ACCESS TO VETERINARY CARE

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ACCESS TO VETERINARY CARE

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BRIEF RESEARCH REPORT
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Barriers to Care in Veterinary Services: Lessons Learned From Low-Income Pet Guardians' Experiences at Private Clinics and Hospitals During COVID-19

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This qualitative study aimed to explore the experiences of low-income pet guardians in accessing veterinary care during COVID-19. Participants were recruited through a purposive sampling method: 12 individuals who applied to and met the low-income threshold to access support for veterinary fees from the Vancouver Humane Society (VHS) were invited for semi-structured in-depth telephone interviews. Participants indicated that they experienced pandemic-related barriers related to and compounded by their low-income status. Their experiences fit into three categories: the barriers to accessing veterinary care pre-and peri-COVID-19, the emotional impact of compounding barriers related to accessing veterinary care during COVID-19, and the human-animal bond and resilience in the context of COVID-19. Drawing on the One Health, One Welfare approach, we argue that veterinary and animal services should evaluate and improve their support services, particularly programs developed for low-income pet guardians. Based on the participants' recommendations, we propose that veterinary and animal services prepare for future disaster situations by increasing their financial capacity to support people needing assistance, undergoing training to better work with people experiencing financial and emotional stress, and providing easily accessible resources to better distribute knowledge about animal needs and available financial assistance programming. The suggestions are intended to benefit animals, their guardians, and both veterinary and animal service sector workers.

Keywords: low-income pet guardians, low-cost veterinary services, financial limitations, COVID-19, human-animal bond, one welfare

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INTRODUCTION

Pets provide significant diverse benefits to their guardians, particularly to those experiencing vulnerabilities (1–3). The COVID-19 pandemic has resulted in many people experiencing mental health challenges, including fears about economic consequences and traumatic stress (4). COVID-19 has also demonstrated the importance of pets in aiding in the resilience of their guardians (5). For example, Ikeuchi and colleagues highlight that during the COVID-19 pandemic, socially isolated older adults without dogs were more likely to report lower psychological health than

their peers who have or have had a dog in their life (6). Furthermore, animals have been shown to positively impact how people react, cope, and recover from disaster situations (7–11). Consequently, current COVID-19-specific research reports increased pet guardianship (12) and confirms the various support roles of the animal within human-animal bonds (13).

One Health and One Welfare frameworks demonstrate the interconnections among human, co-inhabitants, and their environment (14). The One Health approach recognizes that human health is closely connected to animals and our shared environment (15). The One Welfare framework extends the approach of the One Health framework, promoting the links of animal welfare to human welfare and the environment (16). In practice, One Welfare aims to improve animal welfare and human well-being and vice versa (17). One Welfare highlights how relationships between companion animals and humans contribute to well-being. Research suggests that a healthy human-animal relationship can lead to positive physical, emotional, and social outcomes impacts, especially for vulnerable people experiencing mental health challenges (1, 14). Additionally, animal guardians experiencing vulnerabilities have strong bonds to their animals, who motivate positive behavior change in their guardians. The One Welfare approach can include identifying the mutual benefits of the human-animal bond and demonstrating how improving services can acknowledge and help preserve these bonds (1).

COVID-19 has impacted low-income guardians and their pets by compounding financial and emotional stress factors, specifically in accessing veterinary care (13). Indeed, pandemic-specific public health restrictions forced animal hospitals to cancel or limit appointments, prevented pet guardians from accompanying their pets in the clinics, and reduced some pet guardian's communication with veterinarians. This shift to curbside services potentially increased the guardian's emotional stress (18). Although these COVID-19 changes likely impacted many animal guardians, the impacts exacerbated the barriers to veterinary care that people experiencing low income already experience (19).

In a Canada-based study exploring the relationships between human social deprivation and animal surrender to shelters, Ly et al. (20) discuss the importance of the need for free or low-cost veterinary care and desexing services in low-socioeconomic status areas. Specifically, using quantitative data comparison methods, they formed recommendations that services be made available to guardians and the animals they care for to reduce the risk of surrender due to deprivation factors. These include ethnocultural composition, economic dependency, residential instability, and situational vulnerability. Increased access to veterinary care in underserved populations can help reduce animal overpopulation, improve animal welfare, and benefit overall community health from a One Health and One Welfare perspective (21).

