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A web-based survey of horse owners' perceptions and network analysis of horse movements relating to African horse sickness distribution in Namibia and South Africa

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ABSTRACT

Africa horse sickness (AHS) is the most lethal infectious non-contagious horse disease and has accordingly been declared notifiable by the World Organisation for Animal Health. AHS is endemic to sub-Saharan Africa and causes considerable losses to the equestrian industry. The effect of diseases in livestock on socio-economic factors is well researched, but the effect of anthropogenic factors on the distribution of a disease is poorly understood. The purpose of the study was to assess Namibian and South African horse owners' perceptions and the effect of horse movement on AHS distribution. A cross-sectional study was conducted to collect information from horse owners in Namibia and South Africa. To that end 'Fluid survey©' was used for survey development. The survey was launched on Facebook© and the link shared to horse related focus groups in Namibia and South Africa. A total of 508 responses were collected during the survey period. Of the 417 completed questionnaires received, 22% were from Namibia and 78% from South Africa. The participants comprised of 71% social and 29% professional riders. The most popular precautionary measures used, in addition to vaccination, were chemical repellents (64%) and stabling of horses during dusk and dawn (59%). A network analysis was performed in Gephi 0.8.2.B to illustrate the movement of horses between countries and districts/provinces. Network analysis results indicate that areas with the highest movement of horses corresponded to the areas with a high occurrence of AHS. Although 93% of the participants were aware that AHS is a notifiable and controlled disease, the process and efficiency of reporting is mostly unknown. With this snapshot of horse owners' perceptions and the effect of horse movement on the distribution of AHS, it is clear that a more holistic approach is needed. To that end, all environmental and social factors must be taken into account in effective management strategies.

1. Introduction

African horse sickness (AHS) is a devastating, non-contagious, infectious, insect borne disease of equids caused by the African horse sickness virus (AHSV) (Coetzer and Guthrie, 2004). AHSV is usually transmitted by adult female *Culicoides* midges (Diptera: Ceratopogonidae) (Meiswinkel et al., 2004). The aetiological agent AHSV, belongs to the *Orbivirus* genus within the family Reoviridae. There are nine immunologically distinct AHSV viral types (Maree and Paweska, 2005). AHS is endemic to sub-Saharan Africa with outbreaks particularly frequent and severe in Namibia (Schneider, 1994) and South Africa (Baylis et al., 1999) and account for considerable losses to the equestrian industry. South African Animal Disease Act 35 of 1984 (South Africa, 1984), requires that all horses must be vaccinated annually with a registered vaccine, except in the AHS free and surveillance area in the Western Cape (South Africa, 2009). This vaccine is commercially available and produced by Onderstepoort Biological Products (OBP) (Mellor and Hamblin, 2004). AHS is considered one of the most lethal horse diseases with mortality rates exceeding 80% in susceptible hosts (Mellor and Wellby, 1998) and has accordingly been declared notifiable by the World Organisation for Animal Health (OIE). This means that it has the potential for very serious and rapid spreading, irrespective of national borders. It is capable of serious socio-economic or public health consequences that are of major importance in the international trade of animals and animal products (OIE, 2012). The indigenous African equid, the zebra (*Equus burchellii*), does not

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show any clinical signs but is believed to be the primary reservoir of the virus (Barnard, 1993).

The probability of AHSV transmission by *Culicoides* spp. is a function of various biological interactions (Carpenter et al., 2011). Several environmental parameters have been identified as drivers of AHS outbreak occurrence, and have been researched and described by various researchers (Carpenter et al., 2011; Liebenberg et al., 2015). Another well researched area is the effect of diseases in livestock on socio-economic factors (Sutherst, 2004; Thompson et al., 2012). Despite this, the effect of anthropogenic factors on the distribution of AHS disease is poorly understood. Anthropogenic factors that influence the distribution of AHS include the homestead effect (Becker et al., 2013), vaccination practices (Paweska et al., 2003; European Commission, 2013) and distribution/movement of zebras (Lubroth, 1988; Becker 2012). The aim of this research was to assess horse owners' perceptions of human dependent factors that influence the distribution of AHS. This includes factors such as preventative measures and the extent of AHS reporting as well as to determine the effect of movement of horses on AHS outbreaks in Namibia and South Africa.

