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Access to, and use of, water by populations living in a schistosomiasis and fascioliasis co-endemic area of northern Côte d'Ivoire

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ABSTRACT

Water is an essential element of life, but it can also be a source of disease. Apart from direct consumption of unsafe water, direct contact and indirect consumption puts people at risk of many different types of pathogens. Employing a mixed methods approach, consisting of questionnaires and direct observations, we assessed access to, and use of, different water sources by the participants of the district des Savanes in northern Côte d'Ivoire. The use of water sources was put in relation to the potential risk of acquiring schistosomiasis and fascioliasis. Overall, 489 people aged 8 to 82 years participated. While all participants had access to safe water, 63% were in direct contact with unimproved water and 31% directly consumed unsafe water. More than a third of the people who otherwise reported using only improved water for all activities came in contact with unimproved water through crossing open water when going to their workplace, school or other destinations. Self-reported blood in urine – a marker for *Schistosoma haematobium* with reasonable sensitivity and specificity – was reported by 6% ($n = 30$), self-reported blood in stool – an unspecific marker for *Schistosoma mansoni* – was reported by 7% ($n = 35$), while blood co-occurring in both urine and stool was reported by another 10% ($n = 48$) of participants. Accessing unimproved water for any activity (including crossing) was associated with higher odds of reporting blood in urine and/or blood in stool (odds ratio: 1.90; 95% confidence interval: 1.07–3.36). Our results have important ramifications for intervention programmes targeting neglected tropical diseases, and emphasize the need for a wider supply of safe water to rural populations, since the water supply at the workplace needs to be considered as well next to the water supply at home. Crossing of open water sources is an important risk factor for sustained transmission of schistosomiasis.

1. Introduction

Water is an indispensable source of life, yet it can also be a source of disease (Fenwick, 2006; Steinmann et al., 2006; Traoré et al., 2013). A plethora of bacteria, parasites, protozoa and viruses are transmitted via water. Water-borne diseases mostly affect communities which lack access to clean water and adequate sanitation and have substandard hygiene, often in a context of resource-contrained health systems (Bartram and Cairncross, 2010; Brunn and Aagaard-Hansen, 2008; Utzinger et al., 2009). When it comes to the prevention of poverty-related diseases, supply with safe water is paramount (Fewtrell and Colford, 2005; Grimes et al., 2014; Strunz et al., 2014). Apart from direct consumption of unsafe water, indirect consumption through plants that grow in water or were irrigated with unsafe water puts people at risk as well (Drechsel et al., 2010). Human fascioliasis, for example, is acquired through the ingestion of the parasite encysted on freshwater plants or lettuce irrigated with contaminated water, but also through drinking contaminated water or even using utensils washed with contaminated water (Curtale et al., 2003; Marcos et al., 2005; Matthys et al., 2007). Furthermore, even the mere contact with unsafe water during agricultural, domestic and recreational activities puts people

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at risk for diseases such as schistosomiasis (Brunn and Aagaard-Hansen, 2008; Sama and Ratard, 1994).

In the district des Savanes of northern Côte d'Ivoire, water is widely distributed. Many rivers and small water bodies can be found in the area all throughout the year, although some of the small water bodies carry less water or dry out completely during the dry season (Cecchi, 1998; Koné, 2009). Large governmental efforts in the 1970s led to the construction of hundreds of small, multi-purpose dams (Cecchi, 1998). These man-made dams were primarily intended to foster livestock rearing but have long since been repurposed to all kinds of activities, most notably for irrigation of crops and vegetables (Hunter et al., 1993). Yet, next to its positive aspects, water resources development and management can also create new habitats for snails and new mosquito breeding sites, and hence, constitute potential transmission sites for several diseases including, but not limited to, schistosomiasis, malaria, fascioliasis and other food-borne trematodiasis and lymphatic filariasis (Fenwick, 2006; Hunter et al., 1993; Keiser and Utzinger, 2005; Steinmann et al., 2006). It follows that, while access to improved water in the villages and cities can reduce disease exposure to some extent (Fewtrell and Colford, 2005), the nature of life in sub-Saharan Africa renders this more difficult for specific diseases (Hunter et al., 2010). Therefore, access to, and use of, different water sources in a specific eco-epidemiological setting have to be considered for public health interventions.

A recent national survey, coupled with geospatial analysis, revealed that the prevalence of schistosomiasis in the district des Savannes ranges between 1 and 5% (Chammartin et al., 2014). The prevalence of animal fascioliasis in this part of Côte d'Ivoire is estimated to be around 12% in sheep and goats and 4% in cattle (Achi et al., 2003a,c).

