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Understanding the poultry trade network in Kenya: Implications for regional disease prevention and control

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ABSTRACT

Infectious diseases in poultry can spread quickly and lead to huge economic losses. In the past decade, on multiple continents, the accelerated spread of highly pathogenic avian Influenza A (H5N1) virus, often through informal trade networks, has led to the death and culling of hundreds of millions of poultry. Endemic poultry diseases like Newcastle disease and fowl typhoid can also be devastating in many parts of the world. Understanding trade networks in unregulated systems can inform policy decisions concerning disease prevention and containment.

From June to December 2008 we conducted a cross-sectional survey of backyard farmers, market traders, and middlemen in 5/8 provinces in Kenya. We administered a standardized questionnaire to each type of actor using convenience, random, snowball, and systematic sampling. Questionnaires addressed frequency, volume, and geography of trade, as well as biosecurity practices. We created a network diagram identifying the most important locations for trade.

Of 380 respondents, 51% were backyard farmers, 24% were middlemen and 25% were market traders. Half (50%) of backyard farmers said they raised poultry both for household consumption and for sale. Compared to market traders, middlemen bought their poultry from a greater number of villages (median 4.2 villages for middlemen vs. 1.9 for market traders). Traders were most likely to purchase poultry from backyard farmers. Of the backyard farmers who sold poultry, 51% [CI 40–63] reported selling poultry to market traders, and 54% [CI 44–63] sold to middlemen. Middlemen moved the largest volume of poultry on a weekly basis (median purchases: 187 birds/week [IQR 206]; median sales: 188 birds/week [IQR 412.5]). The highest numbers of birds were traded in Nairobi – Kenya's capital city. Nairobi was the most prominent trading node in the network (61 degrees of centrality). Many smaller sub-networks existed as a result of clustered local trade. Market traders were also integral to the network.

The informal poultry trade in Kenya is dependent on the sale of backyard poultry to middlemen and market traders. These two actors play a critical role in poultry movement in Kenya; during any type of disease outbreak middlemen should be targeted for control- and containment-related interventions.

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1. Introduction

Infectious diseases among poultry and other food animals can have serious effects on food supply and food security and significant economic and social consequences. Trade practices can play an important role in the spread of infectious diseases among livestock and poultry populations (Fèvre et al., 2006; Fournié et al., 2013; Fournié, 2013). In Africa, the spread of Newcastle disease and fowl typhoid, which can occur through informal trade networks, has led to flock mortality of up to 90% (Musiime, 1992; Omiti, 2009). In the past decade, the spread of Highly Pathogenic Avian

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Influenza (HPAI) A (H5N1) has led to the deaths and culling of hundreds of millions of poultry in Asia, the Middle East, Eastern Europe, and Africa. The spread of avian viruses has been linked to the poultry trade and live bird markets (Van Kerkhove et al., 2009; Soares Magalhães et al., 2010) as well as to wild bird movements (Cecchi et al., 2008; Fusaro et al., 2010). Studies of trade networks among livestock have consistently shown links between trade and disease spread (Shirley, 2005; Ortiz-Palaez et al., 2006).

In recent years, triggered largely but not exclusively by the emergence of the H5N1 virus (Alexander, 2007), international and national animal health agencies have implemented a number of control and prevention measures (Brown, 2010). These measures have focused in part on anthropogenic factors, such as trade, in spreading the virus among poultry (Statistics, 2010).

Kenya, a developing country of 38.6 million people (Statistics, 2010) in East Africa, is a regional hub for finance and trade. Its economy is largely based on production of small-scale consumer goods and agriculture, which contributes to 25–26% of the GDP, of which poultry trade represents 30% (Nyaga, 2007; CIA, 2011). Infectious diseases circulate regularly in the poultry population; including Newcastle disease, fowl typhoid and influenza viruses (Omiti, 2009), and present the major constraint to poultry production in the country (Omiti, 2009). The Kenyan Ministry of Agriculture and Livestock Development estimates the poultry population of Kenya to be approximately 30 million birds at any given time (Nyaga, 2007; Onkundi, 2008), of which an estimated 74–80% are raised in backyard settings. Approximately 75% of households in Kenya are estimated to keep chickens (Nyaga, 2007). Most poultry are traded in informal, unregulated live bird markets (Nyaga, 2007), making containment of an infectious disease outbreak particularly challenging.

