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Research paper

Risk factors associated with strongylid egg count prevalence and abundance in the United States equine population

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ABSTRACT

Equine strongyle parasites are considered ubiquitous in grazing equids across the world, and cyathostomin parasites are known pathogens causing well-described disease complexes in horses. Decades of intensive anthelmintic treatments have led to anthelmintic resistance in cyathostomins, and current recommendations are to lower treatment intensity and base control strategies on fecal egg count surveillance. Little is known about risk factors associated with strongyle parasite egg shedding patterns in the United States equine population, as the most recent national survey was conducted 20 years ago. The present study was carried out as part of the National Animal Health Monitoring Systems (NAHMS) Equine 2015–2016 study. The aims were to describe strongyle parasite egg shedding patterns in the United States equine population and identify risk factors associated with prevalence and egg count magnitude. Data were collected from equine operations in 28 states via questionnaires and fecal samples submitted to a parasitology research laboratory for fecal egg count analysis and the data gathered underwent comprehensive statistical analyses. Though region and season were related, overall, the summer months and the fall in the southeast tended to have the greatest odds of presence of strongyles eggs on a FEC. Generally, equids resident in the Western region (Arizona, California, Colorado, Montana, Oregon, and Wyoming) had significantly lower strongyle prevalence, no matter the season, as well as a markedly different distribution between strongyle egg shedding levels ($p = 0.0005$). Overall, egg counts were over-dispersed with about 27% of equids (95% Confidence Interval (CI): 20–34%) contributing 80% of the egg output. Pasture history was significantly associated with strongyle egg prevalence ($p = 0.0003$) and egg shedding levels ($p = 0.0063$) with daily access in the previous 30 days being associated with higher odds of presence and greater median egg count levels. Equid gender was significantly associated with strongylid presence ($p = 0.0081$) and egg count level ($p = 0.0008$), with male equids having significantly lower odds and median egg counts than female equids, and age was significantly negatively associated with strongylid prevalence ($p < 0.0001$). Time since last deworming was significantly positively associated with prevalence of strongyle eggs, and this was dependent on the class of dewormer used ($p = 0.0086$), with equids treated with macrocyclic lactone class of drugs having lower odds of strongyle egg presence at 120 days since the last deworming. These data provide useful insights into strongylid egg shedding patterns in the United States equine population, and they can help refine parasite control recommendations depending on region, pasture access, and age distribution.

1. Introduction

Equine strongyle parasites are considered ubiquitous in grazing equids across the world. Cyathostomin (small strongyle) species have been identified to cause a condition termed larval cyathostominosis which has been widely described (Love et al., 1999; Peregrine et al., 2006). This disease complex is characterized by an acute typhlo-colitis with profuse watery diarrhea resulting in a protein losing enteropathy (Love et al., 1999). The case fatality rate has been reported to be around 50% (Reid et al., 1995). For this reason, strongyle parasites are considered main targets in parasite control strategies (Nielsen et al., 2013; Kaplan and Nielsen, 2010). However, increasing levels of anthelmintic

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resistance in equine cyathostomins world-over poses considerable challenges to designing adequate control programs (Peregrine et al., 2014).

The general recommendation today is to use strongyle fecal egg counts as a surveillance tool for estimating levels of egg shedding in individual equids and for evaluating anthelmintic treatment efficacy with the fecal egg count reduction test (Nielsen et al., 2013). The principle of selective treatment is widely recommended, where all equids in a given operation are regularly screened, but only those exceeding a predetermined egg count threshold are treated (Duncan and Love, 1991; Gomez and Georgi, 1991; Nielsen et al., 2014). This strategy is based on the observation that strongyle egg counts are typically unevenly dispersed among horses (Lester et al., 2013; Relf et al., 2013), and that mature horses are likely to consistently maintain their typical egg shedding level over time (Nielsen et al., 2006; Becher et al., 2010; Wood et al., 2013; Kornaś et al., 2015; Scheuerle et al., 2016). This means that a minor proportion of a given herd is responsible for the large majority of total strongyle egg output and that the same individual horses are the primary contributors to the pasture contamination. This has also been described as the '20/80 rule' with approximately 20% of the horses responsible for 80% of the total strongyle egg output (Stratford et al., 2011). Thus, it is imperative to identify these high strongyle egg shedders and ensure that they get appropriately treated in order to reduce the infection pressure.