Recent research highlights the importance of accessibility, communication, empathy, and cultural competence when low-income pet guardians seek veterinary services, specifically in accessing free and low-cost community veterinary services (22). Briefly, cultural competence is defined as awareness, behaviors, knowledge, attitudes, skills, and policies that all come together to enable people to work effectively in cross-cultural situations (23, 24). In practice, exhibiting cultural competence when communicating with animal guardians accessing services promotes inclusion and collaboration, which leads to higher client satisfaction and improved animal well-being (24). Research on low-income-client-only clinics illustrates that transportation, financial hardship, and care provider-client communication were common barriers, impacting the pet guardian's experience in accessing services (22). Furthermore, research has also demonstrated better service outcomes of using trauma-informed practices (TIP) to serve marginalized populations experiencing various traumas (25, 26). In a service context, a trauma-informed provider realizes the widespread impact of trauma and understands potential ways for healing; recognizes the signs and symptoms of trauma in staff, persons accessing animal services, patients, residents, and others involved in the system; and responds by incorporating knowledge about trauma into policies and practices. This is important because experiencing low-income status is considered a marginality and low-income communities are disproportionally affected by trauma (27).

Kogan et al. (22) argue it is not ethically acceptable to deny families the benefits of a pet due to financial barriers in accessing veterinary health care. Similarly, it has been stated that the lack of access to veterinary care threatens pets and their families (17). Through quantitative survey data from Kogan et al., affordable and accessible veterinary care that results in a positive experience is indicated to improve animal welfare and prevent animals from prolonged distress. Based on this data, they hypothesize that low-income pet guardians are more likely to continue to seek out assistance in the future (22). Previous findings also suggest that a positive experience should involve good communication, be culturally competent, and be relationship-centered with balanced power between the client and veterinarian based on mutuality, negotiation, and joint agreement (23, 28–34).

When discussing veterinary services, it is also essential to consider the stresses on veterinarians. Past studies (35–41) have demonstrated the challenges veterinarians face, including debt, shortage of other veterinarians/large client loads, and emotional challenges due to the impact of working with animals and clients in distress. The COVID-19 pandemic impacted veterinarians' ability to provide services to all clients (13, 14, 18).

Although people's experiences of accessing free or low-cost community veterinary services were measured in the United States (22), there is a scarcity of research that qualitatively describes the experiences of low-income clients accessing private veterinary service with external financial support from animal service agencies. Additionally, studies rarely focus on this issue within the Canadian context. Research dedicated to exploring this context is vital because Canada has a comparatively smaller population and many smaller communities distributed across a wide geographic range, with differing political, health, and social systems. Thus, this study qualitatively examines the COVID-19-driven challenges that low-income pet guardians faced in accessing veterinary care from private veterinary clinics within the Canadian context. We further provide recommendations for improving veterinary and animal services based on the

participants' suggestions, informed by their lived experiences and diverse circumstances.

MATERIALS AND METHODS

A phenomenological approach was employed to understand low-income pet guardians' experiences accessing veterinary service and their related impacts during the first wave of COVID-19. The details about these experiences were gathered through in-depth, semi-structured telephone interviews. A purposive sampling strategy was utilized to recruit 12 companion animal guardians who lived in Metro Vancouver, British Columbia, Canada and received Companion Animal Veterinary Emergency Funds (CAVEF) provided by VHS. CAVEF receivers were previously screened and identified as low-income according to the Low-Income-Cut-Offs (LICO) chart available from Statistics Canada (42). VHS randomly contacted 29 CAVEF receivers and the first 12 receivers who self-identified their eligibilities were interviewed. Verbal consent was obtained from each participant at the beginning of the scheduled interview. This study was approved by the Social Sciences and Humanities Research Ethics Board at Dalhousie University (certificate number: 2020-5371).

Two of the authors completed the 12 audio-recorded individual telephone interviews over 5 months (from December 2020 to May 2021). The interviews, ranging from half an hour to 1 h, consisted of 14 open-ended questions, which covered topics such as the participants' basic demographic information, their COVID-19-related challenges, and the resources and support they identified and received to address these challenges. The interview protocol (including interview questions) can be accessed from the online data repository of DesignSafe-CI (43). The 12 interviews were transcribed and coded through a content analysis using the qualitative analysis software NVivo 12. The first two authors applied an inductive approach to analyze all the interview transcripts independently. They compared, discussed, and merged their findings into three main subcategories strongly associated with participants' low-income status.

RESULTS

All participants indicated that their low-income situation was negatively affected by COVID-19 (e.g., a period of limited or no work during the pandemic). This was compounded with other factors that already contributed to their low-income status pre-COVID-19, including having physical or mental health challenges, disabilities, and having existing debt.

The Barriers to Accessing Veterinary Care Pre- and Peri-COVID-19

The participants identified various barriers. Due to limited appointments, several participants (interviews 1, 4, 5, 6) had to access emergency vet services, which were much more costly than a regular visit. Participants (interviews 1, 6, 8) also shared about the stress of accessing veterinary care. One participant (interview 8) shared, "I have found with COVID [it is] annoying trying to find rides now and I don't like taking my cat in a cab because he's very, very loud." Typically, they would have found rides with friends, but COVID-19 made that problematic. The limited appointment options were taxing on participants because it was difficult to get an appointment, and with the uncertainty of COVID-19, veterinarians offered restricted hours (interviews 1, 2).

