



Role of socio-cultural and economic factors in cyprinid fish distribution networks and consumption in Lawa Lake region, Northeast Thailand: Novel perspectives on *Opisthorchis viverrini* transmission dynamics



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ABSTRACT

Opisthorchis viverrini (*Ov*) is a fish-borne parasite endemic in parts of Lao PDR, Cambodia, southern Vietnam and Northeast Thailand (*Isaan*) where an estimated 10 million people are infected. Human *Ov* infection, associated with hepatobiliary complications, including cholangiocarcinoma (CCA), occurs when infected fish are consumed raw or undercooked, a longstanding cultural tradition in the region. This mixed- methods descriptive study was carried out in *Isaan* villages around Lawa Lake, Khon Kaen Province, known for their *Ov* endemicity. Focus group discussions (FGDs) and in depth interviews (IDIs) were used to explore socio-cultural determinants underlying raw fish consumption practices, and global positioning system (GPS) devices to map local fish distribution networks.

Qualitative data affirmed major socio-cultural and dietary lifestyle transitions occurring consequent on recent decades of modernization policies and practices, but also the persistence of *Isaan* traditional raw-fish eating practices and incorrect beliefs about infection risk avoidance. Fish traders/middlemen purchase most of the catch at the lakeshore and play the dominant role in district market fish distribution networks, at least for the larger and less likely infected, fish species. The lower economic value of the small potentially-infected cyprinid fish means local fishermen typically distribute them free, or sell cheaply, to family and friends, effectively concentrating infection risk in already highly *Ov* infected villages.

Our study confirmed the persistence of traditional *Isaan* raw-fish meal practices, despite major ongoing socio-cultural lifestyle transitions and decades of *Ov* infection health education programs. We contend that diffuse socio-cultural drivers underpin this practice, including its role as a valued cultural identity marker. A “fish economics” factor was also evident in the concentration of more likely infected fish back into local villages due to their low economic value at district market level. The complexity of factors supporting “risky” fish-eating traditions in *Isaan* underscores the importance of integrated liver fluke infection control strategies to draw on transdisciplinary knowledge beyond biomedicine and also embrace participatory protocols for engaging communities in developing, implementing and evaluating interventions.

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1. Introduction

Opisthorchis viverrini (*Ov*) is a fish-borne trematode endemic in Thailand, Lao PDR, Cambodia and southern parts of Vietnam with at least 10 million people in this region estimated to be at risk of *Ov* infection (Sithithaworn et al., 2012; Sripa et al., 2010; World Health Organization, 2010). While most infections are asymptomatic, heavy chronic infections are associated with clinical hepatobil-

iary complications such as cholangitis, advanced periductal fibrosis, hepatomegaly and in some cases cholangiocarcinoma (CCA), a bile duct cancer associated with very poor prognosis (Bouvard et al., 2009; Sripa et al., 2011). Northeast Thailand (Isaan) and Laos have the highest human *Ov* infection rates within Southeast Asia (SEA), with hot spots of endemicity near water bodies within the Lower Mekong River Basin (LMRB). The persistence of high infection rates in the region, despite decades of public health interventions (Sripa et al., 2015) is likely due to its cultural and ecological particularities where rice cultivation and a strongly embedded raw-fish consumption culture (Grundy-Warr et al., 2012) create ideal conditions for sustained transmission (Sripa et al., 2011; Sripa et al., 2007).

The human *Ov* transmission cycle involves two intermediate hosts, *Bithynia* freshwater snails and cyprinid fish, and humans as well as cats and dogs as the definitive piscivorous mammalian host (Kaewkes, 2003; Wykoff et al., 1965). Past public health interventions have targeted two transmission interfaces where parasitic stages and hosts encounter each other. First, in rural endemic areas the sustenance of parasite eggs input into the environment, by mostly human-infected hosts, is fostered by labor-related defecation practices where rice farmers and fishermen, spending most of their day time out in the fields, cannot reasonably afford the time to go back home or find latrines to defecate (Phongluxa et al., 2013). Interventions targeting defecation practices have used education, improved sanitation and hygiene to reduce infection (Jongsuksuntigul and Imsomboon, 2003). However, the complexity of the problem, and its only partially addressed underlying behavioral nature, has prevented sustainable transmission interruption at this interface. Defecation by domestic cats and dogs adds to this complexity, after being fed fish waste or scavenging household food waste. Intervention would need to incorporate education to reduce feeding of discarded fish to animals along with improved household waste management systems overall. Secondly, the human-fish interface is even more complex due to the dietary significance of fish in local diets; livelihood connection with the ecosystem; relatively high localized dependence on fisheries; and cultural food practices based on a variety of raw and fermented fish dishes (Grundy-Warr et al., 2012). Isaan people have long-established traditions of consuming raw fish dishes made from small cyprinids that can harbor *Ov* metacercariae, such as *koi-pla* (raw minced fish with Thai herbs); *pla-som* (raw fermented fish); and *pla-ra* (raw fermented fish paste) (Prasongwatana et al., 2013). Cyprinids are a dominant fish family in the LMRB area and more generally in SEA (Winfield and Nelson, 1991) and contribute greatly (economically and nutritionally) to the local communities through: income generation from the sale of fish (Shoemaker et al., 2001); and as a source of cheap protein (Hortle, 2007). However, there is little data, on the diversity, abundance, economic and consumption yield of small cyprinids outside of the major water bodies. This is an important issue because smaller wetlands and reservoirs serve as major sources of occupational fishing for many rural people in LMRB, particularly in Isaan, where *Ov* infection rates are still high and transmission is still occurring (Hortle, 2007; Horwitz et al., 2012; Jongsuksuntigul and Imsomboon, 2003; Sripa et al., 2015; World Wildlife Fund, 2013).