Given the current emphasis on fecal egg counts as parasite surveillance tools, it has become important to understand the factors affecting this measure. Thus, some studies have attempted to identify risk factors associated with strongyle egg count shedding levels in horses. Age remains perhaps the most significant factor affecting this measure as egg counts tend to decline with increasing age (Fritzen et al., 2010; Relf et al., 2013; Levy et al., 2015; Kornaś et al., 2015) until equids become geriatric, when reports indicate they may have elevated counts (Adams et al., 2015). Weather and seasonal differences have been reported to affect strongyle egg counts as well (Wood et al., 2013; Levy et al., 2015). Several management factors have been reported to have significant influences on the level, such as time since last deworming (Fritzen et al., 2010; Levy et al., 2015), pasture hygiene practices (Corbett et al., 2014; Tzelos et al., 2017), usage of manure as fertilizer on pasture, and cropping/harrowing of pastures (Relf et al., 2013). However, all of the studies cited above were conducted in Europe and no such information is currently available for equids managed in North America.

The aims of this study were to describe strongyle parasite egg shedding patterns in the United States equine population and identify risk factors associated with prevalence and egg count magnitude. A secondary aim was to generate information about the presence of other parasite egg types present in the fecal samples.

2. Materials and methods

2.1. Study design

The data collected for this study were collected as part of a larger, cross-sectional, study of the U.S. equine population in the 28 states selected, conducted under a collaborative agreement between the United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, National Animal Health Monitoring System (NAHMS) and the United States Department of Agriculture, National Agricultural Statistics Service (NASS). The study design is similar to national studies performed by NAHMS in previous years (Losinger et al., 1998; Traub-Dargatz et al., 2000; Traub-Dargatz et al., 2001; Lombard et al., 2013; Stromberg et al., 2015). The larger study consisted of several phases. In Phase I, NASS first made contact with operations selected to be part of the study and administered a questionnaire concerning the general management of equine operations to consenting operations. Operations that consented to Phase II of the study were then contacted by NAHMS and were administered a questionnaire containing questions about equine health and disease management. Operations that completed Phase II of the study were eligible for fecal sample testing. The present report concerns the operations that completed fecal sample testing.

We briefly describe the study design, study questionnaires, and data collection procedures. For additional detail, see the NAHMS Equine Study 2015 tabular summary reports and study materials (USDA et al., 2015a; USDA et al., 2015b; USDA, 2015c; USDA, 2016; USDA, 2017). U.S. equine operations with 5 or more equids were targeted for inclusion in this study. A total of 28 States were selected for inclusion in the study based upon each State's contribution to the total number of U.S. equine operations, number of equids, and equine density (number of equids per square mile). The 28 States represented 71.6 percent of all equids on farms with 5 or more equids in the United States and 70.9 percent of all U.S. operations with 5 or more equids.

A stratified random sampling design was used and 3997 operations were selected to be part of the sample. Stratification was based on State and size of operation from the 2012 Agricultural Census (where "size" is defined as the number of resident equids—5 to 9, 10 to 19, and 20 or more). The total sample size was computed to produce estimates with coefficients of variation of 0.20 or less while accounting for the estimated population size, design effect, and expected response rate at the 95 percent confidence level. Population sizes were provided by NASS and can be found in NAHMS tabulation summaries (USDA, 2014a; USDA, 2016). The design effect for the stratified random sampling scheme was estimated to be 2, based on the results from previous NAHMS national studies, while the expected response rate was assumed to be between 60–75% at each phase of the study, based on previous NAHMS national equine studies (USDA, 1999; USDA, 2006).

The reference population was composed of all places/operations in the NASS list frame with 5 or more equids that meet the NASS Agricultural Census (USDA, 2014b) definition of a farm for the 28 States. Sample data were weighted to reflect the reference population from which they were selected (Särndal et al., 1992). The inverse of the probability of selection was used as the initial weight and then adjusted for nonresponse within State and operation size strata using an additional adjustment according to the proportion of non-respondents within each stratum.

2.2. Data collection

From April through July 2015, NASS-trained enumerators administered the Phase I questionnaire through in-person interviews with equine operation personnel who knew best about the management of equids on the operation. During the Phase I administration, the NASS-trained enumerators determined the operator's willingness to be contacted by Veterinary Services for participation in Phase II of the study. Start of Phase II of the NAHMS Equine 2015 study was delayed due to Veterinary Services' response to the highly pathogenic avian influenza outbreak that occurred in 2015. Some operations elected to complete the parasite management portion of the Phase II questionnaire via mail. The remaining operations completed the parasite portion during Veterinary Medical Officer (VMO) and/or Animal Health Technician (AHT) in-person visits to equine operations from May 1 through October 15, 2016. The VMO/AHT personnel completed specialized training in preparation for on-site visits to equine operations. Operations completing the Phase II parasite questionnaire were eligible to submit fecal samples for testing. Fecal samples were collected between August 31, 2015 and December 20, 2016.

2.3. Questionnaires

2.3.1. Phases I and II - general management data

The Phase I questionnaires (USDA et al., 2015b) were used for collecting general management, vaccination, internal parasite control,