



Social network analysis of food sharing among households in opisthorchiasis endemic villages of Lawa Lake, Thailand

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ABSTRACT

Consumption of raw fish is a well-documented risk factor for *Opisthorchis viverrini* infection. Sharing of food, especially raw fish recipes may influence the spread of disease through a community. Using social network analysis of an ego network, we investigated food sharing among households in an *Opisthorchis*-endemic area. Network centrality properties were used to explain the differences in *O. viverrini* transmission and control between villages with a low and high prevalence of infection. Information on demography and *O. viverrini* infection in 2008 from villagers in the Lawa Lake area was extracted from the Tropical Disease Research Center database. The two villages that had the lowest and the highest *O. viverrini* infection at the household level were recruited. Ten percent of households of each village were randomly sampled. Participatory epidemiology and face-to-face structured interviews guided by a social network questionnaire were used to collect data on livelihood, agricultural patterns, food sources, raw fish eating habits, and other food sharing during daily life and social gatherings. The number of contacts including in-degree and out-degree varied from 0 to 7 in the low-infection village and 0 to 4 in the high-infection village. The mean number of contacts for the food-sharing network among the low- and high-infection villages was 1.64 and 0.73 contacts per household, respectively. Between these villages, the mean number of out-degree ($p=0.0125$), but not in-degree ($p=0.065$), was significantly different. Food-sharing differed in numbers of sharing-in and sharing-out between the two villages. Network analysis of food sharing may be of value in designing strategies for opisthorchiasis control at the community level.

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1. Introduction

In developing countries, a culture of sharing food is associated with the spread of foodborne diseases across households (Trostell

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et al., 2008). *Opisthorchis viverrini* is regarded as a major food-borne trematode that causes a significant public health problem and a life-threatening cancer, cholangiocarcinoma (CCA). Infective *Opisthorchis metacercariae* are harbored in various cyprinoid fish (Sithithaworn et al., 1997; Sayasone et al., 2007; Sripa et al., 2011). In Thailand, especially in the North and northeastern provinces, eight million people are estimated to be infected with this parasite (Andrews et al., 2008; Sripa and Pairojkul, 2008). Traditional raw and undercooked dishes of cyprinoid fish, such as *Koi-pla* (raw fish with spiced salad) and *Pla-som* (quick fermented fish), are the typical sources of *O. viverrini* infection (Sripa et al., 2011). Although the influence of eating behavior on opisthorchiasis has been well

understood, information on the social and cultural aspects of liver fluke transmission is limited.

During the past two decades, epidemiologists have studied the effects of social networks on disease spread (Hawe et al., 2004; Riolo et al., 2001; Trostle et al., 2008). Transmission of various diseases has been illustrated by maps of direct contacts through the application of network analysis (Klov Dahl et al., 2001; Zelnor et al., 2012). Person-to-person contact was shown to facilitate transmission of many diseases, including influenza (Sattenspiel et al., 2000), HIV infection (Friedman et al., 2000), tuberculosis (Klov Dahl et al., 2001), staphylococcosis (Lowy and Miller, 2002), SARS (Meyers et al., 2003), sexually transmitted infection (Doherty et al., 2005), obesity (Christakis and Fowler, 2007), and diarrheal diseases (Trostle et al., 2008). One outbreak simulation study found that an individual's position in the network was associated with time-to-infection and risk of infection (Christley et al., 2005). The study of social networks provided insights beyond the ordinary approach of examining individual risk factors for infection in an outbreak of food-borne disease (Trostle et al., 2008).

Social network analysis is the examination of the individual elements or nodes in a network and the nature and extent of connections and relationships (between and among them, particularly social structures) (<https://www.wikiwand.com/en/Social-network-analysis>). Network analysis can help in describing interactions between individuals within a group and in understanding the behavior of a group (Martínez-López et al., 2009). Networks are typically represented as diagrams of node and links between these nodes, in which nodes mean households and links indicate contact ties such as food sharing between two households. Small subgraphs or *components* that are either connected or unconnected may be included in the networks (Wasserman and Faust, 1994). Various types of social networks have been explored to reveal their possible relevance to health (Friedman et al., 2000; Riolo et al., 2001). A sociocentric network is composed of a single, bounded community that has complete or whole links among members. The whole structure of this network can be generalized for other networks having different patterns of interaction within defined groups. Alternatively, ego networks (egocentric or personal networks), which are comprised of egos and alters, are defined only from the focal actors' perspective. This type of network is used for phenomena affecting individual entities across different settings or networks (Hawe et al., 2004). To obtain the nature of an individual's personal network, an egocentric approach is usually applied to a specific population (Doherty et al., 2005).

Ego networks start from focal actors or *egos* and then spread along the ties to connect with alters (Hawe et al., 2004). Upon applying social network analysis to food sharing among specific communities, transmission patterns of foodborne diseases either within or across communities may be delineated (Trostle et al., 2008). The most straightforward assessment at the individual level of an ego network is the number of links or *degrees* between each particular pair of nodes (Doherty et al., 2005). Thus, this study aimed to characterize and compare the pattern of the food sharing network, concerning dishes of fresh water fish in particular, among the villagers in an endemic area of human opisthorchiasis using egocentric social network analysis.

2. Materials and methods

2.1. Ethical consideration

The consent of all informants was obtained before beginning field work. Field work protocols and consent documents were



Fig. 1. Study sites at Lawa Lake with low (A) and high (B) *O. viverrini* infection rates at the household level.

approved by The Khon Kaen University Ethics Committee in Human Research (HE 571073).

2.2. Study area and population

This study was conducted as a part of the Lawa Model, an integrated liver fluke control program established by Tropical Disease Research Center (TDRC) of Khon Kaen University, Thailand. The Model is a transdisciplinary approach for addressing and intervening in *O. viverrini* infection in the Lawa wetland complex of Khon Kaen province, Thailand (Fig. 1, Sripa et al., 2015). Ego-centric network analyses illustrate the links between ego and alter households which were recruited from two villages having laboratory records of low and high opisthorchiasis infection.

2.3. Laboratory procedure

O. viverrini infection status was examined by stool examination using the modified formalin-ether concentration technique (FECT) as described by Elkins et al. (1986). Severity of infection was categorized by number of eggs per gram of feces (EPG). The household was considered positive if at least one individual with a positive result was found.

2.4. Food sources and food eating habits

Stakeholders in the two villages used participatory epidemiology (PE) to collect data on livelihood, agricultural patterns, food sources, raw fish eating habits, and other food sharing during daily life and social gatherings. PE involved semi-structured interviews,

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