nematode infections in humans have been reported in Brazil. Dani et al. (2009) described the first case of gnathostomiosis in the country, and serological analysis suggested infection with the third stage larva of *Gnathostoma binucleatum*. However, this case involved a Brazilian patient who travelled to Peru and ate “Ceviche” three weeks before developing symptoms after having returned to Brazil. Therefore, this case seems to be an imported case in which a Brazilian was infected in Peru. A real autochthonous case of gnathostomiosis in Brazil was reported by Vargas et al. (2012). A man from Rio de Janeiro fishing in the Tocantins River caught a *Cichla* sp. fish and used it to prepare and consume “Sashimi”. Two weeks later he developed reddish lesions on his back, which disappeared after treatment with praziquantel. Later, the symptoms re-appeared and immunoblot analysis performed in Thailand showed positive antibody binding against *Gnathostoma spinigerum* antigen; since *G. spinigerum* is an Asian species of *Gnathostoma* and since *G. spinigerum* antigen can be used to diagnose *G. binucleatum* infection in Latin America (Nawa et al., 2015), this case appears to be the first indigenous case of gnathostomosis in Brazil. Recently, Chaves et al. (2016) reported a case of ocular gnathostomosis in Brazil. Several reports of possible gnathostomosis have appeared on internet-based descriptions by sport fishermen. Despite the convincing description of the symptoms and the epidemiological data strongly suggesting infection with *Gnathostoma* spp., these anecdotal reports were not