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Research paper

Brucellosis in cattle and micro-scale spatial variability of pastoral household income from dairy production in south western Uganda

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ABSTRACT

Brucellosis in cattle and humans has received world-wide research attention as a neglected and re-emerging zoonotic disease with many routes of transmission. Studies of brucellosis in Uganda have emphasized occupational exposures and also revealed variations in prevalence levels by region and cattle production systems. To date, research linking pastoralist household income from dairy production to brucellosis and its transmission risk pathways do not exist in Uganda. We assessed whether spatial differences in unit milk prices can be explained by brucellosis prevalence in cattle along a distance gradient from Lake Mburo National Park in Uganda. Semi-structured interviews administered to 366 randomly selected household heads were supplemented with serological data on brucellosis in cattle. Statistical analysis included Pearson correlation test, multiple regression and analysis of variance (ANOVA) using SPSS version 17. Serological results showed that 44% of cattle blood samples were sero-positive for brucellosis. The results obtained from interviews put the statistical mean of household reported cattle abortions at 5.39 (5.08–5.70 at 95% CI, n = 366). *Post-hoc* analysis of variance revealed that both sero-positive cattle and reported cattle abortions significantly were much lower when moving outwards from the park boundary ($p < 0.05$), while the price of milk increased significantly ($p < 0.05$) along the same distance gradient. Further studies should identify public and private partnerships needed to create and strengthen good zoonotic brucellosis management practices at the nexus of wildlife and livestock in Uganda.

1. Introduction

Bovine brucellosis has a global distribution and recognition as a disease of public health importance (WHO, 2006; Lopes et al., 2010), yet its control in Uganda remains poor and unfocused (Nabukenya et al., 2013). Several brucellosis studies in Uganda have reported levels of sero-prevalence between 7 and 50% among cattle and goats (Nakavuma and Opuda-Asibo, 1999; Bernard et al., 2005; Nabukenya et al., 2013). This rather high prevalence of brucellosis in cattle is a health hazard to people who consume livestock products like milk and meat (Holt et al., 2011) as well as to the abattoir workers (Nabukenya et al., 2013).

The perception that milk produced in areas with a high density of wild animals is contaminated with pathogens causing brucellosis has a distinct spatial pattern in south- western Uganda. The influence of this perception on the unit price of milk is evident despite the fact that the actual role of wildlife as reservoir of brucellosis remains to be adequately understood (Muñoz et al., 2010). Transmission of brucellosis among communities where animal husbandry is the main economic activity has been reported (Kabagambe et al., 2001; Marcotty et al., 2009). Although milk has been identified as an important route of transmission (Marcotty et al., 2009), no study has investigated the influence of brucellosis on the price consumers are willing to pay for a litre of milk perceived to be contaminated with brucellosis in Uganda.

Brucellosis is an infectious and contagious bacterial disease, whose transmission might benefit from the interactions between wild animals and livestock (Tessaro, 1986; Godfroid et al., 2013). The disease is caused by a facultative intracellular parasite known

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as coccobacilli of the genus *Brucella* (Whatmore, 2009; Olsen and Tatum, 2010). Brucellosis affects domestic and wild animals (Mwebe et al., 2011), with humans being accidental hosts (Marcotty et al., 2009). The fact that pathogens causing brucellosis can infect wild animals, livestock and humans alike makes brucellosis a serious public health hazard. Indeed brucellosis can persist in most affected communities in the developing world. Furthermore, conventional healthcare system has not paid adequate attention to the dynamics of brucellosis in terms of its spread and persistence in a population. Lack of integrated attempts at controlling the spread of bacteria causing brucellosis makes this disease one of the neglected endemic zoonoses in the developing world (WHO, 2006). Indeed zoonotic brucellosis is widely endemic in rural Africa (Cosivi et al., 1998; Sheik-Mohamed and Velema Johan, 1999) and should therefore be accorded substantive attention (FAO, 2009; Kabagambe et al., 2001).

Once a person is infected, brucellosis presents with non-specific symptoms, including general weakness, weight loss, febrile flu-like illness, headache and frequent chills (Krause and Hendrick, 2010). However, in cattle *B. abortus* is usually spread by the vaginal discharge of an infected cow or physical contact with aborted foetuses. A few cases also exist where cows have been infected by contaminated semen. Breeding bulls can either get infected by cows or transmit the disease to cows during mating. Animal infection often results in abortion during the last trimester of the gestation period. Abortion in animals occurs due to inflammatory changes which bacterial infection causes in the foetal membranes (Kungu et al., 2010). In general, the severity of brucellosis on human and animal health has important socio-economic implications. Studies suggest that brucellosis can adversely affect livelihood

of rural communities (Jones et al., 2008; Marcotty et al., 2009). Major economic losses associated with *Brucella spp* infections include impediment to market access for animal products such as milk and meat (Mangen et al., 2002). Other losses include decreased animal productivity, where abortions and infertility result in up to 20% reduction in cattle population (FAO, 2009; Mwiine, 2004). Among small holder cattle farmers in rural Africa, especially the pastoralist communities whose livelihood revolves around cattle production, such losses are often sufficient to push the affected rural households to the margins of a livelihood.

