Master of Public Health

Integrative Learning Experience Report

Veterinarian and Para-Veterinarian Perceptions on Canine Hookworms and Riley County's Community Health Improvement Plan Assessment

by

Sara Jessica Ochoa

MPH Candidate

submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

Graduate Committee:
Justin Kastner B.S., MSc, PgDip, Ph.D.
Ellyn Mulcahy B.Sc., MPH, Ph.D.
Paige Adams B.S., DVM, Ph.D.

Public Health Field Experience Sites:
Kansas State University, Department of Diagnostic Medicine/Pathobiology
October 2021 – March 2022
Riley County Health Department
January 2022 – April 2022

Site Preceptors:
Jeba Jesudoss Chelladurai BVSc & AH, MS, Ph.D.
Shanika Rose B.S., M.A.

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2022

Copyright

SARA JESSICA OCHOA

2022

Abstract: Canine Hookworms

Canine hookworms (*Ancylostoma caninum)* are zoonotic intestinal parasites that cause anemia and weight loss in dogs and Cutaneous Larva Migrans in humans, demanding a One Health perspective. This perspective allows veterinarians, health care providers, and others to collaborate to achieve optimal health outcomes for their patients. Overuse of anthelmintics (dewormers) over time has caused the emergence of resistance in several populations of canine hookworms. Anthelmintic resistant hookworms have now spread to many canine breeds. Given the major role of veterinarians, the goal of this cross-sectional study was to obtain a better understanding of current practices and veterinarians' perceptions about diagnosing, treating, and controlling canine hookworms. The survey was taken by 180 veterinarians in 42 states between February and March 2022. We found that 67% of surveyed veterinarians answered they were aware of hookworm prevalence in dogs in their area within the last year. Many respondents (46%) answered that there was no breed predilection but hounds (42%), mixed breed dogs (26%), and pit bulls (17%), were perceived to have a higher predilection. Roughly 36% responded it is very common for dogs with hookworms to be asymptomatic. Most veterinarians (48%) mentioned that their patients are on annual broad-spectrum preventatives that include hookworms. About 43% of veterinarians stated that they have dealt with a hookworm positive dog suspected of drug resistance or reinfection and had to change the course of treatment. Client education on zoonotic infection was always performed by 26% of veterinarians. Control measures advocated include removing feces from yards or parks, prevention of scavenging, having pets on monthly preventatives, and enforcing leash laws. The results from this survey will help veterinarians better consult with clients in the future as well as create a more effective course of treatment, in light of emerging drug resistance in hookworms.
Subject Keywords: Hookworms, Canine, Veterinarians, Para-Veterinarians, Survey, Parasite

Abstract: CHIP Process

The Riley County Health Department introduced a new process to create a better and healthier community. The goal of the Community Health Improvement Plan was to gain community members' and stakeholders' opinions on Riley County and what are its needs and strategies. Apart from gathering vital health information in the community, the Community Health Improvement Plan process is intended for community members and stakeholders to take ownership and partnership in making Riley County a healthier and happier place to live. The Community Health Improvement Plan is the last step of a multitude of assessments. The process is structured into 4 different steps: comprehensive community needs assessment, local public health systems performance, community listening sessions, and a community health improvement plan. Each step has its own importance. The comprehensive community needs assessment surveyed the community to collect data for future use in the community listening sessions. The Local Public Health Systems assessment brought together subject matter experts such as County commissioners, school superintendents, and public service leaders to discuss the current performance of the health system. Community Listening Sessions were held multiple times (in-person and virtually) to receive public opinions on their experience with the public health system in Riley County. The Community Health Improvement Plan is the culmination of all data analysis putting forth a plan for public health in the future years. The results of these steps work cohesively to develop health priorities in the community and stakeholders coordinate to improve the priorities. The priorities are refined in the next couple of years. Every 3-5 years a new process begins, and new priorities are assessed. The first set of priorities included communication and coordination of systems and services, transportation, and mental health. This Community Health Improvement Plan has not selected priorities yet; the priorities will be published in the early fall of 2022. Due to the Covid-19 pandemic, the process was paused in 2020 and not continued until 2022.

Table of Contents

List of Figures

List of Tables

Chapter 1: Literature Review

Canine hookworms—*Ancylostoma caninum, A. brazilense*—are intestinal parasites which get their name from their "hook-like" appearance that helps them attach to the intestinal wall of the host. Of these, *A. caninum* is the most common in the United States. Hookworms consume large amounts of blood from the intestinal wall causing several life--threatening issues to the host. Canine hookworms are zoonotic parasites that can be transmitted from animal to human, causing a One Health concern. Human hookworm disease is found in 740 million people worldwide, but is caused by related parasites—*Ancylostoma duodenale, Necator Americanum, and A. cevlanicum* (*Hookworm Disease*, 2021). While *A. caninum* rarely causes patent infections in humans, larval stages of cause CLM.

Canine hookworms, particularly *Ancylostoma caninum* or *Ancylostoma braziliense* have three stages: egg, larvae, and adult (Burke, 2016). The cycle begins when eggs are passed in the host's stool. L1 larvae hatch within 1-2 days under favorable conditions such as warm and moist weather. After 5-10 days, the larvae become filariform (thin hairlike) L3 larvae. The L3 larvae can then survive weeks, up to a month under favorable conditions, contaminating the environment. L3 larvae are infectious and can penetrate the skin. The larvae then make their way through the host's body through the lungs, trachea, and are coughed up and swallowed before finding their way into the intestine where they mature into adults and lay eggs. Adult hookworms located in the small intestine attach themselves to the intestinal villi using their mouth cavity (*Companion Animal Parasite Council | Hookworms*, 2020). Specifically, adult female and male hookworms are bent dorsally, making their ends look like a fishing hook. *A. caninum,* has the unique characteristic of having three pairs of teeth in the buccal cavity, giving these types of hookworms a better opportunity to attach to the intestinal wall. Eggs range in size from 55 to 90 micrometers by 30 to 55 micrometers depending on the species. Adult canine hookworms range in size from 10 to 20 millimeters by 0.4 to 0.5 millimeters (*Companion Animal Parasite Council | Hookworms*, 2020).

Figure Error! No text of specified style in document.**-1: Ancylostoma caninum teeth (*Companion Animal Parasite Council | Hookworms*, 2020)**

Methods of transmission for canine include oral ingestion of L3s, direct contact with L3s, and through mother's milk (Burke, 2016). Dogs can acquire hookworms by ingesting infected L3s when cleaning their paws, in public areas like local dog parks, or even in their backyard. Dogs can come into direct contact with hookworms L3s in warm, sunny, and moist environments. Mothers who are infected with hookworms can transmit them to their offspring and when feeding after birth. Clinical signs for dogs who are suffering from hookworms include anemia, bloody diarrhea, itchy paws, intestinal bleeding, pale gums, poor growth, and in more severe cases, death (Ward, 2022)

To diagnose dogs with hookworms, a clinical method known as fecal floatation is performed. There are two types of fecal flotation methods: centrifugal fecal flotation and passive flotation. Centrifugal fecal flotation consists of a small fecal sample mixed with a flotation solution (Sheather's Sugar or Zinc Sulfate), strained to remove debris, poured into a tube, centrifuged for 5 minutes at 1200-1500rpm, allowed additional 5-10 minutes for the tube to set and then placed on a slide to look under a microscope (Herrin & Dryden, 2021). A passive flotation consists of a small fecal sample and solution mixed in a disposable container. The solution will help the fecal matter mix together and let the eggs rise to the top of the container, roughly 15-20 minutes are allotted for the process to occur. A cover slip is added to the top of the container where eggs can attach. Once time is up the coverslip can be looked at under a microscope. Centrifugal fecal flotation and passive flotation are used in veterinary clinics and hospitals but have their costs and benefits. Centrifugal fecal flotation is a more expensive technique, in terms of initial costs, includes more steps, and uses more equipment however, it is more reliable, accurate, and sensitive than the passive flotation method.

Treatment for canine hookworms varies depending on the severity of infections in the patient. Treatment can consist of anthelmintics treatments, electrolyte therapy, topical spot-on fluids, a high-protein diet, and blood transfusions. Veterinarians can prescribe one or more of the following medications: moxidectin, praziquantel, pyrantel pamoate, febantel, ivermectin, milbemycin oxime, fenbendazole, lufenuron, and spinosad (*Companion Animal Parasite Council | Hookworms*, 2020). The type of anthelmintic treatments and doses differ depending on the hookworm stage. Typically, after a dog has been infected and treated, veterinarians test and treat the infected dog again 2-4 weeks after the initial treatment. Once the dog is no longer infected with hookworms, veterinarians strongly encourage the client to put their pet in monthly preventative care.
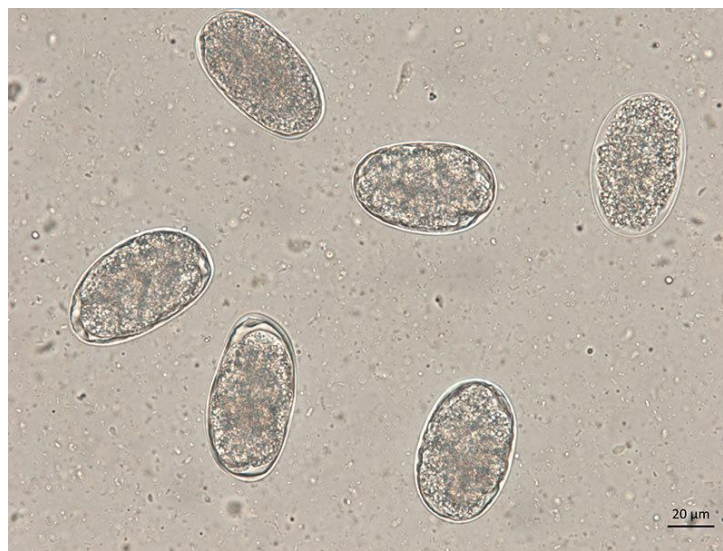
Figure Error! No text of specified style in document.**-2: Hookworm eggs under a microscope (*Companion Animal Parasite Council | Hookworms*, 2020)**

Humans cannot directly become infected with hookworms through a pet but can become infected with hookworm L3s when coming into direct skin contact with an environment harboring the parasite. This can occur when people walk barefoot outside and on contaminated sand or soil. Once a human is infected via direct skin penetration of the infective larvae, humans can suffer from cutaneous larva migrans, also known as CLM. Cutaneous larva migrans are distinguished from the cutaneous manifestation of *Strongyloides stercoralis* infection termed larva currens (Maxfield & Crane, 2022). A person who comes into direct skin contact with hookworms can start developing symptoms within a few days, depending on the severity of the person, symptoms include intense pruritis (uncomfortable intense itching), irregular erythema, swelling, and red growing lesions on the foot (*CDC - Zoonotic Hookworm - Resources for Health Professionals*, 2021). Typically, hookworms penetrate feet or where the skin is not protected by

clothing. Hookworms appear in a track-like appearance moving several millimeters per day and can be 3 millimeters wide. Even though hookworms puncture through the host's superficial cutaneous layers, they are incapable of penetrating the basal membrane to enter the lymphatic system (Maxfield & Crane, 2022). At this point, hookworms stop migrating and die. It normally takes 5-6 weeks in a human host for all hookworms to die and the course of CLM is considered self-limiting (*CDC - Zoonotic Hookworm - Resources for Health Professionals*, 2021). Treatments for CLM and hookworms are available but may not be effective to help the individual control pain and prevent secondary bacterial infections. Health care physicians prescribe topical anthelminthics over the affected area and oral albendazole or ivermectin (*CDC - Zoonotic Hookworm - Resources for Health Professionals*, 2021).
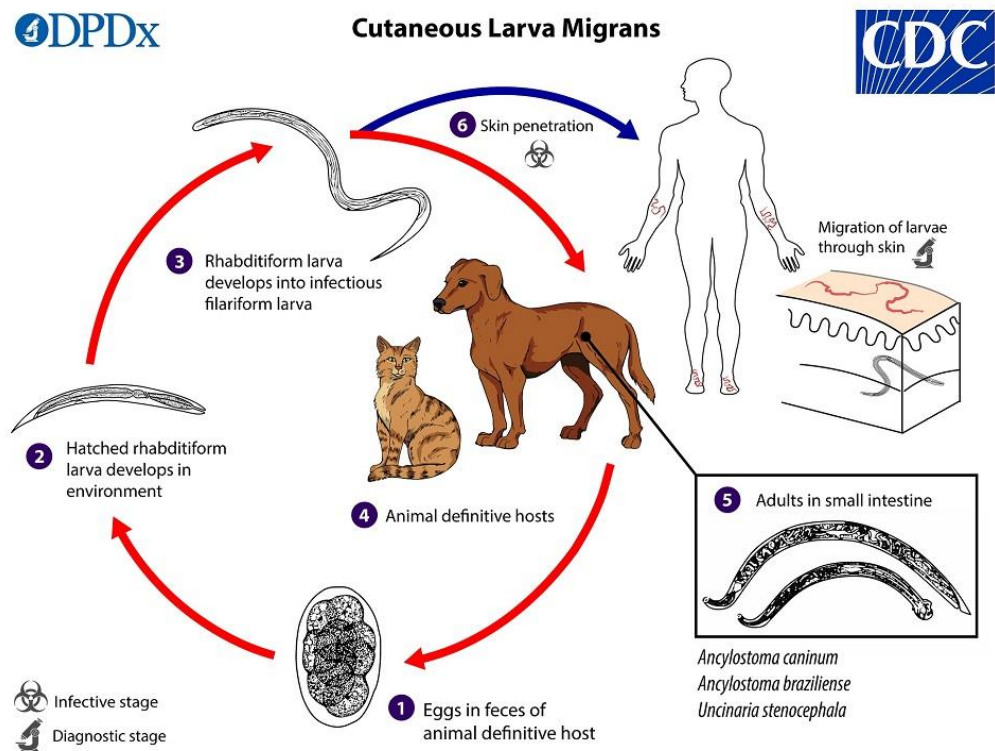
Figure Error! No text of specified style in document.**-3: Zoonotic Hookworm Lifecycle (*CDC - Zoonotic Hookworm - Biology*, 2019)**

To control the spread of canine hookworms, proper precautions should be taken. Puppies infected with hookworms require a more frequent dose of anthelmintic administration than adult or older dogs because they can become infected while nursing. Adult dogs are known to harbor parasite larvae which mature and lay eggs at a later time (*Companion Animal Parasite Council | Hookworms*, 2020). Having puppies on hookworm preventatives is crucial, if left

untreated, it can lead to a serious issue and cause other health problems or even death before being diagnosed or treated. Puppies should be started on preventatives and anthelmintics as soon as possible as well as their mother. Puppies can be treated with anthelmintics and dewormed as young as the label allows (2 weeks). Adult and older dogs should be dewormed, fecal tested, and started on monthly preventatives. If owners do not want their pets to be put on monthly preventatives, they can treat their adult pets four times a year with a broad spectrum anthelmintic with efficacy against internal parasites and get fecal tested (*Companion Animal Parasite Council | Hookworms*, 2020). Other control measures to decrease the number of canine hookworm cases include the removal of feces from yards or parks, preventing scavenging, having pets on monthly preventatives, annual fecal testing, and enforcing leash laws. Humans can also decrease their chances of becoming infected by implementing hygienic practices such as frequent hand and body washing, avoiding being barefoot (especially in places with sand), and avoiding playing in contaminated sand.

Research has shown that the marked increase in the number of hookworm infections began in the greyhound racing community (Jimenez Castro & Kaplan, 2020). Hookworms were transmitted from animal to animal through kennels and racing meets. Route of transmission included ingestion from a contaminated environment, penetration of the skin, or ingestion of consuming infective insects like cockroaches. Although the greyhound racing personnel were aware of the hookworm infections, proper care and cleaning were not administered to mitigate the ongoing problem. The evolution of multi-drug resistant hookworms is a result of a multitude of events, but mainly the long-term use of anthelmintics and the epidemiologic dynamics of the greyhound racing environment (Jimenez Castro & Kaplan, 2020). The abuse of anthelmintics also contributed to multi-drug resistance because certain drugs were being used on Greyhounds instead of their intended and authorized use for livestock (Cima, 2021). The drugs contained the same active ingredients as prescription anthelmintics but different formulations, letting non-veterinarians purchase these anthelmintics (Cima, 2021).

This led to a multi-drug resistant infection in dogs. Castro et al. defines anthelmintic resistance as a heritable genetic change in a parasite population that enables a significantly greater proportion of individual parasites to survive treatment at a dose that was previously effective against the same species and developmental stage (Jimenez Castro & Kaplan, 2020). This problem was mainly isolated to the greyhound racing industry until greyhound dogs began to retire from the racing circuit due to old age or injuries. As these infected animals were released for public adoption, naturally hookworm infection spread to other breeds. Certain canine hookworm samples have indicated resistance to all three anthelmintic drug classes that

are approved for treatment in the U.S. (Cima, 2021). The Food and Drug Administration has approved a drug for hookworm-infected cats that contains emodepside and praziquantel (Cima, 2021). There has been thought of using this product on dogs, but such usage would be considered an extra-label drug use and would come with heart-worm-related concerns (Cima, 2021).

Dr. Antoinette Marsh, associate professor at the Ohio State University College of Veterinary Medicine, current president of the American Association of Veterinary Parasitologists (AAVP), and member of the AAVP task force, said hookworms release hundreds of eggs per gram of feces and hundreds of thousands of eggs in a kennel (Cima, 2021). The overabundance of genetic material at a certain pressure from the anthelmintics produces opportunities for hookworm strains to change their genetic material, allowing the hookworms to become dominant and survive (Cima, 2021). In an interview, Dr. Marsh said, "If you deworm the dogs and one or two of the strains have had a genetic change which allows them to be drug-resistant, they can actually then take over the whole population" (Cima, 2021).

Research has shown that although there are multiple ways to diagnose canine hookworms, there is only one clinical test that is useful for diagnosing anthelmintics resistance in *A. caninum.* This test is known as the fecal egg count reduction test (FECRT) and allows diagnosticians to measure the number of eggs per gram of feces before and after treatment (Jimenez Castro & Kaplan, 2020). This method is common to large animal veterinarians but is not used as much in small animal practices. With the emergence of multi-drug resistant hookworms, veterinarians are strongly encouraged to start using FECRT (Jimenez Castro & Kaplan, 2020).

The Companion Animal Parasite Council (CAPC) is an independent, non-profit organization that is dedicated to parasite awareness (*About CAPC*, 2022). The organization has a credible website where acute and up-to-date information is posted, as well as parasite diagnosis, treatment, prevention, control, and facts. Aside from the website containing parasite guidelines, articles, video archives, and library resources, CAPC has current and yearly parasite prevalence maps dating back to 2012.

