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The effectiveness of different intervention strategies for the prevention of zoonotic metacercariae infection in cultured fish

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ABSTRACT

Fish-borne zoonotic trematodes (FZT) are a major public health problem. It is estimated that in Vietnam 26,366 "disability-adjusted life years" (DALYs) are lost due to FZT. Fish from aquaculture are a main source of protein and of great economic importance in both rural and urban areas. The objective of this study was to compare the impact on transmission of FZT to juvenile fish of drug treatment intervention of final hosts, and pond management interventions on fingerlings produced in nurseries producing Rohu carp in Northern Vietnam. The study design was a parallel group design of nurseries with two intervention groups; a drug treatment of human and animal groups and a farm management group (control of snail vectors and fecal pollution of pond). A third group (non-intervention) served as control. Fish were examined for FZT metacercariae prevalence and intensity before and after interventions, along with density of potential host pond snails. Fecal exams for FZT infections in farm household humans, dogs and cats were also performed. The results showed that although FZT prevalence in fish was not significantly reduced, the intensity of metacercariae in fish from ponds receiving management interventions was reduced 91.7% compared to before interventions. The intensity of FZT was also significantly lower in the pond management group, compared to the drug treatment group and the control group after interventions. The results demonstrate that improving farm and pond management practices can be effective in reducing FZT infections without using drug treatment. This study also highlighted certain obstacles to attaining higher levels of protection for which more research is needed. A major challenge is the ability to completely isolate (or biosecure) the pond from its surrounding environment, especially surrounding water sources which may harbor snails and cercariae that can contaminate the pond through water resupply or runoff. Another is the unknown risk from piscivorous birds, host for intestinal FZT. The strategies employed in this study now need long-term evaluation on a regional basis, the outcome of which could be the development of good management practices crucial to ensuring a good quality product that benefits farmers and the consumers.

1. Introduction

Liver and intestinal fish-borne zoonotic trematodes (FZT) are major fish-borne zoonotic parasites of humans. The World Health Organization (WHO) recently added liver flukes to their list of emerging infectious diseases and it is estimated that more than 18 million people are infected with FZT (FAO, 2010; WHO, 1999, 2002). The liver FZT diseases clonorchiasis and opisthorchiasis result in an estimated loss of 349,737 "disability-adjusted life years" (DALYs) globally and in Vietnam alone, 26,366 DALYs are incurred (Fürst et al., 2011). Human infections with intestinal FZT are reported to cause mucosal ulceration, mucosal and submucosal hemorrhages, fusion and shortening of villi, chronic inflammation, and fibrosis of the submucosa (Thaenkham and Waikagul, 2012).

Cultured fish are a main source of protein in South East Asia, including Vietnam, and of great economic importance in both rural and urban areas (Chai et al., 2005). In Vietnam, FZT infections are prevalent in both farmed and wild fish, and in humans (Dung et al., 2007; Keiser and Utzinger, 2009; Phan et al., 2010a, 2010b; Thien et al., 2007; Thu et al., 2007; Verle et al., 2003). Prevalence is especially high in fish nurseries in Vietnam (Chi et al., 2008; Phan et al., 2010a). Among the chief risk factors for FZT infection in aquaculture systems are fecal contamination of the pond environment with FZT eggs from reservoir hosts i.e. eggs from humans, cats, dogs and fish eating birds (Chai et al., 2005; Lan Anh et al., 2009a, 2009b). Another important risk factors are conditions

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that promote the diversity and growth of snail intermediate host populations (Thiaridae and Bithyniidae) (Dung et al., 2010).

In previous studies it was demonstrated that the prevalence and intensity FZT infection were significantly reduced through interventions aimed at reducing environmental contamination of ponds with eggs shed by human and animal hosts, and at reducing host snail populations in the fish ponds (Clausen et al., 2012a, 2012b; Khamboonruang and Keawvichit, 1997).