Multiple complex socio-cultural and ecological factors associated with the “wetland livelihoods” of the local communities (Friend, 2007) underline the apparent preference for raw cyprinid fish consumption in Isaan and Laos; inadvertently contributing to sustaining high *Ov* infection rates in the region and to the complex geographic mosaic of *Ov* infection distribution (Grundy-Warr et al., 2012). For example, in Khon Kaen Province, infection levels range from 2% to 71% (Sripa et al., 2015). This complexity and lack of appreciation of this complexity have resulted in relatively limited successes in altering traditional dietary habits as a mean to interrupt transmission. This situation is further complicated by

ongoing and possibly accelerating socio-economic development and a transition from subsistence to cash economy with risk pattern changes (Smith and Ezzati, 2005) and their associated health problems (Akrasaneet et al., 1991; World Bank, 2012). Isaan, still the poorest region in Thailand (Baker and Phongphaichit, 2014), is still in transition with the most rural villages characterized as peri-urban environments. And is now facing both traditional parasitic infectious diseases of rural communities and increasing rates of “modern” chronic diseases of urban dwellers (Smith and Ezzati, 2005). Raw fish consumption behavior is a remnant of traditional Isaan practices (Grundy-Warr et al., 2012) and a disappearing landmark possibly associated with a disrupted sense of cultural coherence/identity (Antonovsky, 1979). Although a risky behavior (i.e. from a biomedical perspective), raw fish consumption is associated with cultural identity and social capital (Bourdieu, 1986) contributing to communities’ cohesiveness as well as individual resilience and psycho-social health (Engel, 1977) for example, Isaan communities have long-standing beliefs that eating raw fish demonstrates manhood and strength (Sri-Aroon et al., 2005).

The above complex social-cultural factors are subtle and relatively diffuse and much less quantifiable than infection prevalence and associated physiological risks. Thailand’s national public health education campaigns have largely sought to eliminate foodborne parasitic infection through demonizing the parasite and raw-fish-eating practices, due to their association with opisthorchiasis and CCA (Boonjaraspinyo et al., 2013; Jongsuksuntigul and Imsomboon, 2003; Sriamporn et al., 2004). The relative neglect of complex socio-cultural factors as drivers for raw-fish-eating practices, and simplistic uni-linear focus on raw-fish-eating in risk prevention programs, may be a significant contributor to the limited success of previous public health interventions. More integrated and participatory (i.e. transdisciplinary) research on macro and micro level social-ecological systems; and geographical variations in *Ov* prevalence and infection in humans is thus needed to better inform public health interventions and foster a more sustainable reduction of *Ov* infection risk in humans without negatively impacting the health and well-being of marginalized populations (Ziegler et al., 2016). Accordingly, the objectives of this study were to 1) further our understanding of the socio-cultural determinants underlying raw fish consumption from the perspective of the affected community members in rural Isaan, and 2) to characterize local fish distribution networks as a mean to refine our understanding of *Ov* infection’s geographic distribution and transmission potential.

2. Material and methods

2.1. Study setting

This study focused on the Lawa Lake region in Khon Kaen Province, a semi-manmade reservoir and wetland ecosystem, whose products and services (food, water and traditional medicines) are central to local livelihood practices (Takaya, 1975). Lawa Lake also serves as a habitat to *Bithynia* snails and cyprinid fish (*Ov* first and second intermediate hosts) and is known to be a highly endemic area for human *Ov* infection and CCA incidence (Aunpromma et al., 2012; Sithithaworn and Haswell-Elkins, 2003; Sriamporn et al., 2004; Sripa et al., 2011). Seasonal flooding and climatic changes influence both ecosystem functioning and daily human activities like fishing and farming. We selected 7 villages directly bordering Lawa Lake, all previously identified as *Ov* infection hotspots (Sripa et al., 2011; Sripa et al., 2015). The villages were, (1) Ban Chikokor, (2) Ban Donpordang, (3) Ban Padang, (4) Ban Tad, (5) Ban Nonlamon, (6) Ban Pao and (7) Ban Nongnangkwan (“Ban” is Thai for village) (see Fig. 1).

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