Ancylostoma caninum is a common parasite in dogs throughout the United States and is found in tropical and subtropical environments (*Hookworms*, 2020). A survey in 1996 showed that 19% of the fecal samples collected across the U.S. contained *Ancylostoma spp.* eggs and their results also showed that *Ancylostoma* prevalence ranged less than 5% in the western states and 36% in the southeastern states (*Hookworms*, 2020). Past research has also shown

that *A. caninum* in particular is found in warmer southern states in the U.S. and in dogs who spend most of their time outdoors.
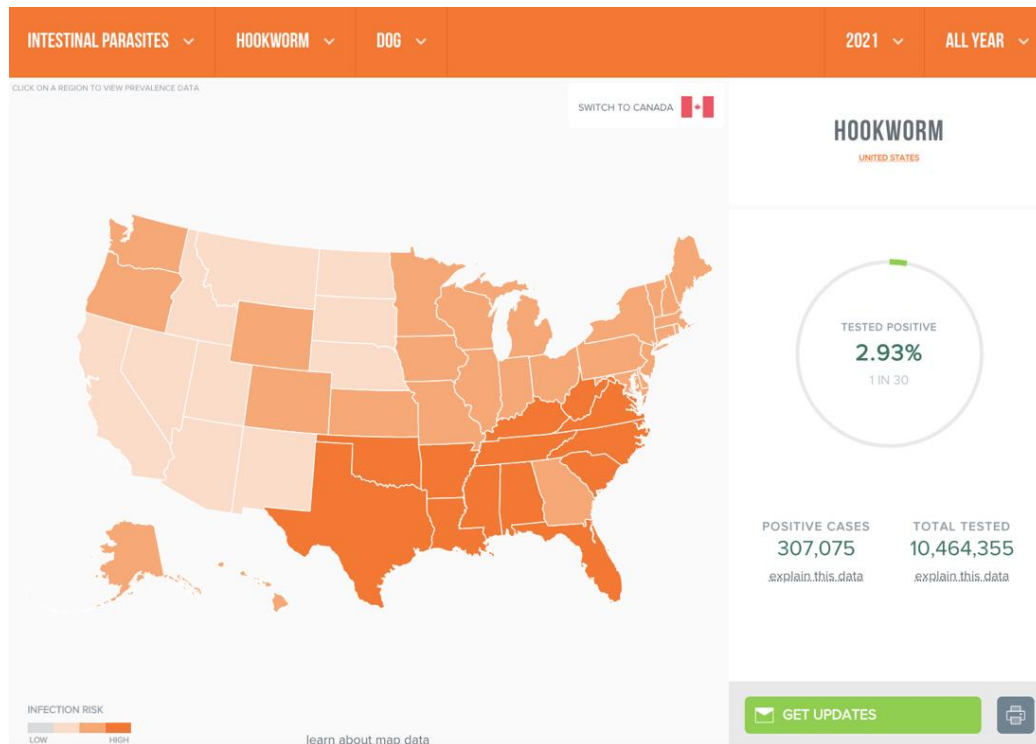
Figure Error! No text of specified style in document.**-4: United States map of canine hookworm prevalence in 2021 (*Parasite Prevalence Maps,* n.d.-a)**

According to CAPC's prevalence map, there was a total of 10,464,355 dogs tested for hookworms and 307,075 positive canine hookworm cases in 2021 (*Parasite Prevalence Maps*, n.d.-a). That is, 2.93% of dogs (1 in every 30 dogs) tested positive for hookworms in 2021(*Parasite Prevalence Maps*, n.d.-a).
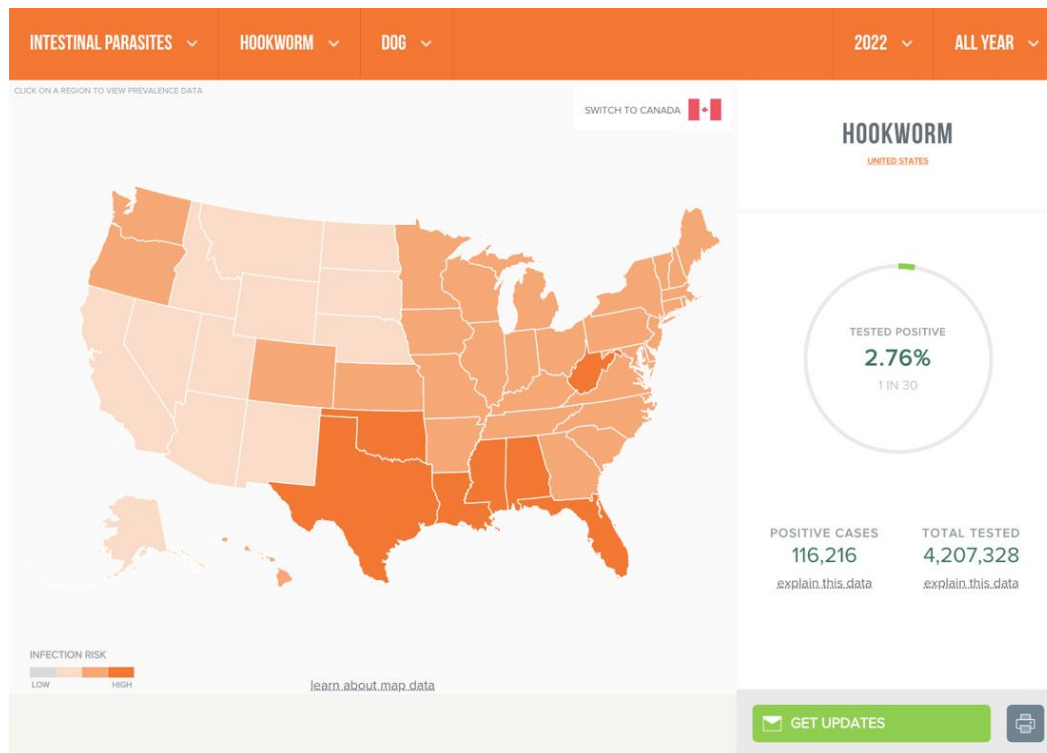
Figure Error! No text of specified style in document.**-5: United States map of canine hookworm prevalence in 2022 (*Parasite Prevalence Maps*, n.d.-b)**

According to the CAPC prevalence map, there was a total of 4,207,328 dogs who tested for hookworms and 116,216 dogs who tested positive for hookworms in 2022 (2.76% of dogs or 1 in 30 dogs) (*Parasite Prevalence Maps*, n.d.-b).

According to the CDC, One Health is a collaborative, multisectoral, and transdisciplinary approach-working at the local, regional, national, and global levels to achieve optimal health outcomes by recognizing the interconnection between people, and animals, plants, and their shared environment. The foundation of the One Health Approach is to communicate, coordinate, and collaborate among human, animal, environmental health, and other relevant partners (*One Health | CDC*, 2022). Zoonotic hookworms are a parasitic infection that threatens the health of humans and dogs and should have a One Health approach. Veterinarians and physicians need to come together and collaborate to come up with a plan to control and decrease hookworm's incidence. This emerging issue has no breed predilection, has the potential to infect humans, and some strains are already multi-drug resistant.

In the Fall of 2021, I contacted Dr. Jamie Retallick, associate professor and director of the Kansas State Veterinary Diagnostic Laboratory, to see if she knew of any professors who had projects that would fit my applied practice experience. Shortly thereafter, I received an email from Dr. Jeba Jesudoss Chelladurai, a faculty member at the Kansas State University

College of Veterinary Medicine Diagnostic Medicine/Pathobiology. Dr. Chelladurai graduated with a Bachelor of Veterinary Science and Animal Husbandry (BVSc & AH) from Madras Veterinary College in Chennai, India. She then pursued a Masters in Microbiology from North Dakota State University in Fargo, North Dakota. Soon after that, she pursued her third degree, a Ph.D. in parasitology from Iowa State University in Ames, Iowa. Dr. Chelladurai has been awarded the American College of Veterinary Microbiologists (ACVM) diplomate for Veterinary Parasitology and Veterinary Immunology. At Kansas State University, Dr. Chelladurai spends a good portion of her time performing research and teaching. She is a co-instructor for the Clinical Veterinary Parasitology course for second-year veterinary students. Dr. Chelladurai also teaches the Parasitology portion of the Diagnostic Medicine Rotation for fourth-year veterinary students.

Dr. Chelladurai wanted to start a project regarding veterinarian perceptions of canine hookworms since there are not many surveys that exist. The purpose of this project was to survey U.S. veterinarians on their perceptions of prevalence, breed predilection, diagnoses, treatment, resistance, and client communication on canine hookworms. We were interested to also see if veterinarians are up to date on canine hookworm facts such as being zoonotic, multi-drug resistant, and on the One Health responsibility they assume when communicating with clients. My role in this project was to develop IRB protocol, create a survey using Qualtrics, distribute a survey to veterinarians in the U.S., gather, and analyze data.

RCHD—CHIP Process

Riley County is located in the northeastern part of Kansas, consisting of five incorporated cities, Manhattan, Ogden, Riley, Leonardville, and Randolph. According to the census, Riley County's estimated population as of July 2021 is 72,208 (*U.S. Census Bureau QuickFacts*, 2021). Out of the 105 Kansan counties, Riley County is ranked as the 7th largest county by population (*Kansas Counties by Population*, 2020). Riley County's health department is in Manhattan, KS. Out of the total health departments in the state of Kansas (not including Fort Riley's health department), seven health departments are accredited, with Riley County being one of them (Public-Health-Accreditation-Board, 2022). The health department was recognized by the Public Health Accreditation Board (PHAB) in 2020 to meet the national standards that provide the essential public health services. Riley County health departments' mission is to "promote and protect the health and safety of our community through evidence-based practiced, prevention, and education" (*About Us - Riley County Health Department | Riley County Official Website*, n.d.). The health department strives to work with other organizations and agencies to create a better and healthier community. Riley County Health Department (RCHD) offers a multitude of services to the community at the health clinic and other departments such as breast cancer awareness, child care licensing, communicable diseases, community health promotions and wellness, emergency preparedness, immunizations, integrated referral and intake system, maternal and child health, raising riley, reproductive health services, sexually transmitted infections, sharps disposal, tuberculosis, and hepatitis control, and women infants and children nutrition (*Services | Riley County Official Website*, n.d.). In addition to these services, RCHD has partnered with several institutions such as Via Christi Health, Riley County Senior Service Center, Konza United Way, and First United Methodist Church to establish a Community Health Improvement Plan or CHIP. Steering committee members include Blue Cross and Blue Shield of Kansas, Pathways to a Healthy Kansas, Flint Hills Wellness Coalition, Ascension Via Christi, Konza Prairie Community Health Center, Pawnee Mental Health Services, and others (*RCCHIP - Home*, 2022). The goal of the CHIP process is to invite the county communities and organizations to identify health issues, create and apply strategies, and establish accountability through health improvement by using the health assessment data collected. There have only been two CHIP processes that RCHD has been a part of. The first one was published in 2015 and the next one was supposed to be in 2020 but was set back to 2022 due to the Covid-19 pandemic.

Every three to five years, Riley County organizations encounter several assessment efforts which become the basis for the CHIP. These assessment efforts include Comprehensive Community Needs Assessment (CCNA) and Local Public Health Systems Assessment (LPHSA). The CCNA comprises of community surveying, focus groups, and data review. Data collected from Riley County members consists of certain areas of interest such as quality of life, physical health, mental health, social issues, children and youth, education, aging, housing, transportation, infrastructure, and economics and personal finance.

Once data is gathered and analyzed, the second assessment takes place. The LPHSA involves an event where community stakeholders and subject matter experts review Riley County's public health system. Participants in this event include but are not limited to elected officials, physicians, professors, teachers, principals, childcare providers, public safety agencies, and health department personnel. In this event, stakeholders and experts are grouped to discuss the benefits, limitations, and improvements in the local public health system. Participants also identify how resources in the community can enhance the health, safety, and quality of its members. They do so by using a national standardized tool known as the 10 essential public health services which include: monitor community health status, diagnose and investigate health problems and hazards, inform and educate about health issues, mobilize community partners to solve health problems, develop policies and plans that support health efforts, enforce laws that protect health and safety, link people to services and assure the provision of healthcare, assure competent public health and healthcare workforce, evaluate the effectiveness and population-based health services, and research new insights to health problems (*CDC - Public Health System and the 10 Essential Public Health Services - OSTLTS*, 2021). The 10 essential public health services are divided into three functions assessment, policy development, and assurance (*Community Health Assessment and Improvement Planning - NACCHO*, 2022). These core functions are the main purpose of public health. Each participant at the LPHSA votes on each essential service and scores based on the activity level of the community, no activity, minimal activity, moderate activity, significant activity, or optimal activity. Ideas between stakeholders are shared and begin to plan how to improve other areas of need in the community. Results are then collected and published once the process is completed.
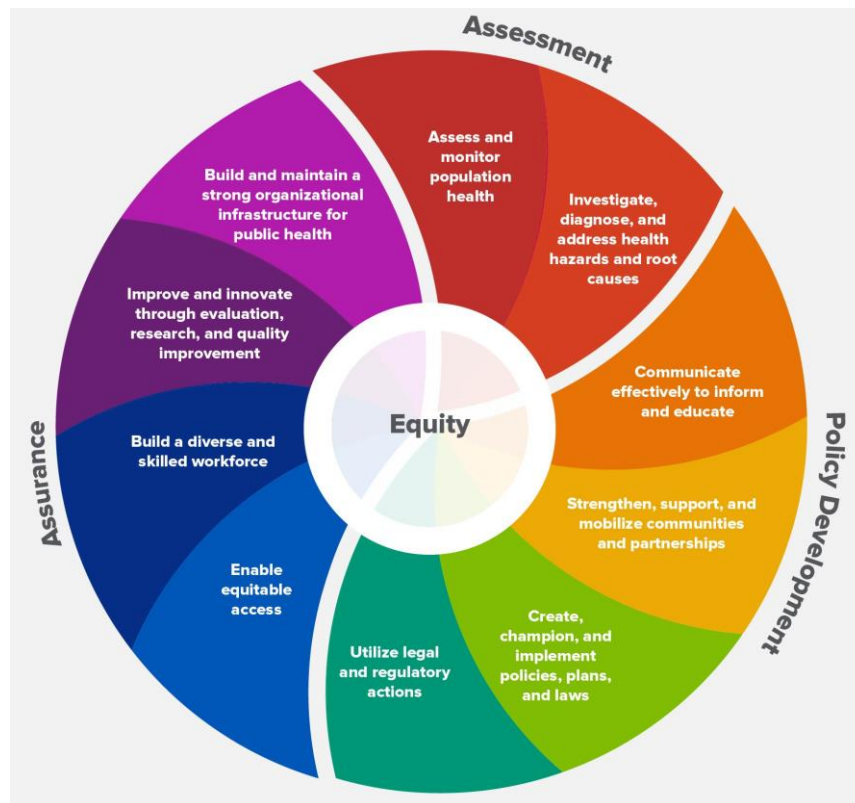
Figure Error! No text of specified style in document.**-6: 10 Essential Public Health Services (*CDC - Public Health System and the 10 Essential Public Health Services - OSTLTS*, 2021)**

The next assessment consists of community listening sessions. These sessions could be held in person and virtually. Sessions in person were held in public places such as the public library, elementary schools, and senior citizen centers. Community listening sessions involved the public coming together to listen to Riley County's collected data and voting on their top health priorities that the county should focus on for the next couple of years.

The last step of the CHIP process is analyzing the responses from the community listening sessions and coming into a conclusion of what are the three main priorities the county needs to improve on. Once this is settled, RCHD and its partners compile all the data from the CCNA, LPHSA, and community listening sessions to create an overview of the RCHD CHIP process.

In the Fall of 2021 Dr. Ellyn R. Mulcahy, Director of the Master in Public Health Program and associate professor in the diagnostic medicine and pathobiology department at Kansas State University, sent a mass student email from the Riley County Health Department (RCHD) asking for interns for their community health improvement program (CHIP). Soon thereafter, I applied for the internship that would be starting in the spring semester. I received an acceptance email from RCHD's main office and an email from Mrs. Shanika Rose. Mrs. Rose is the Health

Educator/Accreditation Coordinator and the performance improvement manager for the RCHD, her overall role is to promote public health, facilitate, develop, implement, and evaluate public health efforts in the community in an integrated and collaborative approach. At RCHD, Mrs. Rose also assists with overall grand efforts to include reviewing grant proposals, data collection, and grant writing, as needed. Mrs. Rose graduated from Kansas State University with a Bachelor of Science in Family Studies and Human Services with an emphasis in Family Life and Community Service in 2002. After taking a break from school, Mrs. Rose graduated from Liberty University with a Master of Arts in Human Services with an emphasis in Business in 2013.

The purpose of the CHIP process is for community members to collaborate into creating a healthier, happier, and better county by collecting data, prioritizing issues, developing goals, and taking action. When I started interning at RCHD, Riley County's data was already collected. The CHIP process was at the LPHSA stage. My role was to invite stakeholders and subject matter experts to the LPHSA, help organize the event, create marketing flyers for the community listening sessions, and attend the sessions. Mrs. Rose graciously let me lead two community listening sessions. The first session I led was to the Spanish-speaking community, and the second one I shared with the other intern Ryan. We created a new session geared toward college students and presented it at Kansas State University.

Chapter 2: Learning Objectives and Project Description

During our first meeting, Dr. Chelladurai discussed the topic and goals she had in mind for this project. We both then collaborated on ideas, pros, and cons and created a plan. We then concurred we would survey veterinarians and para-veterinarians on their knowledge of hookworms, particularly *Ancylostoma caninum*. The goal of this cross-sectional study was to determine what were the veterinarian's course of treatment and prevention for their patient, as well as educate clients about the dangers of hookworms in their area. We decided to have weekly scheduled meetings along with weekly tasks to achieve for the next meeting. Before starting the project, I completed the required training courses from the Collaborative Institutional Training Initiative, also known as CITI. These courses included: Export Compliance, Human Subjects Research (HSR) – IRB researchers and personnel on IRB protocols, HSR – Internet Research, and responsible Conduct of Research (RCR). Once the CITI training was complete, approved and an IRB number (#IRB-10954) was assigned, Dr. Chelladurai introduced me to Qualtrics where our veterinarian and para-veterinarian surveys were created. I explored using the Qualtrics interface and got creative using different methods of answering choices for the questions. I then started writing two different surveys, one for the veterinarians and the other for the para-veterinarians. The difference between these two surveys is the number of questions in each survey. The veterinarian survey consisted of 16 questions, while the para-veterinarian survey had a total of 13 questions. The 3 additional questions in the veterinarian survey regarded medication and treatment. Once the surveys were polished and ready for publishing, Dr. Chelladurai contacted Dr. Hanzlicek who oversees the client care section of the KSVDL. After Dr. Chelladurai spoke to him, he graciously agreed to send out our survey to his contacts. I then wrote a brief summary of what the project was about to be added with the survey link in the email.

The survey was sent out on February 1, 2022, and again on February 11, 2022. While the survey was sent to participants, I started a master excel spreadsheet for each survey. I then had a sheet for each survey question in the excel sheet. I collected data twice a week from Qualtrics and imported the data into the corresponding excel spreadsheet. The survey was open for 1 month and 3 days, March 3, 2022, was the last day I collected data for this project. Once all the data was in the master excel sheets, I started to analyze data by color coding or dividing answer choices and started making graphs and/or tables for each survey question. I made several different graphs for each survey question like pivot tables, bar graphs, pie charts, and stacked bar graphs. I then proceeded to start a PowerPoint presentation for each survey

question graph. I made a few changes to some graphs and started choosing the color scheme. I then added the graphs and tables to my ILE. In April, I registered and applied for a poster presentation for the annual American Association of Veterinary Parasitologists (AAVP) meeting held in Snowbird, Utah in June. Our poster presentation titled "Survey of U.S. Based Veterinarians' Perceptions on Canine Hookworms" was accepted. Dr. Chelladurai and I started creating the layout of the poster and gathering graphs for the poster. The poster went through many edits throughout June before being printed and presented at the annual meeting. During the annual AAVP meeting, I gave a 1-minute summary speech of the poster to the audience followed by poster sessions where I had roughly 3-4 minutes to explain our poster and answer questions. I received much positive feedback about the poster from reviewers and conference attendees.

RCHD—CHIP Process

Towards the middle of the Fall 2021 semester, I met with Dr. Mulcahy for institution suggestions of where I can complete my applied practice experience. She mentioned the local health department would be a good place to start and look for current or ongoing projects, she gave me Shanika Rose's contact information. I then contacted Shanika, the health educator/accreditation coordinator for the Riley County Health Department, who informed me of a project she will be starting in the spring. Shanika further briefed me on the topic by meeting on zoom. I would be part of a team working on the county's community health improvement plan, also known as CHIP. This strategic plan outlines the priority issues of the county as well as measurements and strategies to improve Riley County's health. Over email, I agreed I would intern at the health department over the spring semester and this project would be a part of my applied practice experience. I then applied and filled out paperwork for the health department and was accepted. Shanika and I stayed in contact every month until January 2022. A couple of weeks before the academic semester started, Shanika reached out and sent me some online training courses before my first day. I completed the required training courses from Kansas TRAIN which included: HIPAA Awareness – Module 1 (1047429), HIPAA: Allowable Disclosures and Safeguards – Module 2 (1072478), and HIPAA: Right to Access and Documentation – Module 3 (1072486).

My first day at the Riley County Health Department was on Tuesday, January 25, 2022. I met half of the team I was going to be working with, Shanika, my supervisor, and Ryan, another MPH intern. The rest of the team I met through emails and zoom meetings. The only time we met in person was at the community events like LPHSA and community listening sessions. As

part of the onboarding process, I completed more training courses regarding tobacco from the National Jewish Health. The required training courses included: Kansas Medicaid and Quitline Benefits for Tobacco Cessation, Best Practices for Tobacco Cessation Using Medication and Behavioral Support, Special Quitline Programs for Tobacco Cessation, Tobacco Cessation for Behavioral Health Populations, Connecting the Harms of Tobacco Use to Chronic Health Conditions, Vaping and E-Cigarette Devices, and Conversations for Screening, Responding, and Preventing Vaping.

