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Expert knowledge sourcing for public health surveillance: National tsetse mapping in Uganda

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ABSTRACT

In much of sub-Saharan Africa, availability of standardized and reliable public health data is poor or negligible. Despite continued calls for the prioritization of improved health datasets in poor regions, public health surveillance remains a significant global health challenge.

Alternate approaches to surveillance and collection of public health data have thus garnered increasing interest, though there remains relatively limited research evaluating these approaches for public health. Herein, we present a case study applying and evaluating the use of expert knowledge sources for public health dataset development, using the case of vector distributions of Human African Trypanosomiasis (HAT) in Uganda. Specific objectives include: 1) Review the use of expert knowledge sourcing methods for public health surveillance, 2) Review current knowledge on tsetse vector distributions of public health importance in Uganda and the methods used for tsetse mapping in Africa; 3) Quantify confidence of the presence or absence of tsetse flies in Uganda based on expert informant reports, and 4) Assess the reliability and potential utility of expert knowledge sourcing as an alternative or complimentary method for public health surveillance in general and tsetse mapping in particular. Information on tsetse presence or absence, and associated confidence, was collected through interviews with District Entomologist and Veterinary Officers to develop a database of tsetse distributions for 952 sub-counties in Uganda. Results show high consistency with existing maps, indicating potential reliability of modeling approaches, though failing to provide evidence for successful tsetse control in past decades. Expert-sourcing methods provide a novel, low-cost and rapid complimentary approach for triangulating data from prediction modeling where field-based validation is not feasible. Data quality is dependent, however, on the level of expertise and documentation to support confidence levels for data reporting. Results highlight the need for increased evaluation of alternate approaches and methods to data collection.

Introduction

In much of sub-Saharan Africa, availability of standardized and reliable public health data is poor or negligible due to overburdened or non functioning health systems (Cooper, Osotimehin, Kaufman, & Forrester, 1998). While the Global Burden of Disease Study provides a standardized measurement framework for estimating disease burden (Mathers, Ezzati, & Lopez, 2007; Murray & Lopez, 1997), there has been significant criticism regarding its reliability in regions of high poverty, where projections are based on broad assumptions, limited data, and complex estimation processes (Cooper et al., 1998). Comprehensive data collection and surveillance are for many national governments beyond the financial and logistical feasibility of health programs, whose budgets are strained by prevention and treatment priorities.

Despite continued calls for the prioritization of improved datasets of diseases and their determinants in poor regions, public health surveillance remains a significant global health challenge. Alternate approaches to surveillance and collection of public health data have thus garnered increasing interest. The use of digital technology such as cell phones, crowd sourcing, and online tracking for real time data collection have received growing interest as alternative mechanisms for the collection of public health data where surveillance is otherwise unfeasible or unreliable (Corbane, Lemoine, & Kauffmann, 2012; Gao, Wang, Barbier, & Liu, 2011; Taewoo, 2012). Expert knowledge sourcing – the use of information from 'experts' to inform research, data collection, or decision making – has also been used. Despite this growing interest, there remains relatively limited explicit research evaluating these approaches for public health in the peer-reviewed literature. This is despite a rich literature on expert knowledge integration in diverse disciplines, notably ecology, and a growing acknowledgment of the role of local knowledge as a legitimate information source for data

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acquisition and decision-making. Herein, case studies explicitly presenting and assessing the use of expert knowledge sources for public health dataset development are negligible.

Sleeping sickness, or Human African Trypanosomiasis (HAT), is a neglected tropical disease with significant public health and economic burden in affected regions in sub-Saharan Africa. The disease and its associated impacts are considered important constraints to poverty alleviation and economic development in the region, and the disease occurs almost exclusively in areas with limited capacity for surveillance (Berrang-Ford, 2007; Fèvre, von Wissmann, Welburn, & Lutumba, 2008; Kristjanson, 1999; Welburn et al., 2006). Current international concern focuses on the potential spread of HAT in central Uganda; successful control is predicated on the identification of regions with sufficient conditions to facilitate transmission, including the presence of appropriate vector species: tsetse flies, *Glossina* spp. Despite this, there are no reliable, updated, comprehensive, and standardized data on national vector distributions for the country, and field-based entomological approaches have so far proven unfeasible (Berrang-Ford, Odiit, Maiso, Waltner-Toews, & McDermott, 2006; COCTU, 2004). National and updated tsetse distribution data remain unavailable and methodologically elusive.

Here, we apply and evaluate the use of expert knowledge (EK) sourcing methods to develop preliminary national maps of reported tsetse vector presence, comparing our results to existing tsetse distribution maps. We collect and assemble quantitative and spatially-disaggregated information on tsetse presence and confidence in tsetse reporting. Specific objectives include: 1) Review the use of expert knowledge sourcing methods for public health surveillance, 2) Review current knowledge on tsetse vector distributions of public health importance in Uganda and the methods used for tsetse mapping in Africa; 3) Quantify confidence of the presence or absence of tsetse flies in Uganda based on expert informant reports, and 4) Assess the reliability and potential utility of expert-sourcing as an alternative or complimentary method for public health surveillance in general and tsetse mapping in particular.