Those studies, however, did not assess the relative importance of each of these different interventions. The effort to reduce snails requires changes in aquaculture management, while reduction of egg contamination of the ponds is dependent on diagnosis and drug treatment of infected human and animal hosts as well as reducing fecal contamination of the pond environment. The objective of this study was to compare the impact on transmission of FZT to juvenile fish of drug treatment of final hosts, and pond management interventions. Since transmission could vary seasonally the effect of both interventions was also compared to nurseries with no interventions. The results are critical to the prospects for developing a practical approach to preventing FZT at the farm level.

2. Methods

2.1. Study area and design

The intervention trial was conducted in Nam Dinh province in the Red River Delta of Northern Vietnam (Fig. 1), during one production cycle of juvenile fish (fingerlings) in nurseries (May and September 2011). This province has a high FZT prevalence in fish, humans and animals (Chai et al., 2005; Phan et al., 2010a, 2010b). The study design was a parallel group design of nurseries with two intervention groups and one non-intervention group, which served as a control. The three groups were designated: group 1) drug treatment; group 2) aquaculture management; and group 3) non-intervention. Each group included five ponds (study units) from five different nurseries.

The nurseries were randomly selected from a list provided by the provincial Department of Agriculture and Rural Development. The farms in the three groups were matched as nearly as possible using the following selection criteria: small-scale farms with less than 1500 m^2 of pond area; aquaculture management performed by household members; and production only of Rohu (*Labeo rohita*), which was the species produced at the time of interventions. One pond from each nursery was selected. In order to ensure that farmers selected for the three groups had no interactions with farmers from other groups, three separate areas were selected and farms for the respective group was then selected randomly within that area. The fry from hatcheries supplied to the nurseries were tested (described below) and confirmed to be free of FZT metacercariae. The study design was based on comparisons within each intervention group's FZT infection data from fish sampling at the end of the production cycle preceding the initiation of interventions (pre-intervention) with the fish sampling data at the end of the trial after nine weeks (post-intervention). Nine weeks is the normal length of the production cycle in the nurseries. This design was chosen to control as much variability as possible due to individual pond and household characteristics.

Fig. 1. Map of Vietnam and the province, Nam Dinh, where the research was conducted.

2.2. Parasitological examination of humans and animals and drug treatment

Prior to the trial, all household members including any on-farm workers, and immediate neighbors of the intervention nurseries in group 1 (drug treatment) were examined for trematode infections by medically trained staff using the Kato–Katz fecal egg method (Katz et al., 1972). Neighbors were included because of potential egg contamination of the study farm as neighboring farms generally are very close to each other. Two Kato–Katz smears of fecal samples (41.7 mg) were separately examined microscopically (400×). FZT eggs present were counted and converted to eggs/g. All people found positive for trematodes were treated with Praziquantel® at 25 mg/kg administered three times during one day (total 75 mg/kg body weight). To assess the effectiveness of the drug treatment, fecal examinations were repeated after 30 and 60 days. In addition to the treatment of infected humans and animals, farmers and members of the intervention households were instructed not to eat raw or inadequately cooked fish, and feed uncooked fish to dogs, cats and pigs.

Residents and workers at farms from groups 2 (aquaculture management interventions) and 3 (non-intervention nurseries) were examined for FZT infection at the end of the trial after nine weeks, and offered free treatment with Praziquantel® if they were found to be infected with FZT.

Domestic dogs and cats belonging to the households of the intervention nurseries in the drug treatment group (1) and animals belonging to their neighbors were examined for FZT eggs using fecal examination procedures described previously (Lan Anh et al., 2008; Nissen et al., 2013). Animals found to be egg positive were treated with one dose of Praziquantel® (40 mg/kg) (Lan Anh et al., 2009a, 2009b). Fecal exams were repeated every 30 days during the production cycle and positive animals were treated again if found FZT positive.

Domestic dogs and cats at farms from group 2 (aquaculture management) and group 3 (the non-intervention nursery controls) were examined for FZT infection at the end of the trial, and given free treatment with Praziquantel® if infected with FZT.