Ryan and I collaborated a lot. Our first task was to organize the upcoming community meeting, the Local Public Health Systems Assessment meeting in February. We were in charge of inviting local community members like school district staff, councilmembers, commissioners, health care providers, and country department heads from the police and fire department, etc. After getting a head count of who would attend the meeting, Ryan and I created an excel spreadsheet and divided the community members into five teams, each team consisted of roughly eight to ten community members. Each team represented two essential public health services, and the members of each team would collaborate and determine if Riley County has exceeded, met, or failed these expectations. After two weeks of our team prepping for this meeting, the time came on February 16, 2022. The interns were in charge of the sign-in table and handing out each member their assigned folder for the meeting. A whole day of meeting community members and stakeholders of the county. I met and learned so much about Riley County. Ryan and I were fortunate enough to not only shadow and listen to the teams discussions, but we became a part of a team. Team E participants had to leave early, so we sat in to fill the team, and I received firsthand knowledge of what was happening in the county as well as the community.

Our next task was the community listening sessions that would span until May. Ryan and I created flyers for these meetings through Canva, a user-friendly design tool that is used to create visual content for social media, presentations, documents, and graphics. We created a flyer for each community input meeting, totaling up to twelve. Each meeting was designed for a specific audience. Before starting the community input meetings, Shanika gave us the option to choose a meeting we would like to present to, I chose the Spanish-speaking community. Ryan and I chose to create a meeting tailored to the college-age community since the last chip report did not include much response from the 18-24 age community.

Chapter 3: Results

The first release of the survey was on February 1, 2022. The surveys were sent from a Kansas State Veterinary Diagnostic Laboratory email listserv containing veterinarians' and para-veterinarians' emails. The surveys were sent out a second time on February 11, 2022. Data was collected between February 1 and March 3 2022. A total of 205 individuals participated in answering the survey. Out of the total, 180 respondents identified themselves as veterinarians, and the remaining 25 individuals identified as being para-veterinarians. Two surveys were created with different questions based on their initial answer of what role they had at the clinic, veterinarian, or para-veterinarian. The veterinarian survey consisted of 16 questions. The para-veterinarian survey had a total of 13 questions.

The following data regards the veterinarian survey results:

Q1 asked participants to identify their role in the clinic they work in. Out of the 205 respondents, 180 identified themselves as veterinarians.

Q2 asked veterinarians if they were small or mixed animal veterinarians. Out of the total 180 veterinarians, 67% (n=121) identified as being small animal veterinarians, and the remaining 33% (n=59) identified as a mixed animal veterinarian.

VETERINARIAN ANIMAL PRACTICE

Mixed **Small**
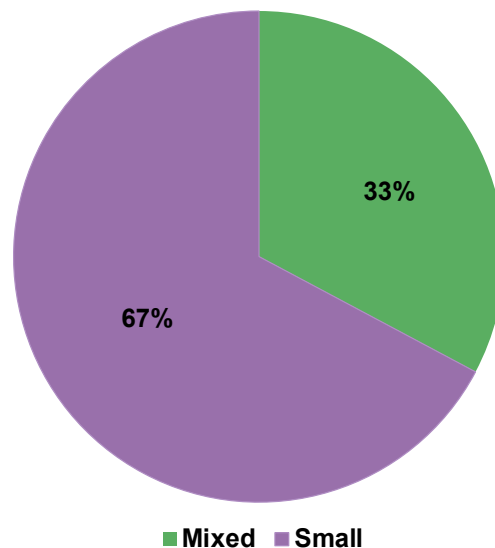
Figure Error! No text of specified style in document.**-7: Q2 Percentage of veterinarians who are in small or mixed animal practice. Created using Microsoft Excel and PowerPoint.**

Q3 asked veterinarians the zip code of their practice or workplace. A total of 42 states with at least one response was recorded.

Veterinarian Locations
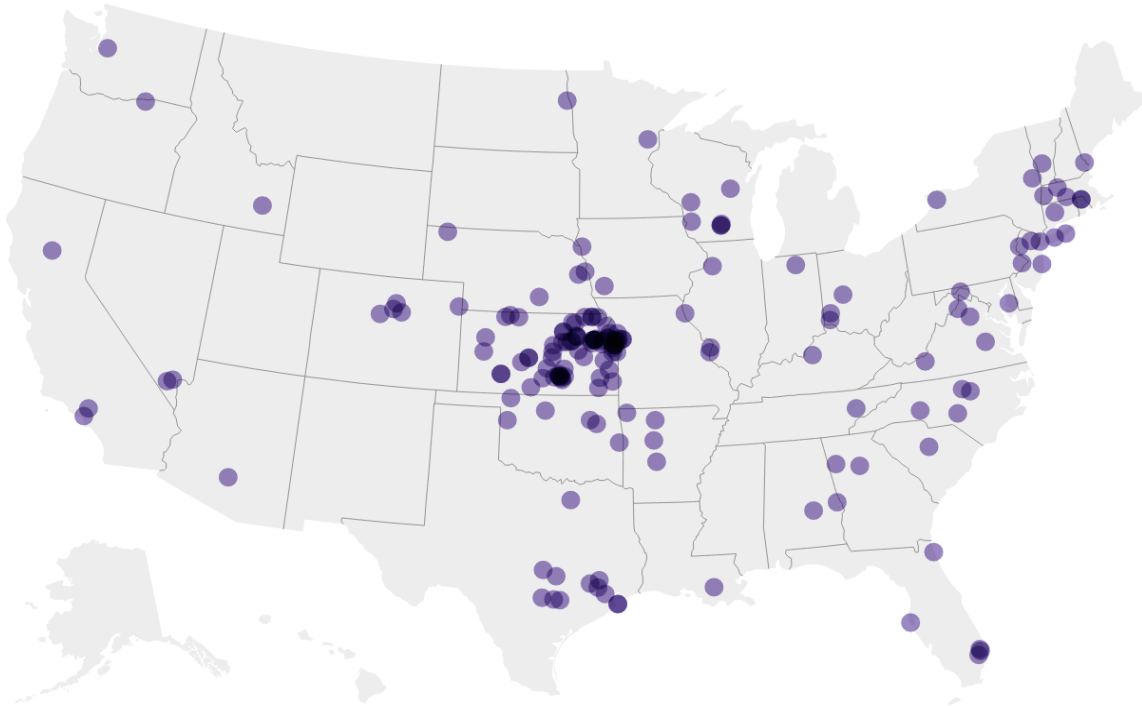
Created with Datawrapper

Figure Error! No text of specified style in document.**-8: Q3 U.S. map shows participating veterinarian locations of the Hookworm Survey. Created using Microsoft Excel and Datawrapper.**

Q4 asked if the participants were aware of hookworm prevalence in dogs in their area within the last year. The majority 67%, (n=111) of the veterinarians who responded to this question were aware of hookworm prevalence in canine in the past year. The remaining veterinarians' answers were recorded as: 20% (n=34) veterinarians stated they were not aware, and 13% (n=22) veterinarians said maybe they were aware of hookworms in their area.

HOOKWORM PREVALENCE AWARENESS

Maybe No Yes
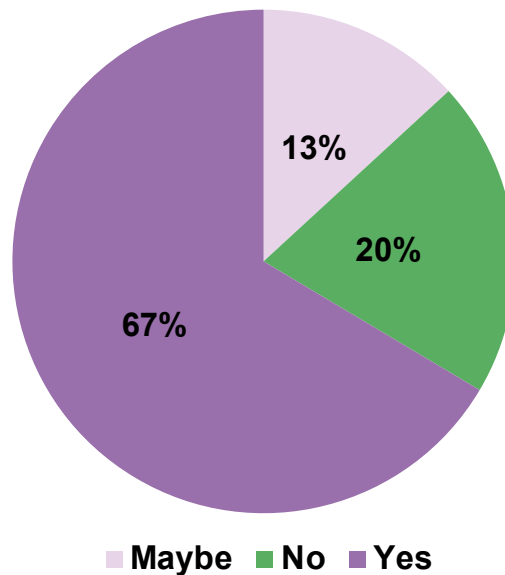
Figure Error! No text of specified style in document.**-9: Q4 Percentage of respondents who are aware of hookworm prevalence. Created using Microsoft Excel and PowerPoint.**

Q5 asked veterinarians how often they saw or diagnose a positive case of canine hookworms (of all breeds) in their practice during a month. Out of 159 veterinarians, the majority 20% (n=32) of veterinarians stated they diagnose roughly 5 dogs with a positive case of hookworms. The results recorded were: 6% (n=9) diagnose 0 dogs a month, 13% (n=21) diagnose 1 dog per month, 11% (n=17) diagnose 2 dogs a month, 8% (n=12) diagnose 3 dogs per month, 6% (n=9) diagnose 4 dogs a month, 3% (n=4) diagnose 6 dogs a month, 2% (n=3) diagnose 7 dogs a month, 4% (n=6) diagnose 8 dogs a month, 9% (n=14) diagnose 10 dogs per month, 1% (n=2) diagnose 11 dogs a month, 1% (n=1) diagnose 14 dogs a month, 7% (n=11) diagnose 15 dogs a month, 5% (n=8) diagnose 20 dogs a month, 1% (n=1) diagnose 24 dogs a month, 1% (n=2) diagnose 25 dogs a month, 1% (n=1) diagnose 27 dogs a month, 1% (n=1) diagnose 28 dogs a month, 1% (n=2) diagnose 30 dogs a month, 1% (n=1) diagnose 39 dogs a month, 1% (n=1) diagnose 40 dogs a month, and 1% (n=1) diagnose 42 dogs a month.

DOGS POSITIVE FOR HOOKWORMS IN A MONTH
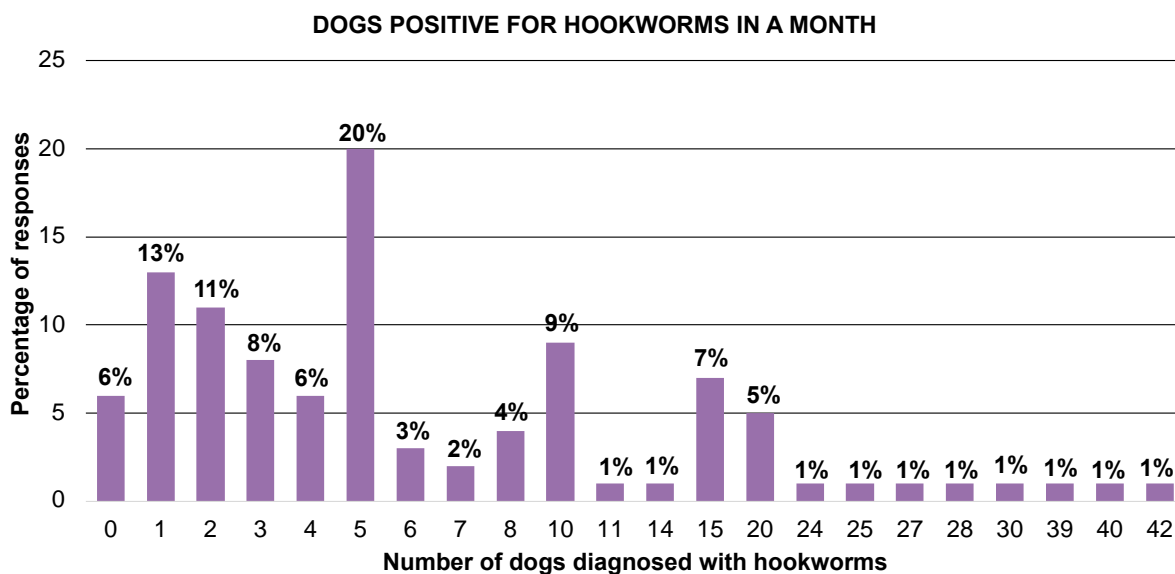
Figure Error! No text of specified style in document.**-10: Q5 A bar graph showing percentage of dogs diagnosed with hookworms in a month by participating veterinarians. Created using Microsoft Excel and PowerPoint.**

Q6 focused on what breed was most commonly seen with a positive case of hookworms, most of the veterinarians 46% (n=57) stated there was no breed predilection in identifying what specific breed hookworms are diagnosed in. The dog breeds were further grouped into American Kennel Club (AKC) classifications and the ones that did not have a classification were recorded as no breed predilection, mixed breed, pit bulls/pit bull mix, large breeds, purebred, hunting breeds, and not diagnosed. The results recorded were: AKC breed groups: 25% (n=10) sporting breeds, 42% (n=17) hound, 5% (n=2) working breeds, 3% (n=1) terrier, 0% (n=0) toy, 10% (n=4) non-sporting breeds, and 15% (n=6) herding breeds. Uncategorizable breed groups: 46% (n=57) no breeds predilection/any/all breeds, 26% (n=33) mixed breeds, 17% (n=21) pit bulls/pit bull mix,3 % (n=4) large breeds, 2% (n=2) purebred, 2% (n=3) hunting breeds, and 4% (n=5) not diagnosed.

Table 1: Q6 Dog breed groups categorized in AKC or uncategorizable breed groups. Created using Microsoft PowerPoint and Word.

AKC BREED GROUPS	NUMBER OF RESPONSES
Sporting	10
Hound	17
Working	2
Terrier	1
Toy	0
Non-sporting	4
Herding	6
UNCATEGORIZABLE BREED GROUPS	
No breed predilection	57
Mixed	33
Pit Bulls/Pitbull mix	21
Large breeds	4
Purebred	2
Hunting breeds	3

Not diagnosed	5

AKC BREEDS COMMONLY SEEN IN HOOKWORMS
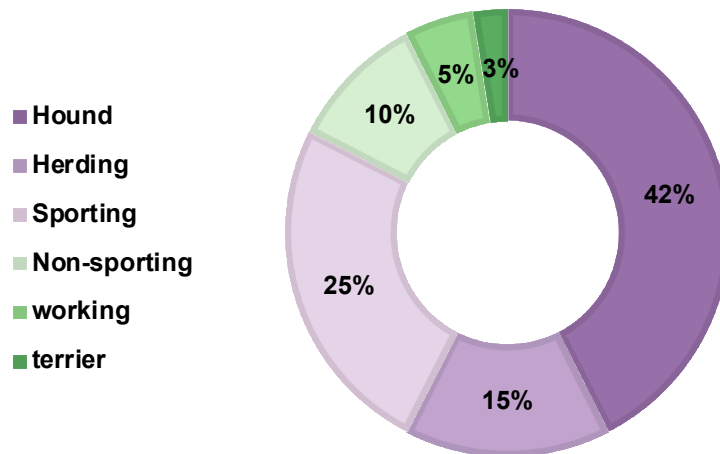
Figure Error! No text of specified style in document.**-11: Q6 Percentage of dog breeds divided into AKC groups. Created using Microsoft Excel and PowerPoint.**

NON-AKC BREEDS COMMONLY SEEN IN HOOKWORMS
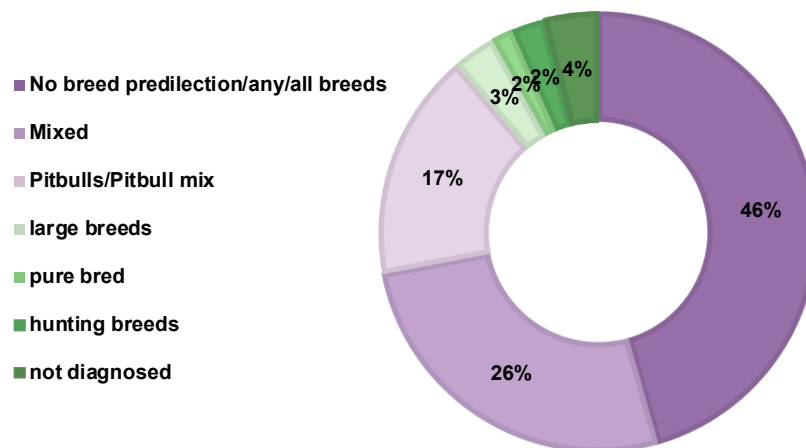
Figure Error! No text of specified style in document.**-12: Q6 Percentage of dog breeds divided into non-AKC groups. Created using Microsoft Excel and PowerPoint.**

26

Q7 focused on how frequently Greyhounds are infected by hookworms. Veterinarians were asked how often they saw or diagnosed hookworms in Greyhounds in their clinic during a month. A total of 53% (n=51) of the respondents stated that they do not see or diagnose hookworms in Greyhounds in a month. Some veterinarians, (26%, n=25) stated they see at least 1 Greyhound positive with hookworms in a month. The remaining responses were recorded: 10% (n=9) veterinarians diagnose 2 Greyhounds in a month, 3% (n=3) veterinarians diagnose 3 Greyhounds in a month, 3% (n=3) veterinarians diagnose 10 Greyhounds in a month, 2% (n=2) veterinarians diagnose 4 Greyhounds in a month, 2% (n=2) veterinarians diagnose 5 Greyhounds in a month, 1% (n=1) veterinarians diagnose 20 Greyhounds in a month.
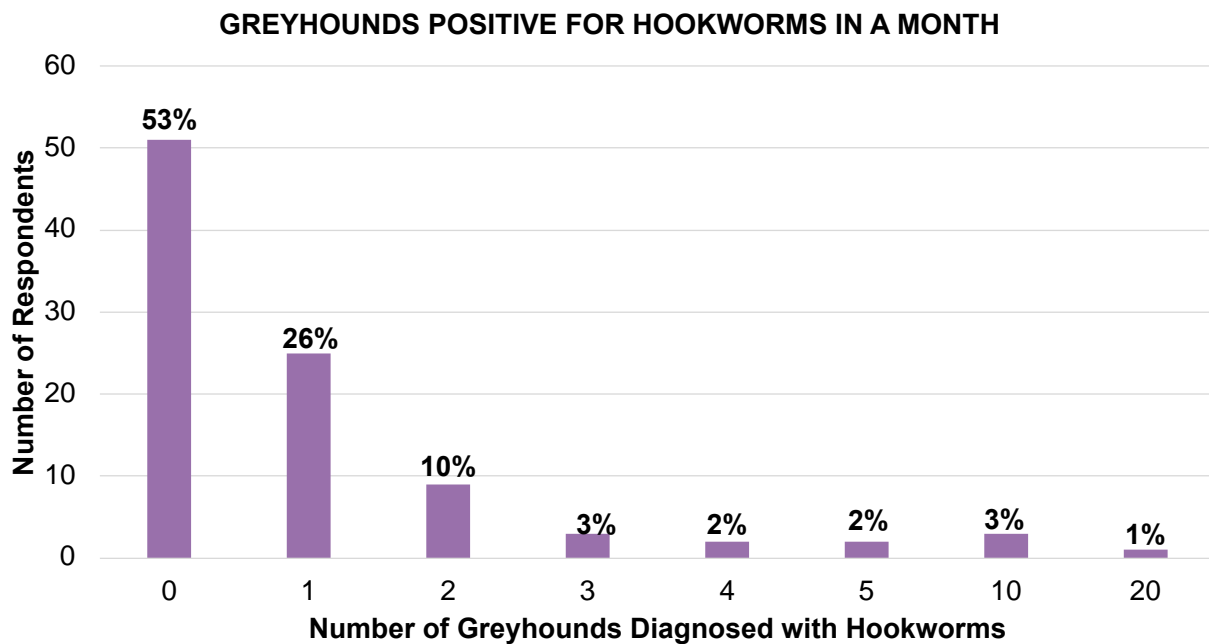
Figure Error! No text of specified style in document.**-13: Q7 Bar graph of number of Greyhounds diagnosed with hookworms in a month by the respondents. Created using Microsoft Excel and PowerPoint.**

Q8 was a two-part question. Part 1 asked veterinarians to identify clinical signs (anemia, diarrhea, itchy paws due to hookworm lesions, and poor growth) they noticed in their canine patients who had hookworms. On a scale of 1 to 10, 1=uncommon and 10=very common. A total of 30 veterinarians (22%) stated 1 on the scale, meaning it was uncommon to see those clinical signs. The second highest response, 19% (n=26) of the veterinarians responded 2 on the scale. The following answers (on a scale of 1 to 10) were recorded: 17% (n=23) said 3, 9% (n=13) said 4, 10% (n=14) said 5, 5% (n=7) said 6, 8% (n=11) said 7, 4% (n=6) said 8, 2% (n=3) said 9, 4% (n=5) said 10. Part 2 of this question asked veterinarians to identify on a scale of 1 to 10, (1 being uncommon and 10 being very common) if they noticed their canine hookworm patients being asymptomatic. A total of 9% (n=13) veterinarians, stated 1 out of 10 on the scale, meaning that it is uncommon to see positive hookworm patients being asymptomatic. The majority of the veterinarians, a total of 18% (n= 24) stated an 8 and 18% (n=24) stated 9 on the scale, meaning that it is very common for their hookworm canine patients to be asymptomatic. The following answers (on a scale of 1 to 10) were recorded: 3% (n=4) said 2, 4% (n=6) said 3, 7% (n=9) said 4, 10% (n=14) said 5, 4% (n=5) said 6, 10% (n=14) said 7 and 17% (n=23) said 10.