Several participants illustrated a lack of empathy from veterinary workers (interviews 2, 3, 5, 6, 9, 12). Specifically, some participants communicated that despite experiencing low-income, they wished to access services from a veterinarian who could offer affordable quality care (interviews 2, 3, 6, 8). Some felt that veterinarians were overlooking issues with their pets, being short and quick during the visit (interviews 2, 5, 6), and recommending services that the guardian was wary of (interview 12), in one case, leading to the sudden death of a pet (interview 3). Some participants shared experiences that indicated they had to decide out of necessity and affordability, including which clinic they go to (interviews 2, 5). Participants stated that "it seems like they just want the money" (interviews 3, 5), or that there is "inconsistency in pricing and care" (interview 9), that they try "to charge me for things unnecessarily" (interview 12), and described having gone to a vet "where they obviously do not really like animals" (interviews 6, 12). Some participants described needing to see multiple veterinarians to get a second opinion because of this, further exacerbating their state of low-income (interviews 1, 5).

Other barriers mentioned by participants included limited access to financial support when payment was required (interviews 2, 6, 7, 10). One participant stated concerns over the veterinarian keeping an animal in distress due to cost, suggesting: "The veterinary clinic, I think they should be more forgiving on asking for an $800 deposit. Most people especially with COVID don't have that kind of money… [it would be helpful to] work out [a] payment plan or if somebody's helping fund it… that they can wait 'til the next day or a couple days just to be more helpful that way. It's more for the animal, they shouldn't be gatekeeping that care." (interview 6)

In addition to the cost, the experience of a pet needing emergency care created acute emotional stress for some participants. One participant described the emergency pushing them to their limit: "They had to do a urine test and then a few other things and it ended up being $450 that I just didn't have and we'd already spent so much money on him." (interview 2) Another participant spoke of themselves and their peers, saying "Everything's fine and all of a sudden bam right? … You just never know. Something goes on with their pets out of the blue and they're not expecting it and everybody's just struggling so hard right now." (interview 1)

The stress of the appointment was also a challenge. One participant (interview 7) remarked, "I don't have [a] cell phone. So you go … to the vet you drop your pet off and then they call you on your phone while they're doing the exam." This participant had to find a way to access a phone to communicate with the veterinarian. Another participant (interview 10) shared, "I still have the fear if you can't pay for the bill, they may ask you to surrender the animal and I didn't want to surrender the animal. I can feed her. She's loved. She's not abused."

The Emotional Impact of Compounding Barriers Related to Accessing Veterinary Care Peri-COVID-19

Compounding factors created significant stress for low-income pet guardians. These included having essential bonds with their pets that supported their health and the emotional impact of their pet being sick, the emotional and financial stresses of COVID-19, and the impacts of COVID-19 on existing barriers to accessing veterinary care that people experiencing low-income status already face. While the low-income pet guardians interviewed demonstrated resilience by accessing financial and emotional support, they still faced challenging situations.

Participants (interviews 1, 7, 10) noted the emotional impact of the pandemic, primarily in response to the factors that impacted their or their pets' health, such as infection risk in taking transportation. One participant (interview 7) shared, "I was afraid to take a cab because I have three autoimmune diseases."

Participants indicated the difficulty of choosing between themselves and their animal suffering (interviews 2, 3, 5, 6). A participant (interview 2) stated, "I'd rather go hungry than be able to have my cat die" and "people live under the constant stress because of bills and then having a sick animal. . . [you] never [want to] be put in a situation that you have to question your animal's health or life over being able to afford a roof over your head." Similarly, another participant (interview 6) shared their perspective on their own and other low-income pet guardian's experiences: "Nobody should have to choose between paying rent and for veterinary care. I find that a really scary thought."

The negative mental impact of not participating in veterinary appointments was also tangible for participants (interviews 6, 8). One participant (interview 8) shared: "Not being allowed inside the vet . . . it's very heartbreaking to not be able to be there with them, [not knowing] what's going on or [being able to] hang out with them because he hates the vet of course." They felt the phone process created complications in understanding the situation: "I definitely spent a lot more time on the phone going over things with the vets . . . I feel like it's harder to communicate over the phone." Another participant (interview 6) also struggled with not being able to comfort their pet, which was difficult for their pet and their mental well-being: "The problem I found was not being able to go in with him 'cause he wasn't used to going to vets, so it was scary for him. . . . That was a horrible night. . . honestly, that was really tough."