In Uganda, low-cost herding and high-cost paddock-keeping of animals have been reported as important contributing factors in the epidemiology of bovine brucellosis (Kungu et al., 2010; Nizeyimana et al., 2013). A study by Nizeyimana et al. (2013) investigated the prevalence and distribution of bovine brucellosis in cattle under contrasting grazing systems (herding and zero- grazing). The study found out that cattle raised under herding had higher prevalence of brucellosis (Nizeyimana et al., 2013). However, there is no evidence of a study linking price fall of fresh milk with brucellosis sero-positivity in cattle and distance from a perceived source of *Brucella* spp. in Uganda. This study therefore sought to test the hypothesis that brucellosis prevalence in cattle along a distance gradient from Lake Mburo National Park (LMNP) boundary significantly influence n the unit price of milk by. One possibility was that LMNP in Uganda had become an important dispersal centre for wildlife, which pastoralists perceive as vehicles of brucellosis transmission. The first study to document brucellosis prevalence in wild species of animals in the LMNP was conducted in the 1990s (Ocaido et al., 1996) and it showed brucellosis prevalence in impala (*Aepyceros melampus*) and buffalo (*Syncerus caffer*). Circumstantial evidence of brucellosis transmission from wildlife to cattle has also been reported elsewhere (Tessaro, 1986; Godfroid et al., 2013). Indeed, the former author argued that free ranging bison constitute a health hazard to cattle, while park confined bison do not. Godfroid et al. (2013). Davis et al. (1990) explained that brucellosis in some wildlife species is very low, but it was the behaviour of individual animals and their interaction with livestock that may actually be the most important drivers for transmission. In spite of the fact that routes of brucellosis infection in cattle might be different, the frequency of the interactions between wildlife and cattle deserve research attention. This is so, because just one infected animal could move extensively between farms thereby disseminating the pathogen.

2. Materials and methods

2.1. Description of the study area

The present study was conducted among pastoralists living in the rangelands around LMNP in Uganda. The study area was part of the larger Akagera ecosystem that extends from eastern Rwanda and north-western Tanzania into south-western Uganda, forming part of Uganda's cattle corridor. The climate of the study area is semi-arid and the main sources of water for the pastoral and agro-pastoral communities and their livestock are valley dams and limited number of swamps. The annual rainfall consists of 'long rains' reaching 1270 mm between March and June and 'short rains' between September and November that together make up an average estimated at 880 mm. The minimum and maximum temperature is 15 °C and 29 °C, respectively (Averbeck et al., 2009).

Wild ungulates, which are often found grazing with cattle in private farms and ranches, include buffalo (*Syncerus caffer*), zebra (*Equus burchellii*), eland (*Taurotragus oryx*), waterbuck (*Kobus ellipsiprymnus*) and impala (*Aepyceros melampus*) (Rannestad et al., 2006; Averbeck, 2009; Ocaido et al., 2009; Nina et al., 2015). Ankole cattle (*Boss indicus*) of Sanga origin is the most dominant breed of cattle reared in the study area. However, cross-breeds between Ankole and Friesian cattle is becoming common, while a limited number of exotic breed of cattle also exists.

2.2. Study design

A cross-sectional survey was conducted at the household level as unit of analysis to determine the sero-prevalence of brucellosis in pastoral cattle herds and history of cattle abortions along a distance gradient of 24 km from the LMNP. The survey was also used to collect qualitative and quantitative data using semi-structured questions administered in face- to- face interviews with the heads of randomly chosen pastoralist households.

2.3. Sampling and serology

To minimize chances of having false positive reactors, only animals aged 12 months and over were considered from selected pastoral households. Studies have shown that maternal antibodies are often present in calves (1–6 months) born of sero-positive cows (Gomo et al., 2011). All cattle in herds present in selected pastoral homesteads on the day of sample collection were eligible for serum sampling. A report by Mugisha et al. (2011) estimated average cattle holding per household at 60 cattle. From a total of 330 households selected for serological surveys, approximately 1980 animals were targeted. However, using a systematic random sampling, we selected one in every 6 animals in small herds <50 and 2 in every 10 for large herds >50 (Faye et al., 2005). This yielded 1962 cattle, which were bled for blood

samples between August 2012 and June 2013. The 330 homesteads selected for cattle sampling were proportionately distributed in six zones along a distance gradient from LMNP. All blood samples were centrifuged and the sera stored at −80 °C in the microbiology laboratory of Mbarara University before carrying out screening and subsequent confirmatory tests for brucellosis. Of the 1962 serum samples stored at the laboratory, 213 were