CLINICAL SIGNS IN PATIENTS WITH HOOKWORMS
SCALE OF 1-10, 1=UNCOMMON, 10=VERY COMMON
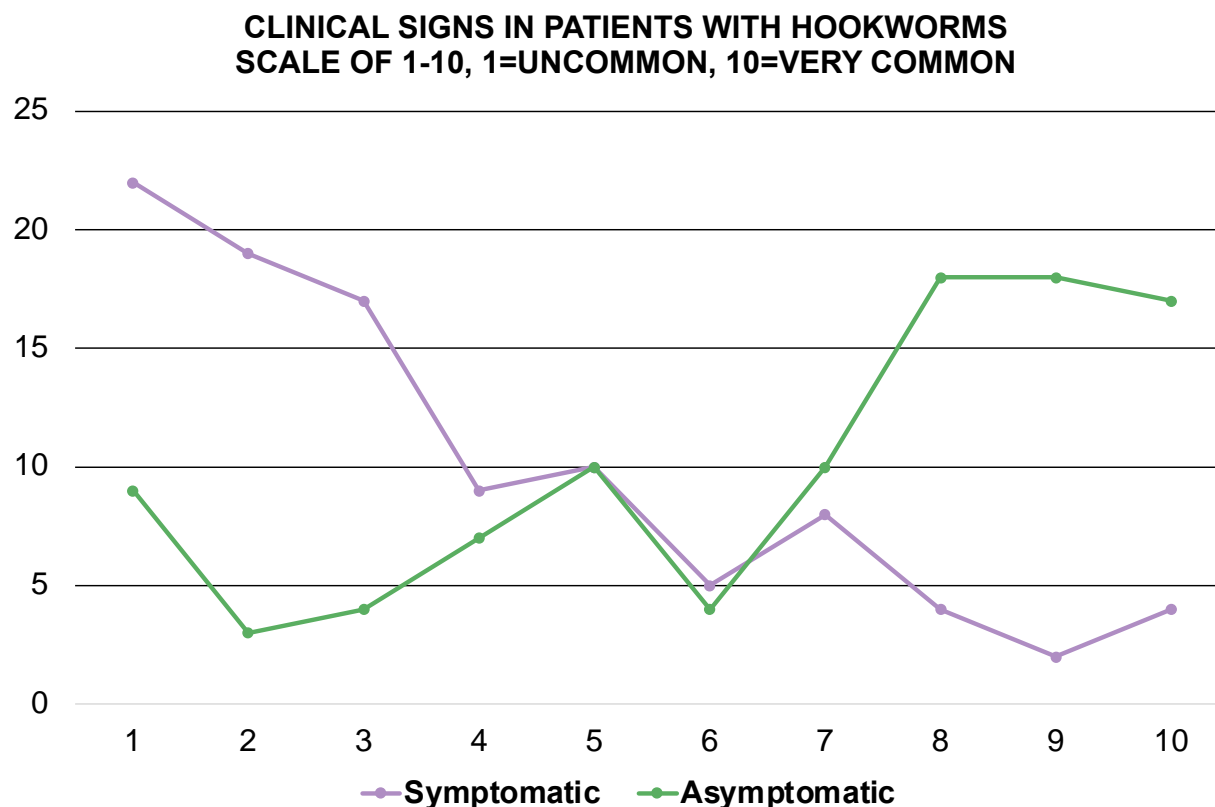
Figure Error! No text of specified style in document.**-14: Q8 Bar graph shows the number of respondents who see clinical signs on hookworm patients in percentages. Created using Microsoft Excel and PowerPoint**

Q9 regarded what testing site veterinarians used to diagnose canine hookworms in their patients, whether it was through in-clinic fecal testing, commercial diagnostic laboratories (IDEXX or ANTECH), or state diagnostic laboratories. More than half of the veterinarians 56% (n=90), said they diagnose hookworms in their patients through in-clinic fecal testing. The following answers were recorded: 28% (n=45) of veterinarians use commercial diagnostic laboratories, 11% (n=18) of veterinarians use in-clinic fecal testing and commercial diagnostic testing, 3% (n=5) of veterinarians use in-clinic fecal testing and state diagnostic laboratories, 1% (n=1) of veterinarians use in-clinic fecal testing, state diagnostic laboratories, and commercial diagnostic laboratories, 1% (n=1) of veterinarians use state diagnostic laboratories to diagnose hookworms in their canine patients.

TYPES OF FECAL TESTING
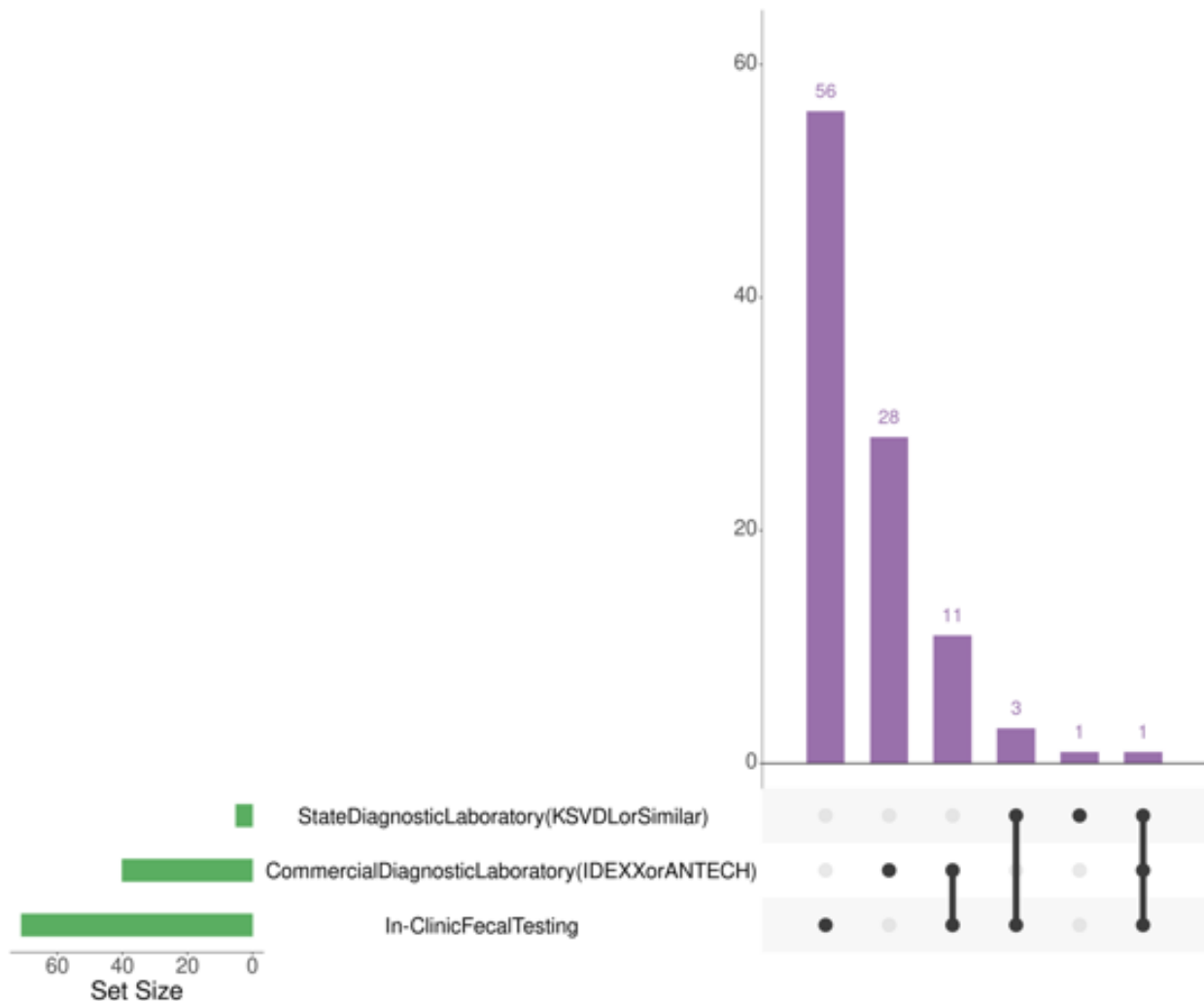
Figure Error! No text of specified style in document.**-15: Q9 Setup graph comparing the main testing sites used by veterinarians for hookworm diagnoses in percentages. Created using Microsoft Excel and Intervene.**

Q10 asked veterinarians how often (in a month) they tested for hookworms in different age groups such as puppies (8 months), young adults (non-breeding), mature adults (non-breeding), old dogs (non-breeding), and pregnant or breeding dogs. This question was divided into 5 categories of age to properly answer the question in its entirety. The answer choices consisted of frequently (10 or more dogs per month), sporadically (3-9 dogs per month), and rarely (0-2 dogs per month). The first category regarded puppies (8 months), 69% (n=112) of veterinarians stated frequently, 22% (n=35) stated sporadically and the remaining 9% (n=14) said rarely. The second category concerned young non-breeding adults, 50% (n=78) of the veterinarians responded frequently, 37% (n=59) said sporadically and 13% (n=21) stated rarely. The third category regarded mature non-breeding adults, 41% (n=65) of veterinarians stated frequently, 35% (n=56) said sporadically and the remaining 24% (n=39) said rarely. The fourth

category pertained to old non-breeding dogs, 36% (n=57) of veterinarians responded rarely, 31% (n=50) stated frequently and 33% (n=52) said sporadically. The last category regarded how often in a month, did veterinarians test for hookworms in pregnant or breeding dogs. Most of the veterinarians 44% (n=68) said rarely, 28% (n=44) stated frequently and 28% (n=44) said sporadically.

FREQUENCY OF TESTING FOR HOOKWORMS IN DIFFERENT AGE GROUPS

■ Rarely (0-2 dogs per month)　■ Sporadically (3-9 dogs per month)　□ Frequently (10 or more dogs per month)

Age group	Rarely	Sporadically	Frequently
Puppies (<8months)	9%	22%	69%
Young adults (non-breeding)	13%	37%	50%
Mature adults (non-breeding)	24%	35%	41%
Old dogs (non-breeding)	36%	33%	31%
Pregnant or breeding dogs	44%	28%	28%
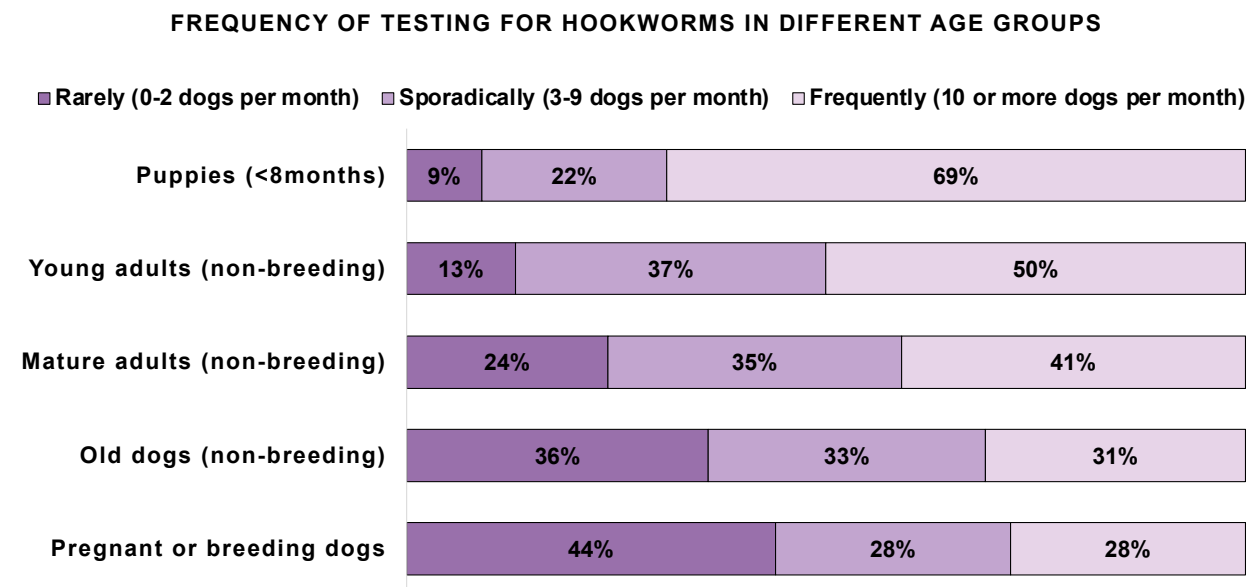
Figure Error! No text of specified style in document.**-16: Q10 Bar Graph comparing different dog age groups and frequency of being diagnosed with hookworms. Created using Microsoft Excel and PowerPoint.**

Q11 asked veterinarians if their patients were on broad-spectrum preventatives that also prevent hookworms. Respondents were able to select all that apply to this question. A total of 48% (n=76) of veterinarians said their patients are on annual broad-spectrum preventatives while 14% (n=23) of veterinarians said their patients are on seasonal broad-spectrum preventatives. Only 10% (n=16) of veterinarians said their patients are on seasonal or annual broad-spectrum preventatives. Approximately, 17% (n=27) of veterinarians selected "other". Roughly 7% (n=11) of veterinarians stated their patients are on seasonal, annual, or other preventatives, while 3% (n=5) of veterinarians said their patients are on annual and other preventatives. A total of 1% (n=2) of veterinarians selected that their patients are on seasonal and other broad-spectrum preventatives.

TYPE OF BROAD SPECTRUM PREVENTATIVES
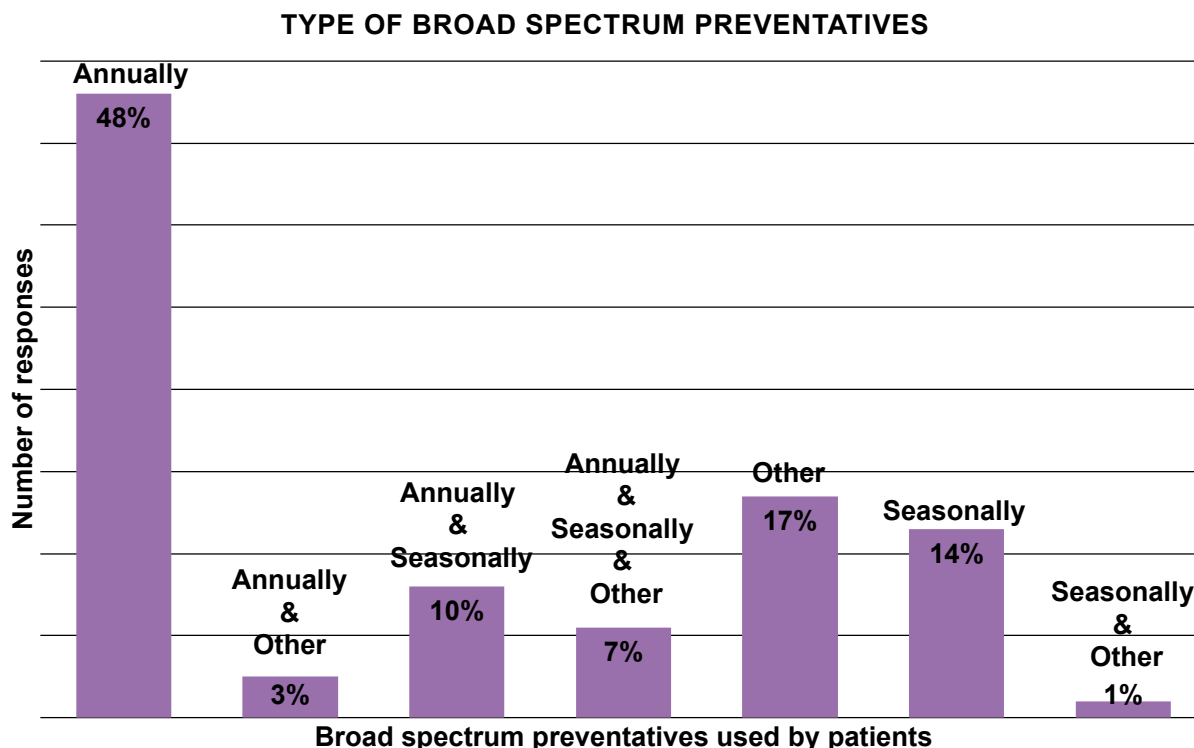
Figure Error! No text of specified style in document.**-17: Q11 Shows what kind of broad-spectrum preventatives (to prevent hookworms) the veterinarians' patients are in. Created using Microsoft Excel and PowerPoint.**

Q12 regarded veterinarians' course of treatments. In this question, participants were able to select up to 5 options, 4 of them being medications (Fenbendazole, Pyrantel pamoate, Milbemycin oxime, Moxidectin, and 1 write-in option for other. The option of other refers to Ivermectin, Febantel, Emodepside, and immune boosters. Most veterinarians said they used Pyrantel pamoate and Fenbendazole as a course of treatment for their patients with hookworms. The following data was recorded: 21% (n=33) Pyrantel pamoate and Fenbendazole, 16% (n=26) Fenbendazole, 15% (n=25) Pyrantel pamoate, 13% (n=20) Milbemycin oxime, Pyrantel pamoate, and Fenbendazole, 11% (n=18) Moxidectin, Milbemycin oxime, Pyrantel pamoate, and Fenbendazole, 3% (n=5) Milbemycin oxime and Pyrantel pamoate, 3% (n=5) Moxidectin, Milbemycin oxime, and Fenbendazole, 3% (n=4) Milbemycin oxime and Fenbendazole, 3% (n=4) Moxidectin, Pyrantel pamoate, and Fenbendazole, 2%

(n=3) Other, Pyrantel pamoate, and Fenbendazole, 2% (n=3) Other, Moxidectin, Milbemycin oxime, Pyrantel pamoate, and Fenbendazole, 1% (n=2) Milbemycin oxime, 1% (n=2) Moxidectin and Milbemycin oxime, 1% (n=2) Moxidectin, Milbemycin oxime and Pyrantel pamoate, 1% (n=1) Other, 1% (n=1) Moxidectin, 1% (n=1) Other and Moxidectin, 1% (n=1) Other and Pyrantel pamoate, 1% (n=1) Other, Moxidectin, and Milbemycin oxime, 1% (n=1) Moxidectin and Pyrantel pamoate, 1% (n=1) Moxidectin and Fenbendazole, 1% (n=1) Other, Moxidectin, Pyrantel pamoate, and Fenbendazole, 1% (n=1) Other, Milbemycin oxime, Pyrantel pamoate, and Fenbendazole.

VETERINARIANS' PERCEPTIONS ON COURSE OF TREATMENTS
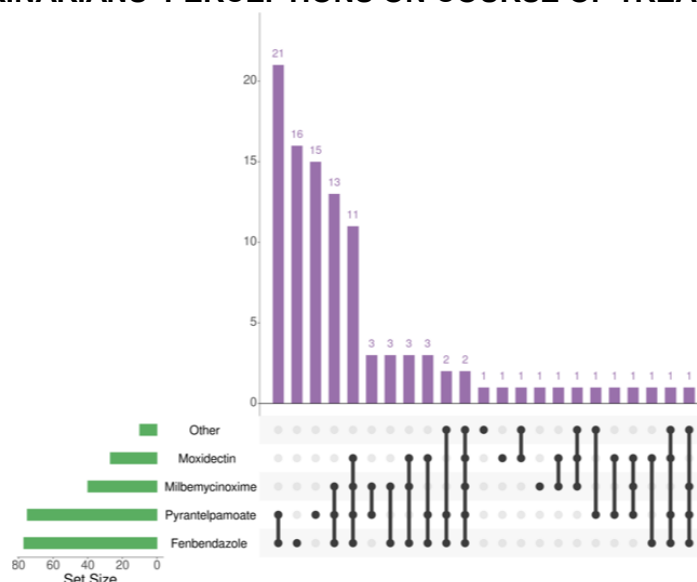
Figure Error! No text of specified style in document.**-18: Q12 Setup graph compares the veterinarians' course of treatment for their hookworm infected canine patients in percentages. Created using Microsoft Excel and Intervene.**

Q13 was a two-part question, it asked veterinarians if they followed up on patients who were being treated for hookworms and if they did follow up, how. Most of the veterinarians 81% (n=128) said they do follow up with their hookworm patients, and the remaining 19% (n=30) said they do not follow up. Additional data was collected to find how the 81% of veterinarians who said they followed up with their hookworm patients. The responses were recorded as follows: 91% (n=117) said they either recheck, retest, or repeat fecal testing, 4% (n=5) said they recheck fecal testing and deworm, 2% (n=3) said they perform fecal antigen testing, 1% (n=1) said they perform periodic testing, 1% (n=1) said they recheck PCV, and the remaining 1% (n=1) said they text or call the client if/as needed.