Although the current spread of AHS is not completely understood, movement of equines has been regarded as the most likely and biggest threat for the distribution of the disease across borders (Coetzer and Guthrie, 2004; De Vos et al., 2012). According to Coetzer and Guthrie (2004) AHS can be distributed over great distances when equids, incubating the disease, are translocated by land, air or sea. The AHS outbreak of 1987 in central Spain was believed to have originated by the importation of 10 zebras from Namibia (Mellor and Hamblin, 2004). The outbreak of 1965 in Northern Africa was initiated by the movement of infected donkeys across the Sahara from West Africa (De Vos et al., 2012). The 2011 AHS outbreak in the Western Cape is believed to be associated with the illegal movement of an infected animal into the area (Grewar et al., 2013). As a result, several restrictions and policies have been put in place to protect the equine populations of other countries. In an effort to keep southern Africa in the horse export trade, the OIE code of 1995 allowed the creation of an AHS free zone. Movement control measures were put in place and a control area was established in the Western Cape (Bosman et al., 1995). However, for the rest of the country and for Namibia, movement restrictions were still lacking during an AHS outbreak or within the peak AHS season. A new regulation was adopted during the OIE's general assembly in May 2012 where AHS is now one of four animal diseases for which countries can request an AHS-free recognition status (OIE, 2013). However, the establishment of an AHS free zone, as developed in the Western Cape, was not successful due to several outbreaks in the controlled area (Guthrie, 2014), with the most recent outbreak in 2014.

The first part of the article consists of a description of the distribution of AHS in Namibia and South Africa together with relevant census data needed for integration with the questionnaire results. The second part of the article focuses on the results and discussion of the questionnaire survey and the integration of these results with distribution data to determine the effect of movement of horses on AHS outbreaks. The influence of other parameters such as the various environmental factors influencing *Culicoides* presence and abundance and zebra movement was not assessed in this study.

2. Material and methods

2.1. Study area

The study area included Namibia and South Africa on a regional scale as per district (Namibia) or province (South Africa). Both countries were included in this study due to the movement of horses between the two countries for competitions and South Africa is also one of the biggest export markets for Namibian horses. Furthermore, Namibia does not export/import horses directly, but utilises the facilities in the controlled area (Western Cape) of South Africa.

2.2. Reported data of African horse sickness outbreaks

Reported data of AHS outbreaks (1993–2011) in Namibia and South Africa, were used to determine the distribution of AHS. A comprehensive literature review of the historical AHS reported data collected from the Windhoek archives as well as annual reports from the Directorate of Veterinary services in Namibia was conducted (Namibia, Annual reports 1993–2011, Division of Veterinary Services). South African AHS reported data was collected from the South African Department of Agriculture, Forestry and Fisheries as published in the annual reports 1993–2011 (Liebenberg et al., 2015).

The prevalence of reported AHS cases per annum was calculated for each district/province. Namibian data for 2002, 2003 and 2007 were found to be only descriptive and therefore tagged as missing. The human population census of 2011 for Namibia (Namibia, 2011) and South Africa (South Africa, 2012) was used as a quantitative index of anthropogenic activities (Liebenberg et al., 2015). According to the most recent agricultural census of 2004 (South Africa, 2004), South Africa had a total of 469 208 horses and Namibia (Namibia, 2000) a total of 61 902 in the year 2000 (Table 1).

2.3. Questionnaire survey

A cross-sectional study was conducted to collect information from horse owners in Namibia and South Africa. Ethical clearance for the study was obtained from the North-West University, Potchefstroom Campus's ethical committee (ethical approval number NWU-00041-14-S3). Completion of the questionnaire was anonymous and voluntary. A web-based survey was chosen for this study due to the extent of the area to be surveyed (2044290 km^2) and because detailed surveys are expensive, time consuming and traditional questionnaire surveys are often perceived as intrusive (Heiervang and Goodman, 2011). Advantages and disadvantages of web-based surveys and response rates, as opposed to traditional questionnaires, is a topic on which several studies have been conducted (Heiervang and Goodman, 2011; Van Gelder et al., 2010). The questionnaire was designed to ensure the credibility and trustworthiness of the data. Only completed (all compulsory sections) and fully submitted questionnaires were used for this study. The target group for the questionnaire was a very specific sub-group within the horse owning community who regularly transport their horses within and between countries and have access to Facebook©, (2015). FluidSurvey© (2015) was used for the development of the survey, and although this was only available in English, participants were also given the option to answer in Afrikaans. The survey was launched on the 6th of May 2014 on Facebook and the link was shared to horse related focus groups in Namibia and South Africa. Facebook©, (2015) is an online social network, connecting friends, family and colleagues. Once a link is shared on a group, the members of that group can share the link to other groups and post it on their timelines. Groups were found by using the Facebook search function with keywords such as: equine; horses and AHS. The link to the questionnaire was posted on two groups; after which it was shared to another five groups and reposted on members' timelines. The researcher's email and contact details were supplied to participants in case there were any questions. The post was continuously "bumped up the thread" so that it remained at the top of the Facebook pages for the duration of the study. The survey was closed at