Expert knowledge for public health surveillance

While uncommon in public health surveillance literature, the use of expert knowledge as a data source has received increasing interest in the ecological and social sciences. EK concepts are found extensively within both the human, physical, and health sciences, including agriculture (Cornelissen, van den Berg, Koops, & Kaymak, 2003), political science (Evans, 2004) history (Muntanyola-Saura, 2012), conservation (Bojorquez-Tapia et al., 2003; O'Neill, Osborn, Hulme, Lorenzoni, & Watkinson, 2008), and transportation (Seyedabrishami & Shafahi, 2011). The concept of expert or local knowledge has arisen predominantly within two disciplinary paths. Firstly, within the social sciences in response to the desire to integrate local or Indigenous knowledge into understandings of social or environmental systems. Paralleling developments in community-based participatory research (CBPR), growing research has called for Indigenous, local, or other so-called 'informal' knowledge banks to be acknowledged, thus providing increased empowerment and legitimacy for community and local experiences and perspectives (Berge, Mendenhall, & Doherty, 2009; Davis & Wagner, 2003; May & Law, 2008; Seifer & Sisco, 2006). From this perspective, there is substantive emphasis on the integration of social knowledge systems as a *process*, reflecting recognition of local or indigenous rights in decision-making, or as voices informing social and ecological research. More recently, crowd sourcing and on-line approaches to data collection have arisen, paralleling the capacity of internet technology to create new venues for collection of data through new media. Ushahidi (ushahidi.com), for example, is an on-line platform for collecting and disseminating crisis event information. Other sites, such as Google's Flu Tracker (http://flutracker.rhizalabs.com/) and HealthMap (http://www.healthmap.org/en/) provide platforms for collation and communication of public health data outside of traditional national surveillance programs.

In parallel, use of knowledge sources (often in the context of 'expert' knowledge) has been employed more explicitly for data collection and quantification. Expert knowledge herein has been used extensively in a range of disciplines, and can apply to data collection and interactive techniques that include evaluation of agreement or consensus, knowledge assessment, decision weighting, data acquisition and validation, and estimation (Hoffman, Shadbolt, Burton, & Klein, 1995). The use of expert knowledge in the creation of datasets has been motivated by a lack of data or the need for triangulation of sources (Yamada, Elith, McCarthy, & Zerger, 2003). Such approaches have been used extensively within ecology and conservation research and practice (Davis & Wagner, 2003), including geographic applications (Bradley & Marvin, 2011; Store & Kangas, 2001; Yamada et al., 2003). Concepts of expert knowledge are implicit in the use of some advanced analytic methods, including Bayesian approaches (Goldstein, 2006; Kuhnert, Martin, & Griffiths, 2010) and Fuzzy modeling (Sattler, Stachow, & Berger, 2012; Zhu, Hudson, Burt, Lubich, & Simonson, 2001). These approaches integrate EK as *a priori* or complimentary knowledge into quantitative modeling frameworks, and assign value to the information held in expert knowledge systems. It is in this latter context – the use of expert knowledge as a data source rather than a participatory process – that we employ here.

In the field of health, EK has been predominantly applied to evaluating diagnostics (Alberdi, Taylor, & Lee, 2004; Marten et al., 2004; Papageorgiou et al., 2008), or within the context of multi-criteria decision analysis (MCDA) for health service provision (Fischer, Thomas, Niemitz, Reineking, & Beierkuhnlein, 2011; Garthwaite, Chilcott, Jenkinson, & Tappenden, 2008; Lieferink, Til, Groothuis-Oudshoorn, Goetghebeur, & Dolan, 2011; Madi et al., 2007). There is limited research on the use of expert knowledge techniques for the explicit creation of surveillance datasets. Myers, Rogers, Cox, Flahault, and Hay (2000) call for the use of expert knowledge as a component of disease forecasting and epidemic preparedness, reflecting what appears to be a general consensus within the broader literature that there exists significant and valuable surveillance data within the knowledge base of public health experts. Similarly, participatory approaches to data collection and surveillance are prevalent in the literature (Aanensen, Huntley, Feil, al-Own, & Spratt, 2009; Bellet et al., 2012; Jost, Mariner, Roeder, Sawitri, & Macgregor-Skinner, 2007; Mariner et al., 2011). Despite this, there has been negligible explicit consideration and evaluation of expert knowledge acquisition as a methodological tool for public health surveillance. As noted by Kynn (2008), the quality of the information gained from expert knowledge bases is significantly increased when methods for acquiring the data are explicitly designed and structured. Similarly, such data sources should be subject to evaluation regarding their validity and reliability. Thus, while the use of expert sources of knowledge holds significant potential for supporting public health data collection, the use of transparent and systematic approaches is critical for data reliability and methodological rigor.

Tsetse distributions and mapping in Uganda

Current renewed international concern regarding HAT has arisen in response to the risk of geographic overlap of two forms of the disease: *Trypanosoma brucei rhodesiense* (TbR) and *Trypanosoma brucei gambiense* (TbG). These two diseases have never