FOLLOW-UP ON PATIENTS TREATED WITH HOOKWORMS

No

Yes. If so, how?
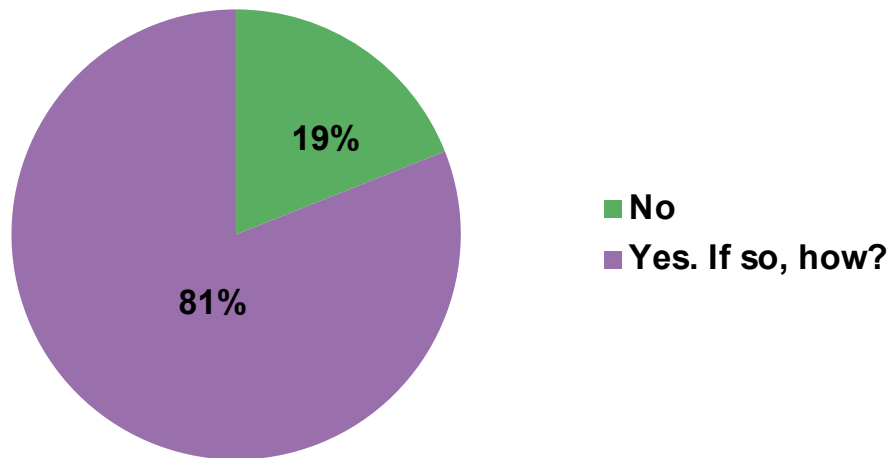
Figure Error! No text of specified style in document.**-19: Q13 Percentage of veterinarians who follow up on patients with hookworms. Created using Microsoft Excel and PowerPoint.**

HOW DO YOU FOLLOW-UP ON YOUR PATIENTS?

- **Recheck/retest/repeat fecal**
- **Recheck fecal and deworm**
- **Fecal antigen testing**
- **Periodic testing**
- **Recheck PCV**
- **Texting with client or phone if/as needed**
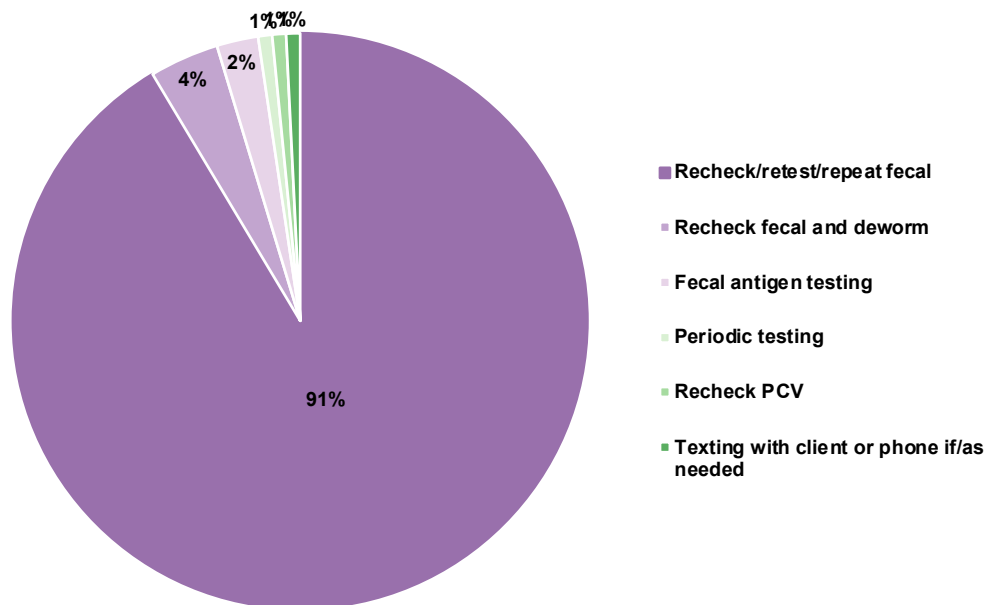
Figure Error! No text of specified style in document.**-20: Q13 Pie chart shows how veterinarians or their coworkers follow up with their hookworm positive patients. Created using Microsoft Excel and PowerPoint.**

Q14 asked veterinarians if they knew multi-drug resistant hookworms are being reported from multiple states across the United States. Out of the total, 74% (n=119) of the respondents said they were aware of multi-drug resistant hookworms, and the remaining 26% (n=41) said no, they were not aware.

MULTI-DRUG RESISTANT HOOKWORM AWRENESS
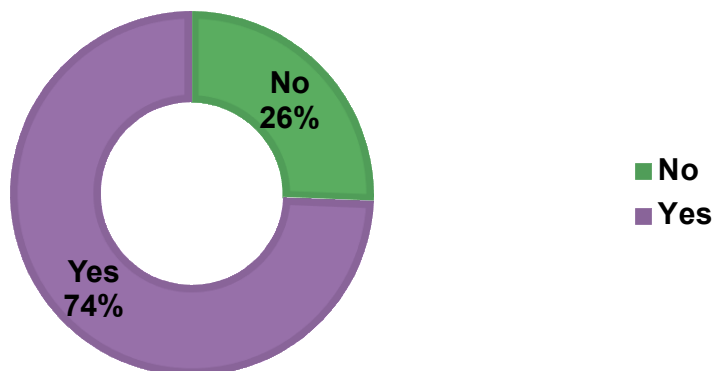
Figure Error! No text of specified style in document.**-21: Q14 Percentage of veterinarians asked if they knew about multi-drug resistant hookworms across the United States. Created using Microsoft Excel and PowerPoint.**

Q15 asked the veterinarians if they ever dealt with a dog who was hookworm positive multiple times either due to suspected drug resistance or re-infection. The majority of the respondents, 57% (n=91) stated no; they had not dealt with a patient being drug-resistant or suspected of re-infection. The remaining 43% (n=68) said yes, they have dealt with a patient being re-infected or being drug resistant. The 43% (n=68) who said yes were asked a follow-up question if they had to alter any course of hookworm treatment because it was ineffective. Much of this population, 18% (n=13) left this section blank with no comment.

The following data was collected: 12% (n=8) Changed medications/multiple medication (didn't specify drugs), 12% (n=8) Changed to/increased fenbendazole, 9% (n=6) Used different dewormers/deworming (not specified), 6% (n=4) Started/modified monthly preventatives (not specified), 6% (n=4) Suspected re-infection, 6% (n=4) Switch to moxidectin or milbemycin oxime, 4% (n=3) Treated with fenbendazole & monthly preventative, 4% (n=3) Advantage Multi, 3% (n=2) Transferred patient to a vet school, 3% (n=2) Pyrantel pamoate, 1% (n=1) Blood transfusions, 1% (n=1) Not found parasites resistant to medication, 1% (n=1) Some hookworms are resistant to everything, 1% (n=1) Lost to follow up, 1% (n=1) Tried multiple dewormers and blood transfusions, 1% (n=1) Hygiene was a major factor, 1% (n=1) Monthly preventatives and lab testing, 1% (n=1) Called other colleagues for advice on drug doses, 1% (n=1) Switched to Drontal Plus, 1% (n=1) Drug therapy off label, 1% (n=1) Pyrantel, fenbendazole and advantage muti simultaneously, 1% (n=1) Monthly moxidectin along with rotating between fenbendazole and pyrantel pamoate.

MULTIPLE POSITIVE HOOKWORMS CASES DUE TO RE-INFECTION OR DRUG RESISTANCE

43%

57%

■ No
■ Yes.
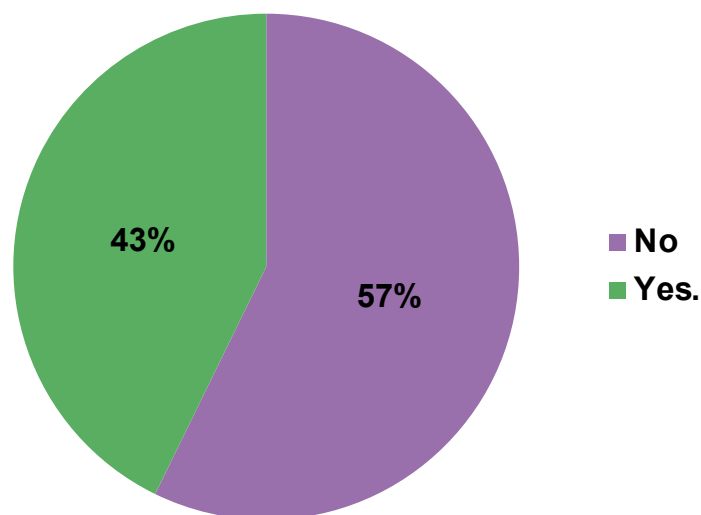
Figure Error! No text of specified style in document.**-22: Q15 Percentage of veterinarians asked if they have ever dealt with a canine patient who was hookworm positive multiple times due to re-infection or suspected drug resistance. Created using Microsoft Excel and PowerPoint.**

Table 2: Q15 A table of veterinarian responses on how to alter hookworm course of treatment. Created using Microsoft Excel and Word.

Respondents who answered "yes"	Number of Responses
Left comment section blank	13
Changed medications/multiple medications (didn't specify drugs)	8
Changed to/increased fenbendazole	8
Used different dewormers/deworming (not specified)	6
Started/modified monthly preventatives (not specified)	4
Suspected re-infection	4
Switch to moxidectin or milbemycin oxime	4
Treated with fenbendazole & monthly preventative	3
Advantage Multi	3
Transferred patient to a vet school	2
Pyrantel pamoate	2
Blood transfusions	1
Not found parasites resistant to medication	1
Some hookworms are resistant to everything	1
Lost to follow up	1
Tried multiple dewormers and blood transfusions	1
Hygiene was a major factor	1

Monthly preventatives and lab testing	1
Called other colleagues for advice on drug doses	1
Switched to Drontal Plus	1
Drug therapy off label	1
Pyrantel, fenbendazole, and advantage muti simultaneously	1
Monthly moxidectin along with rotating between fenbendazole and pyrantel pamoate	1

Q16 was divided into three sections, asking veterinarians about their client education. All three sections had the same answering options; always, often, rarely or I don't know/never. The first question asked if their co-workers or themselves educate clients about worms (including hookworms) in dogs, 52% (n=83) stated often, 42% (n=68) said always and the remaining 6% (n=9) said rarely. The next question asked veterinarians if their co-workers or themselves educate clients about worm (including hookworm) preventatives, 55% (n=89) said always, 41% (n=65) said often, 3% (n=5) said rarely and 1% (n=1) said I don't know/Never. The last question regarded about educating clients on how canine hookworms can cause human infection, 44% (n=70) said often, 29% (n=46) said rarely, 26% (n=42) said always and 1% (n=1) said I don't know/never.
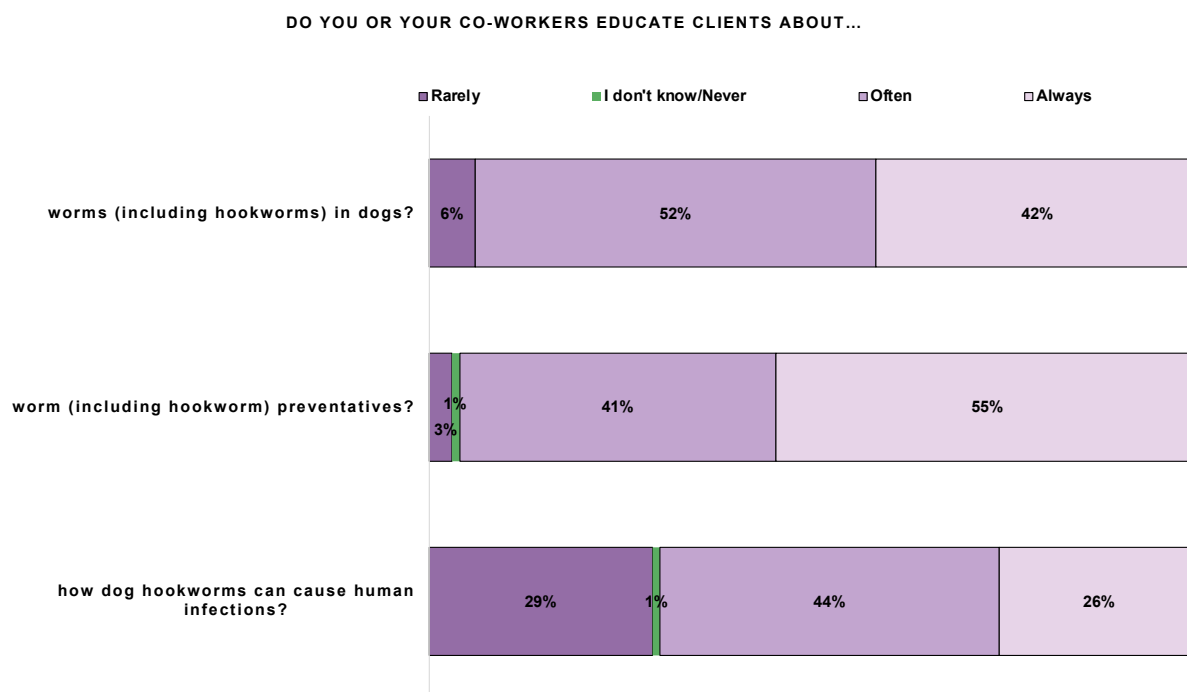
Figure Error! No text of specified style in document.**-23: Q16 Bar Graph compiling information on client education. Created using Microsoft Excel and PowerPoint.**

The following data regards the para-veterinarian survey results:

Q1 asked participants to identify their role in the clinic they work in. Out of the total 205 respondents, 25 identified themselves as para-veterinarians across the United States. Much of this population, 80% (n=20) said they were either a veterinarian technician, assistant, or nurse. The other 20% (n=5) identified as an office manager/technician, lab manager, manager, parasitology lab senior research technician and the last respondent left the comment blank.

PARA-VETERINARIAN ROLES

■ Other

■ Veterinarian
technician/assistant/
nurse
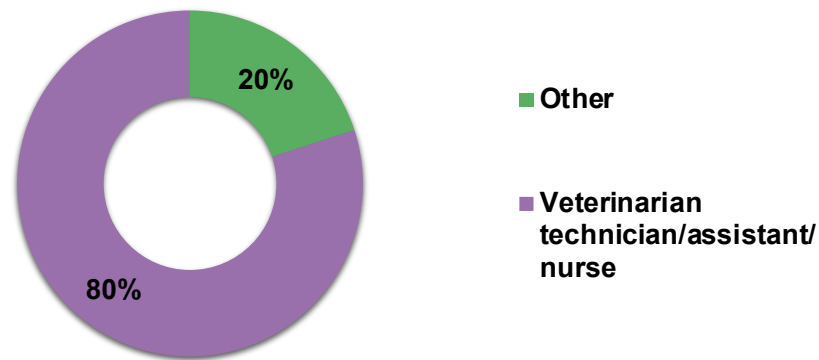
Figure Error! No text of specified style in document.**-24: Q1 Percentage of Para-veterinarians' role at the clinic. Created using Microsoft Excel and PowerPoint.**

Q2 asked para-veterinarians if they worked at a small or mixed animal practice. Out of the 25 para-veterinarians, 76% (n=19) said they worked at a small animal practice, while 24% (n=6) said they worked at a mixed animal practice.

PARA-VETERINARIAN ANIMAL PRACTICE
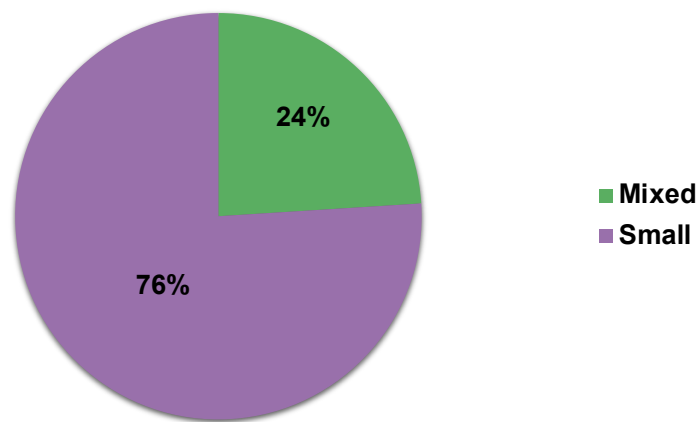
■ Mixed
■ Small

Figure Error! No text of specified style in document.**-25: Q2 Percentage of Para-veterinarians who are in small or mixed animal practice. Created using Microsoft Excel and PowerPoint.**

Q3 asked para-veterinarians the zip code of their practice or workplace. A total of 18 states with at least one response was recorded.

Para-veterinarian Locations
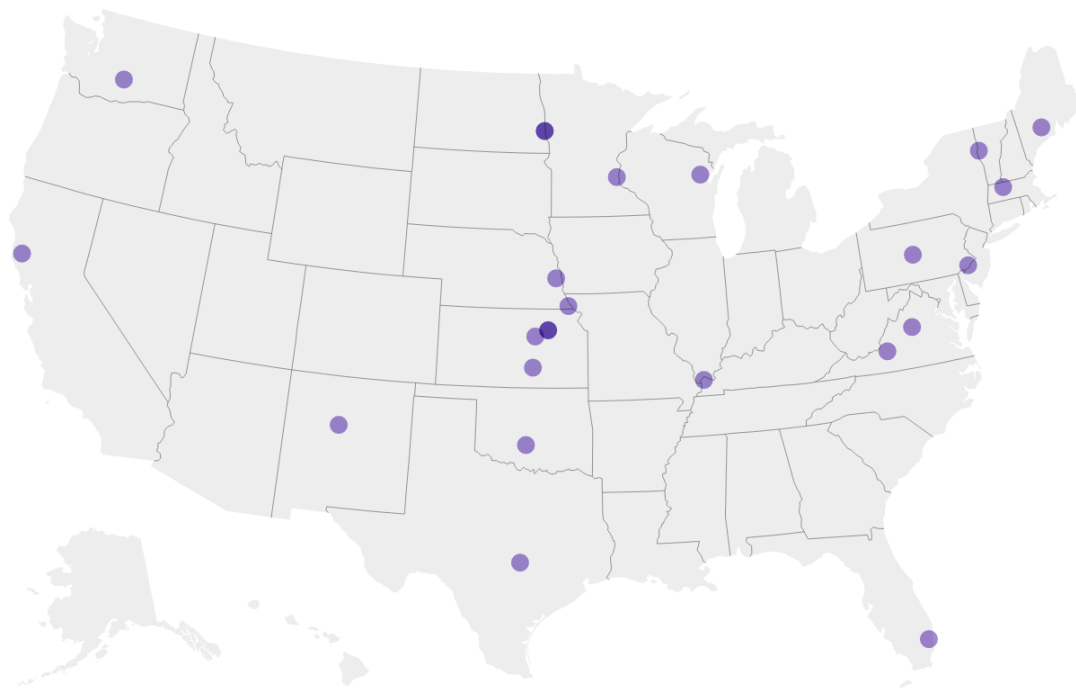
Figure Error! No text of specified style in document.**-26: Q3 U.S. map shows participating para-veterinarian locations of the hookworm survey. Created using Datawrapper.**

Q4 asked para-veterinarians if they were aware of hookworm prevalence in dogs in the area, they work in. A total of 73% (n=16) said yes, they were aware of hookworm prevalence,

while 14% (n=3) said no and the remaining 13% (n=3) said maybe being aware of hookworm prevalence in the area.

HOOKWORM PREVALENCE AWARENESS
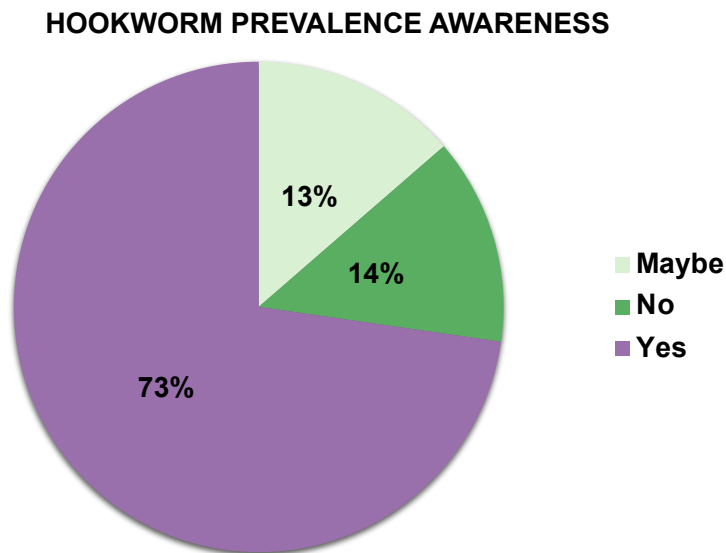
Figure Error! No text of specified style in document.**-27: Q4 Percentage of respondents who are aware of hookworm prevalence. Created using Microsoft Excel and PowerPoint.**

Q5 regarded an estimation of how many dogs (of all breeds) per month are diagnosed with hookworms in the clinic. The following data was recorded: (n=2) said 0 dogs/month, (n=2) said 1 dog/month, (n=3) said 2 dogs/month, (n=3) said 3 dogs/month, (n=1) said 4 dogs/month,

(n=1) said 5 dogs/month, (n=1) said 7 dogs/month, (n=3) said 10 dogs/month, (n=1) said 15 dogs/month, (n=2) said 20 dogs/month, (n=1) said 23 dogs/month, (n=1) said 30 dogs/month, (n=1) said 36 dogs/month.