The purpose of this study was to deepen our understanding of access to, and use of, different water sources by the population of the district des Savanes, northern Côte d'Ivoire. Our aim was to gather knowledge about the availability of different improved and unimproved water sources in the area, the various activities performed at specific water sites and to understand why water is being used the way it is. Furthermore, we related the use of water to the potential risk of acquiring schistosomiasis and fascioliasis, as assessed through reported blood in urine and/or reported blood in stool, as well as the consumption of potentially infected water and plants.

2. Methods

2.1. Ethics statement

The study protocol was approved by the institutional research commission of the Swiss Tropical and Public Health Institute (Swiss TPH; Basel, Switzerland). Ethical approval was granted by the ethics committees of Basel (reference no. EKBB 64/13) and Côte d'Ivoire (reference no. 32-MSLS/CNERdkn). District health and village authorities, study participants and parents/guardians of individuals aged <18 years were informed about the purpose and procedures of the study, including potential risks and benefits. It was emphasised that participation was voluntary and people could withdraw from the study at any time without further obligation. Written informed consent was obtained from participants or the parents/guardians of minors before the start of the interviews. All results were coded and treated confidentially.

2.2. Study area and population

The study was carried out in 10 randomly selected villages within the district des Savanes in northern Côte d'Ivoire. All study villages lie between 3 and 113 km radial distance from the district's capital Korhogo, which is situated approximately 660 km north of Abidjan, the economic capital of Côte d'Ivoire. The northern part of Côte d'Ivoire is characterised by a Sudano-Guinean climate with a single rainy season that lasts from June to October. The average annual precipitation ranges between 800 and 1400 mm (FAO, 2009). The dry season spans over a 6-month period from November to May with a desiccating, dust-carrying Sahara wind (Harmattan) between November and February. This Harmattan period is marked by cold nights, hot days and very low humidity and is followed by an upsurge in temperature from the end of February to mid-May (MPARH, 2003). The mean temperature is 25 °C during the rainy season and 28 °C during the dry season (Aka et al., 2000).

The ecology of northern Côte d'Ivoire is characterised by mostly semi-arid soil interspersed by many small rivers draining from North to South, small water bodies that often drain during the dry season and small dams that had been constructed in the 1970s (Cecchi, 1998). The prevailing ethnic groups of the study area are the Senoufo and members of the semi-nomadic Peulh population, also known as Fulani. For the purpose of this study, only the sedentary villagers have been considered.

2.3. Selection of villages and households and questionnaire survey

Fieldwork for this study was conducted in the month of December 2013 employing a mixed methods approach consisting of questionnaires and direct observations. In a first step, 10 villages were randomly selected. A readily available list of all primary schools of the district des Savanes was used for this purpose. The villages were selected by generating a corresponding set of random numbers using the online application Research Randomizer Version 4.0 (Urbaniak and Plous, 2013).

Within the selected villages, local authorities were informed and then 12–18 households were selected in each village using a method adapted from the Extended Program of Immunization (EPI) described elsewhere (Henderson and Sundaresan, 1982). In brief, starting from the village centre, as defined by a village authority, a geographical direction was randomly determined for each investigator by turning a pen. Subsequently a paper lot numbered from 1 to 20 was drawn and settlements on each side of the path were counted and the drawn number was then sampled. In case a selected house was unoccupied, the neighbouring house was selected instead. For subsequent houses, the procedure was repeated and counting started from the last sampled house and in the original direction. Within each household, two to four people were invited to participate. Wherever possible, two adults and two children (<15 years of age) of both genders were encouraged to participate in each household.

After participants gave their written informed consent, they were interviewed with a pre-tested questionnaire pertaining to water use patterns related to everyday activities as well as self-reported blood in urine and stool. Questionnaires were administered as an interview held in either French, the official national language, or one of the two most common vernacular languages in the district des Savanes, namely Dioula (similar to Malinke and Bambara) and Senufo, or in a combination of these languages. All investigators had received a 3-day training on questionnaire-based interviews, methods, practices and underlying ethical considerations. Interviews were performed from 8 a.m. to 5 p.m.

2.4. Direct observations

In a second part of the study, water bodies, habitually frequented by people and domestic animals in and around the villages, were visited by the study team accompanied by 1–2 locals with an informed consent. During these visits, the accompanying locals