In order to improve the national capacity to control and prevent disease spread in poultry, from June to December 2008, the Kenya Ministry of Agriculture and Livestock Development (MoLD), along with the Kenya Medical Research Institute/Centers for Disease Control and Prevention-Kenya (KEMRI/CDC), conducted an analysis of the informal poultry trade network in five provinces in Kenya.

2. Materials and methods

2.1. Data collection

We conducted a cross-sectional survey of three main types of actors in the Kenyan poultry trade in five of Kenya's eight provinces. Actors included middlemen, who travel among villages and markets buying and selling poultry from other actors in the system; backyard farmers, who raise poultry both for household consumption and for sale; and market traders, who sell poultry in poultry markets or at roadside poultry stalls.

We developed three different questionnaires – one for each type of actor. The surveys included questions about volume and frequency of trade, distances covered by each actor while conducting trade and species farmed or traded. Questions were tailored to specific activities associated with each actor's role. Questions about volume, distance, and frequency of trade were included in order to better understand how birds were traded, which trade relationships were most important, and whether certain locations were more important in the movement of poultry.

Survey teams – staff of the MoLD and KEMRI/CDC – administered the questionnaires. We spent a full day training survey staff on the purpose of the study, the details of individual questions, the importance of a uniform approach to administering the questionnaire, the use of GPS units, and the importance of completeness of questionnaires. Team leads supervised and attempted to ensure the uniformity of survey administration. We administered an initial version of questionnaires in Nairobi and Central provinces. A total of 30 middlemen, 38 market traders, and 60 backyard farmers were interviewed using the first version of the questionnaire. In response to feedback from staff and interviewees in these two provinces, we made small revisions in the wording of some questions and eliminated redundant questions. Revised questionnaires were used in the three other provinces. Questions that were changed too significantly to allow for comparison were excluded from our analysis.

2.2. Site selection

From June 16 to December 4, 2008, survey teams visited each province and identified actors to interview. Within each study province surveys were conducted in selected sublocations, the smallest administrative unit in Kenya. The source of poultry was recorded by village; several villages make up a sublocation. Sublocations were selected based on poultry population density, which was determined using raster data from the UN FAO GeoNetwork (UN Food and Agriculture Organization, 2005). Each raster represents 1 km^2 on the ground, and has been assigned a poultry density by FAO, using density estimation methods (FAO, 2011). Using GIS software we selected sublocations that had ≥50% coverage by rasters with a minimum density of 200–500 poultry per km^2. In total, we selected 507 sublocations in five provinces with high poultry density as study areas. We selected a subset of the sublocations by evaluating the proximity to population centers (villages, towns) in order to capture markets in these areas. In the selected sublocations, we identified all markets known by local Ministry of Livestock staff. At each of those sites, we administered the questionnaire to all actors except backyard farmers.

We used the probability-proportional-to-size sampling method to select a smaller subset of sublocations from which to identify backyard farmers to interview. The human population of each sublocation was obtained from the 1999 Kenyan census (Statistics, 1999) and these numbers were used to assign a probability of selection to each sublocation using SPSS 14 (Illinois, USA; 2001) statistical software. These probabilities of selection were then used to generate a random, representative sample of sublocations from those in the study areas based on human population size, ensuring that the number of interviewees was representative of the population of the sublocation. We visited backyard farmers in villages chosen randomly in the selected sublocations.

2.3. Sampling methods

In each sublocation, we visited every market identified by local MoLD staff. We used convenience sampling to identify market traders and middlemen to interview. During some interviews, traders or middlemen informed us about markets and roadside stalls that had not been identified by MoLD staff. For these sites, we used a snowball sample to identify markets and stalls to interview. In some instances market traders also worked as middlemen. In these cases, the respondent was asked which role they identified most closely with, and the corresponding questionnaire was used.

To identify households to interview for the survey of backyard farmers, we used a systematic random sample. The survey team randomly selected a starting point within the sublocation, and teams identified households to interview along transects; teams moved in opposite directions from the starting point and selected households to interview at every third homestead. If the household did not keep poultry, a household member was not present, or was unwilling to participate, the next household along the road was selected.