DOGS POSITIVE FOR HOOKWORM IN A MONTH
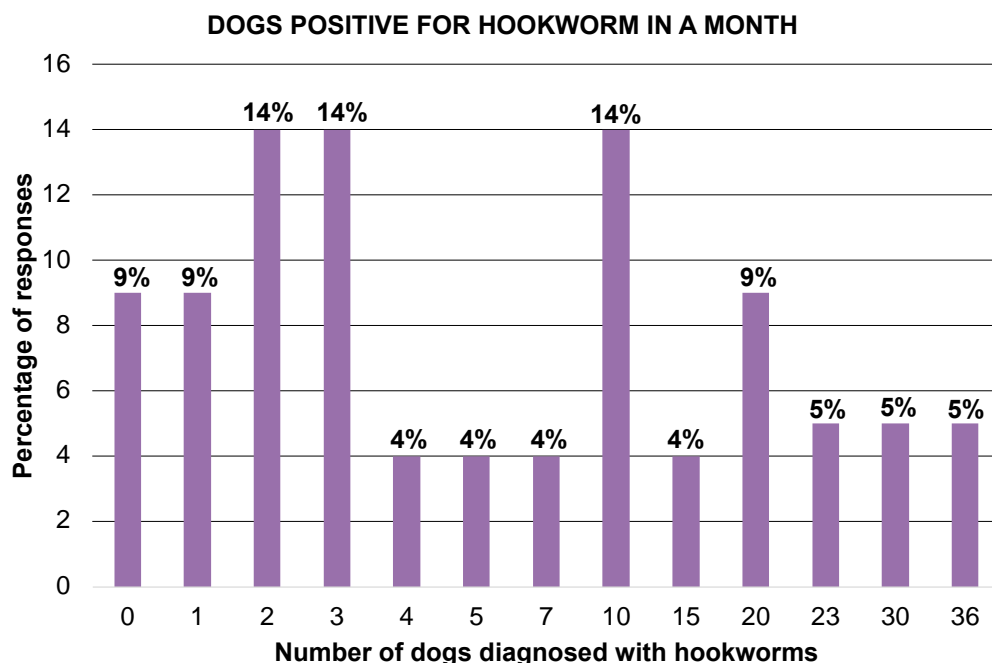
Figure Error! No text of specified style in document.**-28: Q5 A bar graph showing number of dogs diagnosed with hookworms in a month by participating para-veterinarians. Created using Microsoft Excel and PowerPoint.**

Q6 asked para-veterinarians what dog breed is commonly seen in hookworm patients in the clinic. The majority, 16% (n=5) said Labradors/Labrador mixes while another 16% (n=5) said Greyhounds were commonly seen in hookworm patients. The following data was recorded: 13% (n=4) said mixed breeds, 10% (n=3) said Golden Retrievers, 10% (n=3) said non-specific

breeds/all different breeds, 7% (n=2) said Poodle/Poodle mix, 7% (n=2) said puppies, 6% (n=2) said outdoor/country dogs, 6% (n=2) said unknown/other, 3% (n=1) said dogs from southern states, 3% (n=1) said small dogs, 3% (n=1) said German Shepherds.

Table 3: Q6 Dog breed groups categorized in AKC or uncategorizable breed groups. Created using Microsoft Excel and PowerPoint.

AKC Breed Groups	Number of Responses
Sporting	8
Hound	5
Non-sporting	2
Herding	1
Uncategorizable Breed Groups	
No breed predilection	11
Mixed	4

AKC BREEDS COMMONLY SEEN IN HOOKWORMS
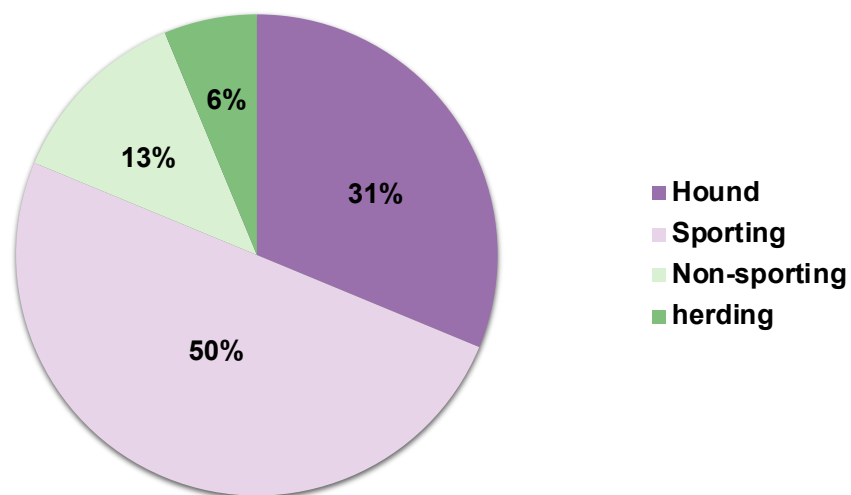
Figure Error! No text of specified style in document.**-29: Q6 Percentage of dog breeds divided into AKC groups. Created using Microsoft Excel and PowerPoint.**

NON-AKC BREEDS COMMONLY SEEN IN HOOKWORMS
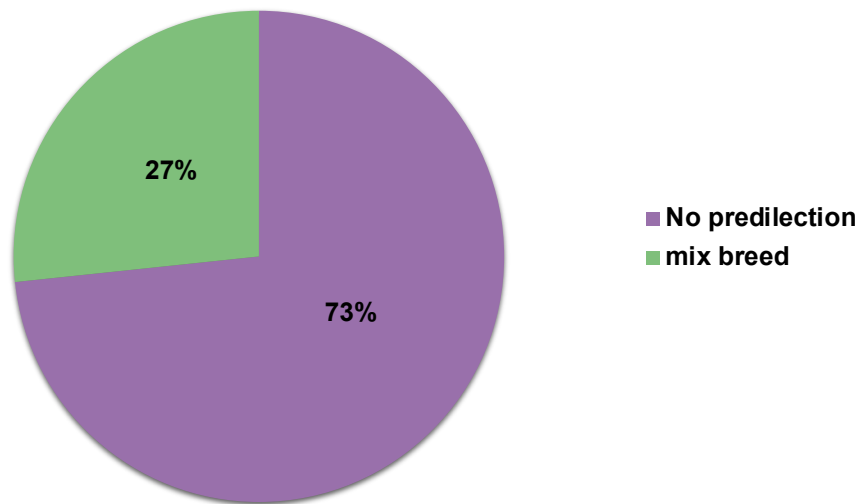
Figure Error! No text of specified style in document.**-30: Q6 Percentage of dog breeds divided into non-AKC groups. Created using Microsoft Excel and PowerPoint.**

Q7 asked para-veterinarians to estimate how many Greyhounds per month are diagnosed with hookworms in the clinic. Roughly 46% (n=7) said 0 Greyhounds are diagnosed with hookworms in a month while 27% (n=4) said 1 Greyhound is diagnosed with hookworms. The following data was recorded: 7% (n=1) said 20 Greyhounds are diagnosed in a month, 7% (n=1) said 15 Greyhounds are diagnosed, 7% (n=1) said 7 Greyhounds are diagnosed, and 6% (n=1) said 2 Greyhounds are diagnosed with hookworms in a month at the clinic.

GREYHOUNDS POSITIVE FOR HOOKWORMS IN A MONTH
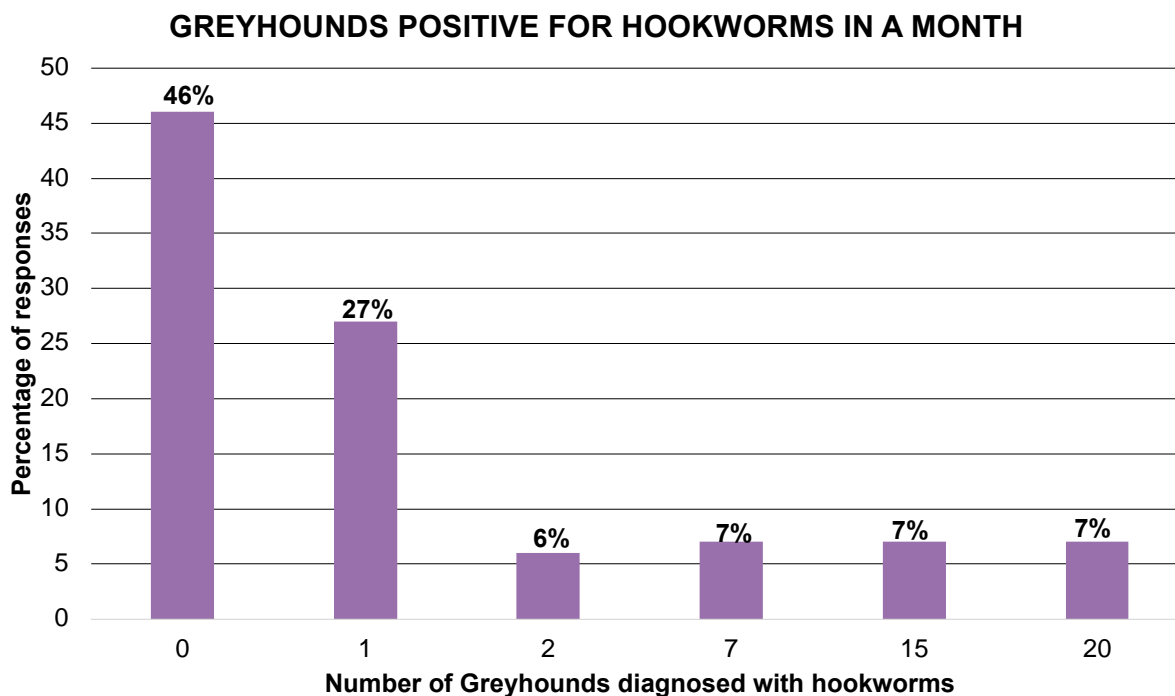
Figure Error! No text of specified style in document.**-31: Q7 Bar graph of number of Greyhounds diagnosed with hookworms in a month by the respondents. Created using Microsoft Excel and PowerPoint.**

Q8 was a two-part question. Part 1 asked para-veterinarians to identify clinical signs (anemia, diarrhea, itchy paws due to hookworm lesions, and poor growth) they noticed in canine patients who had hookworms. On a scale of 1 to 10, 1=uncommon and 10=very common. A total of 4 para-veterinarians (23%) stated 4 on the scale, meaning it was uncommon to see those clinical signs. The second highest response, 17% (n=3) of the para-veterinarians responded 8 on the scale. The following answers (on a scale of 1 to 10) were recorded: 6%

(n=1) said 1, 12% (n=2) said 2, 12% (n=2) said 3, 12% (n=2) said 5, 12% (n=2) said 6, 6% (n=1) said 9.

CLINICAL SIGNS IN PATIENTS WITH HOOKWORMS - SYMPTOMATIC
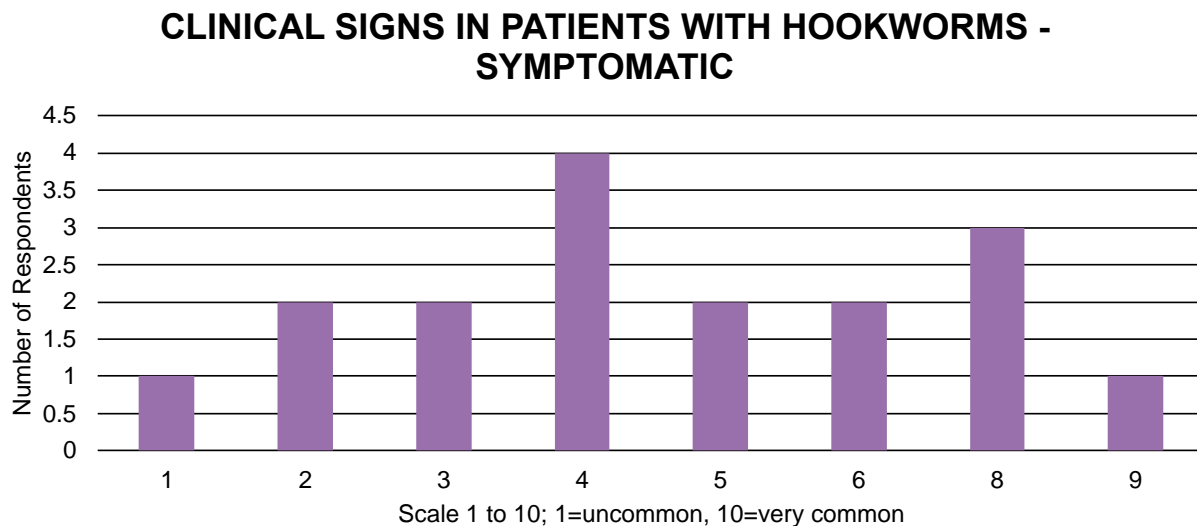
Figure Error! No text of specified style in document.**-32: Q8 Bar graph shows the number of respondents who see clinical signs on hookworm patients. Created using Microsoft Excel and PowerPoint.**

Part 2 of this question asked para-veterinarians to identify on a scale of 1 to 10, (1 being uncommon and 10 being very common) if they noticed canine hookworm patients being asymptomatic. A total of 28% (n=3) para-veterinarians, stated 7 out of 10 on the scale, meaning that it is common to see positive hookworm patients being asymptomatic.

The following answers (on a scale of 1 to 10) were recorded: 18% (n=2) said 1, 9% (n=1) said 3, 18% (n=2) said 5, 18% (n=2) said 8 and 9% (n=1) said 10.

CLINICAL SIGNS IN PATIENTS WITH HOOKWORMS - ASYMPTOMATIC
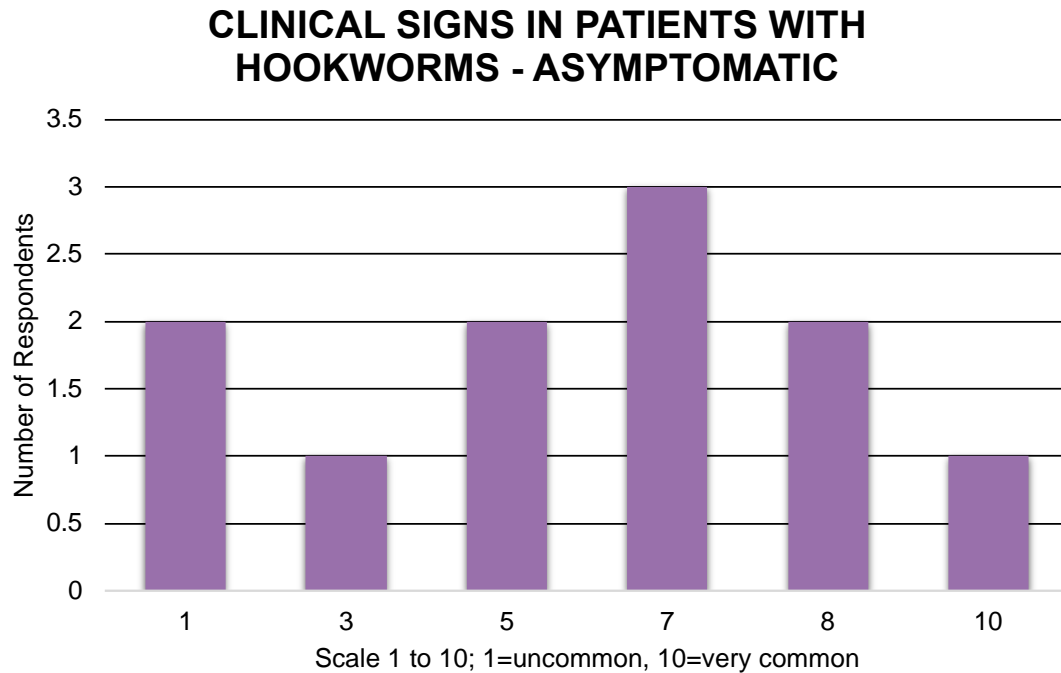
Figure Error! No text of specified style in document.**-33: Q8 Bar graph shows the number of respondents who see asymptomatic hookworm patients. Created using Microsoft Excel and PowerPoint.**

Q9 asked para-veterinarians how the veterinarians they work with diagnose hookworms in canine patients. Roughly 47% (n=10) of para-veterinarians said they test fecal samples in the clinic, while 38% (n=8) said they send out their samples for fecal testing at a Commercial Diagnostic Laboratory like IDEXX or ANTECH. The following data was recorded: 10% (n=2) responded other and 5% (n=1) said they send out samples for fecal testing at State Diagnostic Laboratories like KSVDL.

TYPES OF FECAL TESTING
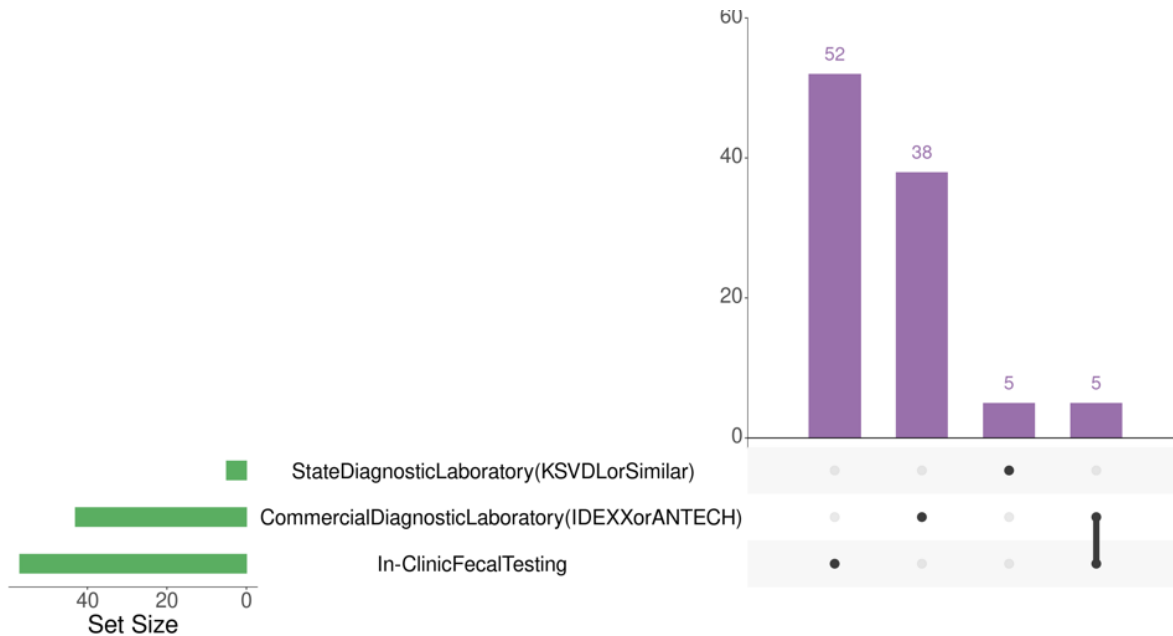
Figure Error! No text of specified style in document.**-34: Q9 Setup graph comparing the main testing sites used by veterinarians for hookworm diagnoses in percentages. Created using Microsoft Excel and Intervene.**

Q10 asked para-veterinarians how often (in a month) did the veterinarian they worked with tested for hookworms in different age groups such as puppies (8 months), young adults (non-breeding), mature adults (non-breeding), old dogs (non-breeding), and pregnant or breeding dogs. This question was divided into 5 categories of age to properly answer the question in its entirety. The answer choices consisted of frequently (10 or more dogs per month), sporadically (3-9 dogs per month), and rarely (0-2 dogs per month). The first category regarded puppies (8months), 85% (n=17) of para-veterinarians stated frequently, 5% (n=1) stated sporadically and the remaining 10% (n=2) said rarely. The second category concerned young non-breeding adults, 60% (n=12) of para-veterinarians responded frequently, 35% (n=7) said sporadically and 5% (n=1) stated rarely. The third category regarded mature non-breeding adults, 60% (n=12) of para-veterinarians stated frequently, 25% (n=5) said sporadically and the remaining 15% (n=3) said rarely. The fourth category pertained to old non-breeding dogs, 50% (n=10) of para-veterinarians responded frequently, 15% (n=3) stated sporadically and 35% (n=7) said rarely. The last category regarded to pregnant or breeding dogs. Most of the para-veterinarians 35% (n=7) said frequently, 15% (n=3) stated sporadically and 50% (n=10) said rarely.

FREQUENCY OF TESTING FOR HOOKWORMS IN DIFFERENT AGE GROUPS

Age Group	Rarely (0-2)	Sporadically (3-9)	Frequently (10+)
Puppies (<8months)	10%	5%	85%
Young adults (non-breeding)	5%	35%	60%
Mature adults (non-breeding)	15%	25%	60%
Old dogs (non-breeding)	35%	15%	50%
Pregnant or breeding dogs	50%	15%	35%

■ Rarely (0-2 dogs per month) ■ Sporadically (3-9 dogs per month) □ Frequently (10 or more dogs per month)
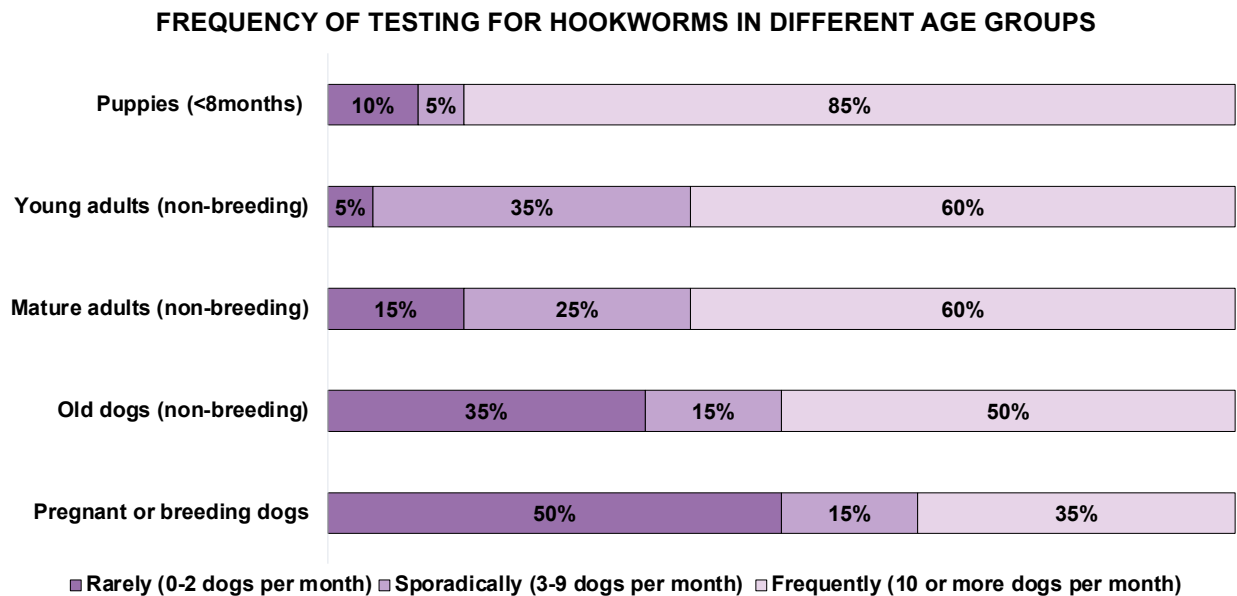
Figure Error! No text of specified style in document.**-35: Q10 Bar Graph comparing different dog age groups and frequency of being diagnosed with hookworms. Created using Microsoft Excel and PowerPoint.**

Q11 asked para-veterinarians if canine patients at the clinic they work in are on broad-spectrum preventatives that also prevent hookworms. Roughly 81% (n=17) of para-veterinarians said the canine patients are on annual broad-spectrum preventatives, while 10% (n=2) stated the patients are on seasonal preventatives and 9% (n=2) said patients are on other preventatives such as monthly doses.

TYPE OF BROAD SPECTRUM PREVENTATIVES
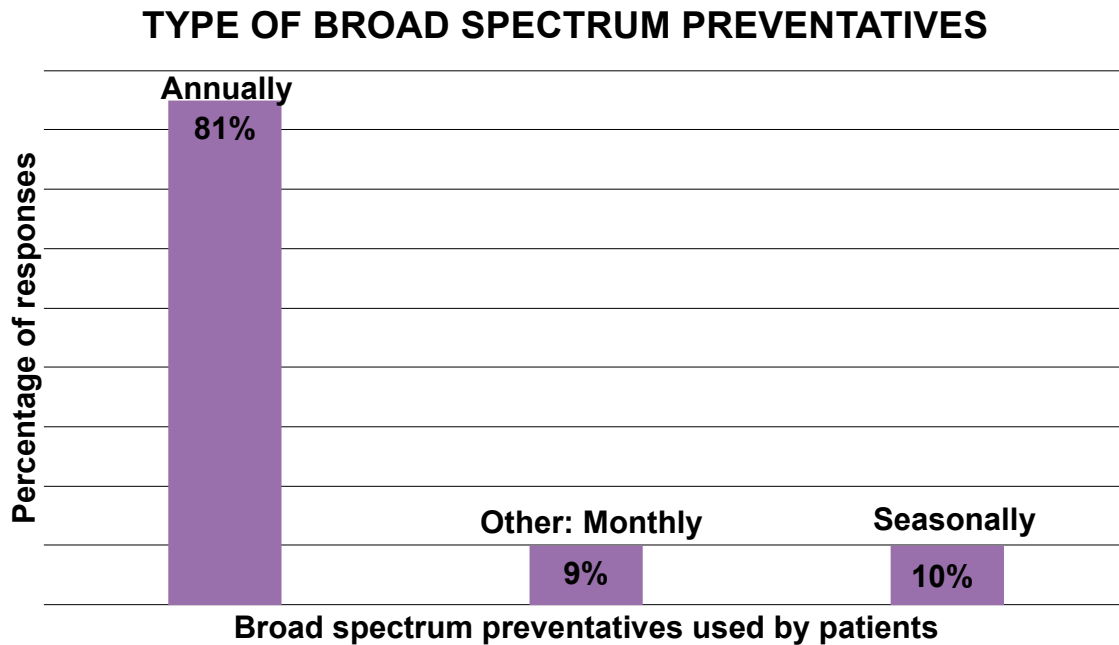
Figure Error! No text of specified style in document.**-36: Q11 Shows what kind of broad-spectrum preventatives (to prevent hookworms) the veterinarians' clients are in. Created using Microsoft Excel and PowerPoint.**

Q12 was a two-part question, it asks how para-veterinarians and their co-workers at the clinic follow up on their patients who are being treated with hookworms. Most of the para-veterinarians 81% (n=17) said they do follow up with their hookworm patients, 10% (n=2) said they do not follow up, and the remaining 9% (n=2) said they do not know. Additional data was collected to find how 81% of para-veterinarians said they or their co-workers follow up. Roughly 50% (n=9) of para-veterinarians said they would recheck or retest fecal (no time specified). The

following data was recorded: 22% (n=4) said they would call or email the client, 11% (n=2) said they would recheck fecal in 10 days, 6% (n=1) said they were retest fecal after treatment, 6% (n=1) said they would retest fecal until fecal came back negative for hookworms, 5% (n=1) said they recheck fecal in a month after the appointment.

FOLLOW-UP ON PATIENTS TREATED WITH HOOKWORMS
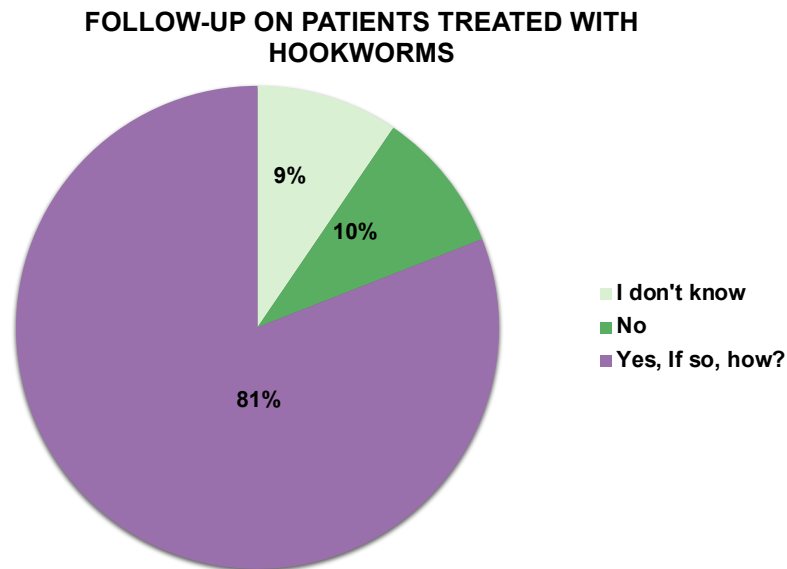
Figure Error! No text of specified style in document.**-37: Q12 Percentage of para-veterinarians who follow up on patients with hookworms. Created using Microsoft Excel and PowerPoint.**

RESPONDENTS WHO SAID "YES"
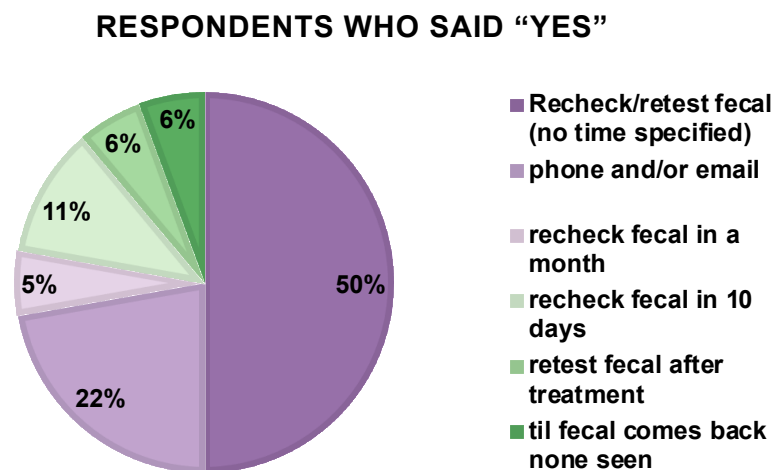
Figure Error! No text of specified style in document.**-38: Q12 Pie chart shows how para-veterinarians or their coworkers follow up with their hookworm positive patients. Created using Microsoft Excel and PowerPoint.**

Q13 was divided into three sections, asking para-veterinarians about client education. All three sections had the same answering options; always, often, rarely or I don't know/never. The first question asked if their co-workers or themselves educate clients about worms (including hookworms) in dogs, 55% (n=11) stated often, 30% (n=6) said always and the remaining 15% (n=3) said rarely. The next section asked para-veterinarians if their co-workers or themselves educate clients about worm (including hookworm) preventatives, 62% (n=13) said always, 33% (n=7) said often, and 5% (n=1) said rarely. The last question regarded about educating clients on how canine hookworms can cause human infection, 50% (n=10) said often, 35% (n=7) said rarely, and 15% (n=3) said always.

DO YOU OR YOUR CO-WORKERS EDUCATE CLIENTS ABOUT …

■ Rarely ■ Often □ Always

	Rarely	Often	Always
worms (including hookworms) in dogs?	15%	55%	30%
worm (including hookworm) preventatives?	5%	33%	62%
how dog hookworms can cause human infections?	35%	50%	15%
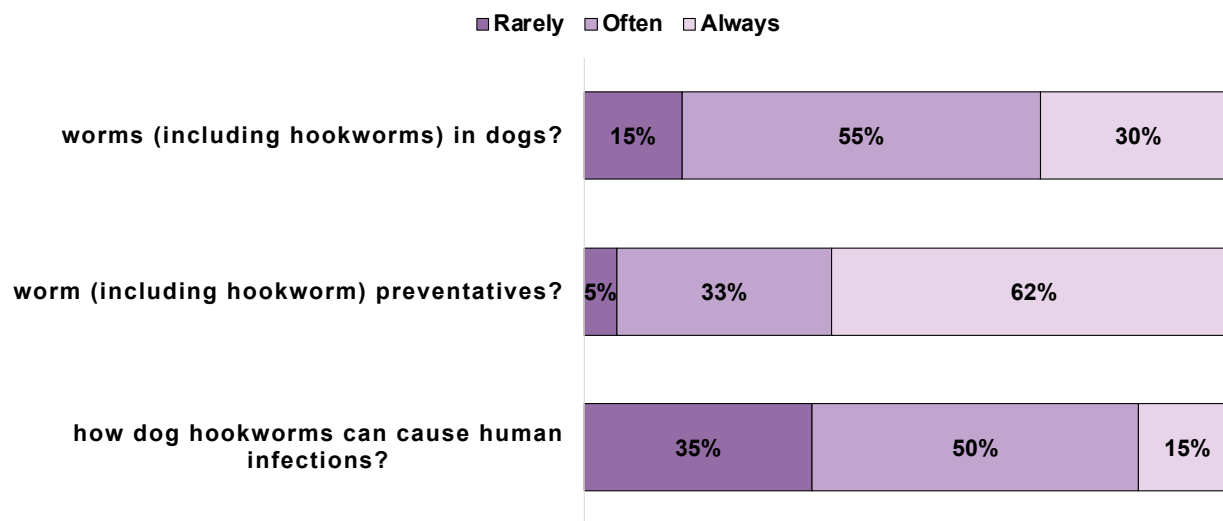
Figure Error! No text of specified style in document.**-39: Q13 Bar Graph compiling information on client education. Created using Microsoft Excel and PowerPoint.**

RCHD—CHIP Process

The purpose of the LPHSA is for ongoing community health improvement. Local health departments can use this insightful information to have a better understanding of how the health care system is functioning, identify strengths, prioritize weaknesses, value quality improvement, develop strategies to achieve goals in the community, and re-evaluate the progress after completed (*RCCHIP - Home*, 2022). The results from the LPHSA are also used for health departments and their partners to communicate better and produce an effective public health system for the community. A couple of weeks after the LPHSA, the results were finalized.

Participants who attended the LPHSA scored the 10 essential public health services based on the Riley County public health system. The figure below shows the average of the essential services performance in the local community.

Summary of Average ES Performance Score

Essential Service	Score
Average Overall Score	62.5
ES 1: Monitor Health Status	62.5
ES 2: Diagnose and Investigate	77.8
ES 3: Educate/Empower	52.8
ES 4: Mobilize Partnerships	62.5
ES 5: Develop Policies/Plans	81.3
ES 6: Enforce Laws	95.1
ES 7: Link to Health Services	50.0
ES 8: Assure Workforce	51.6
ES 9: Evaluate Services	32.9
ES 10: Research/Innovations	59.0
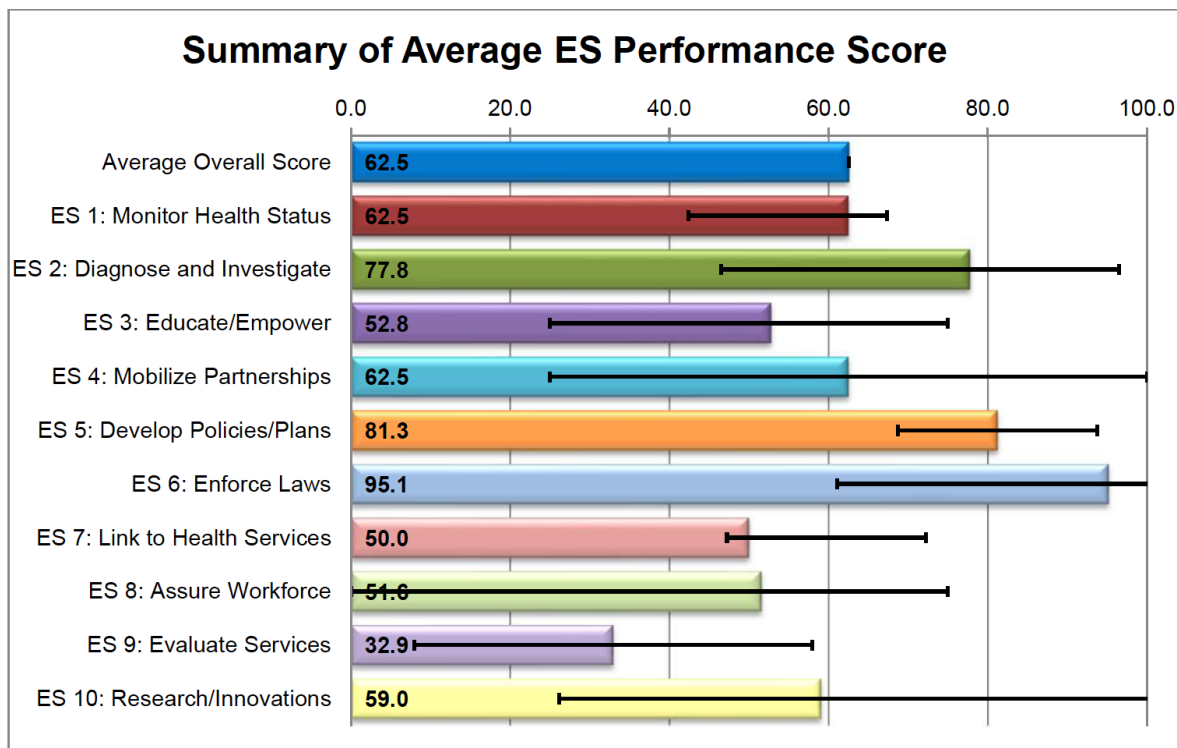
Figure Error! No text of specified style in document.**-40: LPHSA Average Summary**

To break it down further, the table below shows the score of what the stakeholders voted on for each public health service. The attendees had options in their score sheets for these services as the following: no activity (0%) absolutely no activity, minimal activity (1-25%) greater than zero but no more than 25% of the activity described within the question is met, moderate activity (26-50%) greater than 25% but no more than 50% of the activity described within the question is met, significant activity (51-75%) greater than 50% but no more than 75% of the activity described within the question is met, optimal activity (76-100%) greater than 75% of the activity described within the question is met.

Table 4: 10 Essential Services performance score at LPHSA

Model Standards by Essential Services	Performance Scores
ES 1: Monitor Health Status	**62.5**
1.1 Community Health Assessment	25.0

1.2 Current Technology	75.0
1.3 Registries	87.5
ES 2: Diagnose and Investigate	**77.8**
2.1 Identification/Surveillance	58.3
2.2 Emergency Response	87.5
2.3 Laboratories	87.5
ES 3: Educate/Empower	**52.8**
3.1 Health Education/Promotion	58.3
3.2 Health Communication	50.0
3.3 Risk Communication	50.0
ES 4: Mobilize Partnerships	**62.5**
4.1 Constituency Development	50.0
4.2 Community Partnerships	75.0
ES 5: Develop Policies/Plans	**81.3**
5.1 Governmental Presence	83.3
5.2 Policy Development	83.3
5.3 CHIP/Strategic Planning	58.3
5.4 Emergency Plan	100.0
ES 6: Enforce Laws	**95.1**
6.1 Review Laws	93.8
6.2 Improve Laws	91.7
6.3 Enforce Laws	100.0
ES 7: Link to Health Services	**50.0**
7.1 Personal Health Service Needs	50.0
7.2 Assure Linkage	50.0
ES 8: Assure Workforce	**51.6**
8.1 Workforce Assessment	0.0
8.2 Workforce Standards	75.0
8.3 Continuing Education	75.0
8.4 Leadership Development	56.3
ES 9: Evaluate Services	**32.9**
9.1 Evaluation of Population Health	43.8
9.2 Evaluation of Personal Health	30.0

9.3 Evaluation of LPHS	25.0
ES 10: Research/Innovations	**59.0**
10.1 Foster Innovation	50.0
10.2 Academic Linkages	83.3
10.3 Research Capacity	43.8
Average Overall Score	**62.5**
Median Score	**60.8**

The goal of each community listening session was to get as many people involved and their opinion about Riley County's services. Throughout the meeting, participants were encouraged to talk about what Riley County needs to improve or even design a service from scratch. A different member of our team was assigned to be the note taker for each community input meeting. The ending results of each meeting included: the number of participants, their concerns or priorities specific to the individual, and toward the end of the meeting the participants came together to vote on the top 3 priority issues in Riley County. Out of the twelve community input meetings, I only have results for eight of them. This is due to my internship ending before all the meetings were completed.

Table 5: Community listening sessions' results

Date	Location	Number of Attendants	Top 3 voted priorities
March 22, 2022	Manhattan Public Library	2	• Mental Health • Affordable Housing • Access to Care
March 29, 2022	Riley County over Zoom	11	• Affordable Housing • Mental Health • Nurse Shortage
April 1, 2022	Spanish Speaking community over zoom	5	• Bilingual personnel (Medical or RCHD) • Community news bulletin • English Classes

April 5, 2022	Ogden Community Center	9	• Transportation • Gym/Clinic • Lack of fresh/healthy foods
April 7, 2022	BLM MHK over zoom	7	• Mental Health • Recreation location/recreational activities • Access to Healthcare
April 12, 2022	Leonardville Community Center	16	• Affordable Healthcare • Transportation Services • Lack of Grocery Store
April 12, 2022	Northview Elementary	3	• Child Care • Mental Health • Resources for the elderly population
April 14, 2022	KSU Leadership Studies Building	2	• Mental Health • Affordable Housing • Maternal Health

Chapter 4: Discussion

The hookworm survey was created because there is no survey of its kind. Dr. Chelladurai and I are not aware of anyone who has developed a survey regarding veterinarians' perceptions of canine hookworms. This is the first survey of U.S. based veterinarians' perceptions about prevalence, breed predilection, diagnoses, treatment, resistance, and client communication on canine hookworm. Unfortunately, there is no data we can compare to the survey's results. We can only compare the results between the veterinarian and para-veterinarian surveys.

This study had its own set of limitations such as a small sample size, sample bias and time constraint. The participants in this study were somehow connected to Kansas State Veterinary Diagnostic Laboratory since the survey was only distributed to clients and KSU veterinarian alumni. Therefore, this study was limited in bias and sample size. We also did not

have a balanced amount of responses from across the country, mainly all were from the Midwest. Due to time constraints for me to finish my project, the survey was only open for a limited time, making it hard for people to participate.

Improvements for future work design include: having a wider net of participants, making this survey worldwide, and allowing participants more time to take the survey. I would also like to improve or use different statistical methods to collect and analyze data. Allowing this study to have a bigger sample size, broader geographical locations and more time will better this study greatly. I also would have asked more specific questions about the participants' geographical area.

The questions in the survey were in order of demographics, breed, diagnose, treatment, control, and education. This order helped the participant answer the questions in the survey by order of operation in treating a patient. According to raw data, not all participants (both veterinarians and para-veterinarians) answered every question in the survey. This made it difficult when analyzing data. In future research, I would like to correlate which answers and participants responded or not responded to a specific survey question.

In Q5, 20% of the veterinarians answered they diagnosed 5 dogs with hookworms in a month. The same question was asked to the para-veterinarians, 14% said 2 dogs are diagnosed, 14% said 3 dogs are diagnosed and 14% said 10 dogs are diagnosed in a month with hookworms. The number of diagnosed dogs can vary depending on the environment, warmer climate, and/or infected areas. Southern states in the U.S. tend to have a higher population of infected dogs.

For Q7, 53% of veterinarians said they diagnosed 0 Greyhounds in a month while 46% of para-veterinarians answered they see 0 Greyhounds diagnosed in a month by a veterinarian at their clinic. Both veterinarians' and para-veterinarians' responses correlated together. This question was asked specifically for Greyhounds because we were curious if hookworms were more common in a particular breed.

In Q6, veterinarians and para-veterinarians were asked what dog breeds are commonly seen in hookworm patients. Mainly 46% of veterinarians answered there is no breed predilection when it came to non-AKC breeds. Most veterinarians (42%) answered the hound breed was commonly seen with hookworms. Para-veterinarians had similar answers for the non-AKC category, 73% of para-veterinarians answered there's no breed predilection commonly seen in hookworms. In the AKC category, 50% of the para-veterinarians answered the sporting breed group was commonly seen in hookworms. Dr. Chelladurai and I were not expecting these answers to this question. Before sending out the survey we hypothesized that Greyhounds

would be a popular answer due to the greyhound racing industry and their exposure to hookworms.

Clinical signs are key indicators for veterinarians to diagnose their patients. Dogs who are infected with hookworms may or may not show clinical signs, making it difficult for them to be diagnosed. In Q8, Veterinarians and para-veterinarians were asked how common clinical signs are in patients with hookworms on a scale of 1 to 10 (1=uncommon and 10=very common). Many veterinarians (22%) answered 1 on the scale, meaning it was uncommon to see clinical signs such as diarrhea, anemia, and/or paw lesions. A total of 53% of veterinarians answered an 8 or above on the scale, meaning that patients who are infected are asymptomatic. In contrast, the majority (17%) of para-veterinarians answered 8 on the scale for commonly noticing symptomatic patients. For commonly identifying asymptomatic patients, 28% of para-veterinarians stated 7 on the scale. This was an eye-opener when analyzing results. This comes to show that hookworms in patients can be symptomatic and asymptomatic. Veterinarians and their co-workers should be vigilant when handling patients especially when there's an outbreak or during the hot summer months due to it being a zoonotic parasite.

In Q10, veterinarians and para-veterinarians were asked about the frequency of canine hookworm testing in different age groups. The biggest age group that both veterinarians and para-veterinarians responded to being frequently (10 or more dogs a month) tested were puppies (less than 8 months old). Frequently testing puppies for hookworms is a must due to their poor immune response and being easily susceptible to infections. Another concerning response from a different age group was rarely (0-2 dogs a month) testing pregnant/breeding dogs. This is an issue that needs to be brought up to attention. Pregnant dogs should be frequently tested for infections especially hookworms since they can infect their offspring in the womb and through feeding. By not testing pregnant dogs who could be infected, leads to puppies being sick and spreading hookworms.

For Q14, Veterinarians were asked if they were aware of multi-drug resistant hookworms being reported in multiple states across the country. Most veterinarians (74%) said yes, they were aware. This is a step toward the right direction in controlling and preventing canine hookworms in the United States. It is preferred that more veterinarians and people in the animal health care industry are aware of canine hookworms. A greater population of canine hookworm awareness leads to more treatments, prevention, and control measures.

In the client communication question, veterinarians and para-veterinarians were asked if they or their co-workers educate their clients about worms in dogs, worm preventatives, and how canine hookworms can be zoonotic. Both veterinarians and para-veterinarians responded

they often educate clients on worms (including hookworms) in dogs and hookworms being zoonotic but responded they always educate about worm (including hookworm) preventatives. It's great that the veterinary industry is always educating their clients on preventatives, but all the client communication questions should have been answered with an always. We need to work on communicating with the client and educating them about testing, treatment, and prevention. Very few clients understand that hookworms are zoonotic and are not aware of the danger their pets can be in.

RCHD—CHIP Process

Riley County decided to incorporate the CHIP process to better serve the community. This CHIP process is the second of its kind to RCHD, making it fairly new to the department. The CHIP process was scheduled to begin in 2020 but had to come to a pause as a consequence of the Covid-19 pandemic. We suspect that the responses received from the community during this process were mainly due to their Covid-19 pandemic experience. The pandemic caused a greater emphasis on what the RCHD could do to support its residents and community members through the CHIP process.

The majority of the LPHSA average essential public health service performance scores from 2015 and this year have increased. Comparing both results, out of the 10 essential services (ES), 3 of them have decreased; ES2: Diagnose and navigate, ES7: Link to health service, and ES9: Evaluate services. These specific ESs' have decreased over time due to the pandemic. RCHD did not have the time nor the means to approach these areas due to prioritizing Covid-19 regulations, testing, and monitoring.

In the first RCHD CHIP report released in 2015, numerous priorities were brought up by community members in stakeholder meetings and community input meetings such as mental health, healthy lifestyle, transportation, housing, communication and coordination of systems and services, access to critical services outside Manhattan, child care and before/after school care, substance abuse, employment, binge drinking, environment and infrastructure, special needs, and poverty and economic challenges. Out of these priorities, 3 were selected as having the most potential at improving Riley County, communication and coordination of systems and services, transportation, and mental health. Additional priorities that were mentioned in this year's stakeholder and community input meetings include nurse shortages, bilingual medical personnel, Spanish-speaking community bulletin board and English classes, access, and affordable healthcare, and resources for the elderly population. The priorities that were brought up most frequently were access/affordable healthcare, affordable childcare, mental health,

bilingual services, and healthy lifestyles. The 3 priorities that would make the most impact have not been selected at this time for this RCHD CHIP report.

The Covid-19 pandemic not only showed RCHD how to prepare and go through a health crisis but opened the community's eyes to new services they didn't know they needed. The Covid-19 pandemic showed an increase in usage of services due to the stress of the pandemic where people did not have access to their normal routines causing them to value services that could improve their lives in the communities. RCHD's initial rollout of the CHIP process was in 2014-2015, in this instance more data was generated to better assess the community. This can be attributed to the fact that this was before the Covid-19 pandemic. In this second CHIP process, there were fewer attendees therefore fewer data was generated. The assessments fell under standard Covid-19 protocols such as social distance and masks. In order to raise community input meeting attendance, accommodations were made for participants to join in virtually via Zoom.

Chapter 5: Competencies

This chapter details how specific competencies were achieved in the overall field experience with Dr. Chelladurai (hookworm survey) and Mrs. Shanika Rose (RCHD—CHIP process). This chapter first reviews overall MPH competencies numbers 2, 3, 11, 19, and 21. Next, this chapter details how I achieved specific emphasis areas (infectious diseases and zoonoses) competencies.

Competency 2: Select quantitative and qualitative data collection methods appropriate for a given public health context.

In the hookworm project, we selected qualitative and quantitative variables for each survey question. Each question was carefully thought out and written to maximize a public health context (see appendix, portfolio A). For my second project, the team collected data from the previous CHIP report and recognized the challenges and benefits of the community. This helped us compare what the community needed to improve and what has improved from the past. The past and current data helped identify and transition to the next obstacle to better the community from a public health perspective. Many improvements ideas were thought of after the Covid-19 pandemic which made people realize what is a priority and what can wait for the next couple of years to be improved.

Competency 3: Analyze quantitative and qualitative data using biostatistics, informatic, computer-based programming, and software, as appropriate.

Quantitative and qualitative data were analyzed by using several software such as Qualtrics, Datawrapper, Intervene, and Microsoft Excel. Qualtrics was used to create the online survey, download the results, and look at current participation progress. Datawrapper and Intervene are online graphic platforms that were used to enrich results by translating them into design charts. Lastly, I used Excel to separate and analyze survey results as well as to create multiple charts to interpret results.

Competency 11: Assess population needs, assets, and capacities that affect communities' health.

My first project was created after assessing the population's needs and their overall health. Canine hookworms pose a multi-drug resistant threat that also happens to be zoonotic in nature. This is a major public health concern worldwide that needs to be controlled and

prevented when possible. While analyzing the participants' answers, I realized how many veterinarians have different methods and courses of treatment for canine hookworms.

For my second project, community input meetings were facilitated to assess the cost and benefits of the county's overall health. Community members were encouraged to discuss their struggles and speak their opinions about their community needs such as access to mental health services, health care, affordable housing, and other resources.

Competency 19: Communicate audience-appropriate public health content, both in writing and through oral presentation.

For my first project, I presented my survey results on veterinarian perceptions of canine hookworms at the annual AAVP meeting (see appendix, portfolio B). During my second project in the local community input meetings, we presented general facts and data about Riley County. This information was presented to the community in graphic designs and tables that were easy to follow and understand. During the input meetings, handouts were also given to show additional information that the oral presentation did not cover (see appendix, portfolio C).

Competency 21: Perform effectively on interprofessional teams.

During my second project, I was a member of the CHIP team. This team consisted of EnVisage Consulting Inc., Riley County Director and Health Educator/Accreditation Coordinator, and interns. We worked as a team to correlate dates for events, events, handouts, presentations, and meetings for the CHIP program (see appendix, portfolio C and D). Riley County Health Department also worked with local organizations such as BlueCross BlueShield of Kansas, Pathways to a Healthy Kansas, Flint Hills Wellness Coalition, Ascension Via Christi, Konza Prairie Community Health Center, and Pawnee Mental Health Services to help with the CHIP project.

I am now going to discuss the MPH emphasis area competencies, which are summarized in the table below.

MPH Emphasis Area: Infectious Diseases/Zoonoses	
Number and Competency	**Description**
1 Pathogens/pathogenic mechanisms	Evaluate modes of disease causation of infectious agents.
2 Host response to pathogens/immunology	Investigate the host immune response to infection.
3 Environmental/ecological influences	Examine the influence of environmental and ecological forces on infectious diseases.
4 Disease surveillance	Analyze disease risk factors and select appropriate surveillance.
5 Disease vectors	Investigate the role of vectors, toxic plants, and other toxins in infectious diseases.

Competency 1: Pathogens/pathogenic mechanisms

I learned how to evaluate modes of disease causation of infectious agents when I took DMP 814-Veterinary Bacteriology and Mycology and MPH 802-Environmental Health courses. DMP 814-Veterinary Bacteriology and Mycology course taught me about pathogenic bacteria and fungi that infect and cause disease in domestic animals. Along with that, this course also taught me organisms' morphology, major characteristics, virulence factors, pathogenesis of infection, clinical signs, and lesions. Taking this course allowed me to expand on my vocabulary and lay out the foundation for my first project on canine hookworms. MPH 802-Environmental Health course taught me how to recognize public health issues and concerns for populations, observe lifestyle behaviors that promote health and well-being in a community setting, and how to apply planning concepts in a public health program. I was able to use my learned knowledge from this course in my second project (CHIP project) by integrating knowledge and principles for health improvement in the community, assessing population needs and capacities that affect the communities' health, and detecting the effects of environmental factors on a population's health.

Competency 2: Host response to pathogens/immunology

I learned how to investigate the host immune response to infection when I took DMP 817-Principles of Veterinary Immunology course. This course taught me the functions of a normal and abnormal immune system and how the immune system fights diseases. I also learned how to identify immunodeficiency syndromes, immune responses, and the properties of

vaccines. DMP 817-Veterinary Immunology course helped me in my first project on canine hookworms by being able to understand the life cycle of the parasite as well as the host being invaded by hookworms. This class gave me the understructure for vocabulary and made learning about canine hookworms more interesting.

Competency 3: Environmental/ecological influences

I learned how to examine the influence of environmental and ecological forces on infectious diseases when I took MPH 802-Environmental Health and DMP 710-Introduction to One Health courses. MPH 802-Environmental Health course taught me how to realize major public health concerns and how to apply multidisciplinary strategies and interventions in addressing public health issues. This course gave me the advantage to detect and address the needs of the local community during the community input meetings of my second project. DMP 710-Introduction to One Health course taught me the One Health concept and zoonotic diseases along with their routes of transmission. This course gave me the basic knowledge and prepared me for my canine hookworm project.

Competency 4: Disease surveillance

I learned how to analyze disease risk factors and select appropriate surveillance when I took MPH 754-Introduction to Epidemiology and DMP 854-Intermediate Epidemiology. MPH 754-Introduction to Epidemiology taught me the basic principles and methods of epidemiology. This course laid the groundwork for the next highest course, DMP 854-Intermediate Epidemiology. This course taught me how to assess bias, confounding, association, and causal relationships. Having been able to take these courses allowed me to make proper decisions on my canine hookworm project such as choosing a type of study, being aware of study bias, and knowing the ethical and legal principles of the study. Both courses included real-world scenarios and problem-solving which prepared me for my applied practice experience. After taking these two courses, I was able to evaluate raw data and analyze it by using epidemiological software for my hookworm survey.

Competency 5: Disease vectors

I learned how to investigate the role of vectors, toxic plants, and other toxins in infectious diseases when I took DMP 814-Veterinary Bacteriology and Mycology, MPH 802-Environmental Health, and DMP 710-One Health courses. DMP 814-Veterinary Bacteriology and Mycology taught me how to identify the etiology, characteristics, pathogenicity, clinical signs, diagnoses,

treatment, vaccines, and control methods of bacterial and fungal pathogens. This course emphasized on treatment and control of diseases which helped me in my hookworm project. This class and applied practice experience reinforced my thoughts on prevention, treatment, and control. MPH 802-Environmental Health taught me the biological and genetic factors that affect a population's health and how globalization affects disease. This course benefited me in assessing population needs and proposing strategies to improve public health outcomes in my CHIP project. DMP 710-One Health taught me how natural, and human-made environmental issues affect animal health and human health. This course helped my hookworm project by having a mindset of health improvement. Canine hookworm is a One Health concern where animal health, human health, and environmental health work together to reach optimal health.

References

About CAPC. (2022). Companion Animal Parasite Council. https://capcvet.org/about-capc/

About Us—Riley County Health Department | Riley County Official Website. (n.d.). Retrieved

    July 17, 2022, from https://www.rileycountyks.gov/2010/About-Us---Riley-County-Health-

    Departmen

Burke, A. (2016, September 12). *Understanding Hookworms in Dogs*. American Kennel Club.

    https://www.akc.org/expert-advice/health/understanding-hookworms-in-dogs/

CDC - Public Health System and the 10 Essential Public Health Services—OSTLTS. (2021,

    December 20). https://www.cdc.gov/publichealthgateway/zz-

    sddev/essentialhealthservices.html

CDC - Zoonotic Hookworm—Biology. (2019, September 17).

    https://www.cdc.gov/parasites/zoonotichookworm/biology.html

CDC - Zoonotic Hookworm—Resources for Health Professionals. (2021, September 8).

    https://www.cdc.gov/parasites/zoonotichookworm/health_professionals/index.html

Cima, G. (2021, August 25). *Drug-resistant hookworms spreading in dogs, parasitologists warn*.

    American Veterinary Medical Association. https://www.avma.org/javma-news/2021-09-

    15/drug-resistant-hookworms-spreading-dogs-parasitologists-warn

Community Health Assessment and Improvement Planning—NACCHO. (2022).

    https://www.naccho.org/programs/public-health-infrastructure/performance-

    improvement/community-health-assessment

Companion Animal Parasite Council | Hookworms. (2020, July 29).

    https://capcvet.org/guidelines/hookworms/

Herrin, B., & Dryden, M. (2021, November 22). *Steps to Increase the Value of Fecal*

    Diagnostics.

https://www.ksvdl.org/resources/news/diagnostic_insights_for_technicians/december201

7/fecal_diagnostics.html

Hookworm Disease: What Is It, Causes, Symptoms & Treatment. (2021, June 24). Cleveland

Clinic. https://my.clevelandclinic.org/health/articles/14072-hookworm-disease

Hookworms. (2020, July 29). Companion Animal Parasite Council.

https://capcvet.org/guidelines/hookworms/

Jimenez Castro, P. D., & Kaplan, R. (2020, April). *NEW RESEARCH: Multiple-Anthelmintic*

Resistance in the Canine Hookworm. https://www.cliniciansbrief.com/article/new-

research-multiple-anthelmintic-resistance-canine-hookworm

Kansas Counties by Population. (2020). https://www.kansas-

demographics.com/counties_by_population

Maxfield, L., & Crane, J. S. (2022). Cutaneous Larva Migrans. In *StatPearls [Internet].*

StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK507706/

One Health | CDC. (2022, July 15). https://www.cdc.gov/onehealth/index.html

Parasite Prevalence Maps. (n.d.-a). Companion Animal Parasite Council. Retrieved July 17,

2022, from https://capcvet.org/maps/

Parasite Prevalence Maps. (n.d.-b). Companion Animal Parasite Council. Retrieved July 17,

2022, from https://capcvet.org/maps/

Public-Health-Accreditation-Board. (2022). Accreditation Activity. *Public Health Accreditation*

Board. https://phaboard.org/accreditation-recognition/accreditation-activity/

RCCHIP - Home. (2022). https://datacounts.net/rcchip/index.asp

Services | Riley County Official Website. (n.d.). Retrieved July 17, 2022, from

https://www.rileycountyks.gov/1133/Services

U.S. Census Bureau QuickFacts: Riley County, Kansas. (2021, July 1).

https://www.census.gov/quickfacts/rileycountykansas

Ward, E. (2022). *Hookworm Infection in Dogs | VCA Animal Hospital*. Vca.

https://vcahospitals.com/know-your-pet/hookworm-infection-in-dogs

Appendix

The appendix features in the following order my 4 portfolio products:

- Portfolio A: Veterinarian & Para-Veterinarian Hookworm Survey
- Portfolio B: AAVP Annual Meeting Poster
- Portfolio C: Riley County Community Input Meeting support in Spanish
- Portfolio D: Riley County advertisement & Social media content