The Human-Animal Bond and Resilience in the Context of the COVID-19 Pandemic

Most participants in this study demonstrated a meaningful human-animal bond, as previous research showed that participants' love for their pets was strong (1). Participants (interviews 3, 5, 6, 7, 8, 10, 11) indicated this as "I love my cats with all my heart and soul" (interview 3), "I've never had a connection to an animal like this" (interview 8), and "She brings us so much joy" (interview 10).

Participants also showed resilience and strength in identifying assistance for their pets (interviews 2, 3, 5, 6, 7, 10, 11). One participant (interview 2) commented about resourcefulness, saying, "I think anybody who's. . . lived in poverty already knows how . . . resourceful you have to be." A participant (interview 3) who collected bottles to help supplement her income to provide food and care for her pets stated, "If it wasn't for me going out collecting those empty bottles I wouldn't have groceries and I wouldn't have gas for my vehicle either."

Resourcefulness also presented itself as accessing supports from family, friends, and the community (interviews 1, 5, 7, 8, 12). One participant (interview 1) assisted their son with accessing discounted veterinary services and taking his cat to the vet, which was otherwise difficult due to his mental health challenges that COVID-19 exacerbated.

Another participant (interview 7) was able to find support from a friend to overcome the barrier of transportation: "I asked if a good friend of mine would help us, take us to the vet and let me use his cellphone and he let me put coins in the meter, but he wouldn't take any money. [That] was amazing [for] him to do because these vet visits were like 45 min on the phone, right? You can't really go anywhere for coffee or do anything."

One participant (interview 12) contacted 16 different agencies by doing online searches. "There was quite a few that were independent women that just this is their passion. So they couldn't actually do anything for me other than emotional support, but it was kind of nice for that. And then others, they gave me lists of possible non-profits, that would be able to help and to contact. It was kind of a network that became something that wound up helping me out quite a bit."

Participants (interviews 2, 3, 7, 10) also demonstrated a willingness to rescue animals in need. Previous research (44) shows the value of rescue for seniors who identify as low-income. One participant (interview 2) stated, "a lot more people who live in poverty or are low-income are more willing to rescue animals, because there's this greater sense of community. You see that a lot too where people who are poor are more likely to be giving to homeless people and give them money. People who are poor will take on animals that have health problems or you know have special needs to help take care of them because of that level of compassion."

Deeply affected by the pandemic, some participants (interviews 1, 4, 7, 8) began to consider pre-preparedness, especially financial readiness for the next extreme event. One participant (interview 4) shared that they would like to purchase medical insurance for their pets and indicated that their limited income might not support the monthly insurance payment. Another participant (interview 1) proposed that animal clinics could offer some payment flexibility for low-income pet guardians. These factors demonstrate that people experiencing low-income are well-positioned to continue caring for their pets under a service framework that is supportive in addressing social inequities.

DISCUSSION

Recognizing the challenges low-income guardians and veterinarians faced during the pandemic and the strength

of the human-animal bond, this section reviews the participants' recommendations, providing ideas for how veterinary clinics and animal service providers can implement these in their practices.

The most prominent theme mentioned by participants (interviews 2, 3, 5, 6, 9, 12) was more compassion toward low-income pet guardians. Animal and veterinary service providers can work toward providing a trauma-informed model (25) to overcome unconscious bias when providing services to clients that identify themselves as low-income. As specified in the literature, a trauma-informed model is beneficial for the person accessing services and the workers in these circumstances. It leads to better service outcomes by centering a non-judgmental, collaborative, and empathetic approach (26). Resources for trauma-informed care training are in the process of being developed for the animal services sector by the Vancouver Humane Society (25).

One participant (interview 1) suggested accessing more freely available information on assessing their pet's well-being or degree of suffering, sharing that no matter what they ask on the phone, they are instructed to bring their pet in, which can be a significant barrier. Phone conversations or telemedicine to triage an animal, as well as written guidance by email or as a handout as a follow-up to a visit, could provide opportunities to improve access to care and share knowledge in a way that could have a lasting effect and reduce the animal's current and future suffering. Some community-based animal service organizations distribute information (e.g., informative flyers) to pet guardians about animal care; the veterinary sector could expand on this.

Cost, as expected, was a significant barrier to low-income pet guardians accessing services. Participants shared suggestions related to improving access to discounted services. These included reducing limits on charitable veterinary assistance programs, including geographic barriers (interview 2) and the number of animals assisted per person (interview 3), providing assistance with other types of pet services such as pet products (interview 2), providing support for preventative services in addition to emergencies (interview 12), and improved program design as it relates to making programs more accessible (interview 6). Participants also suggested increasing the advertising of programs (interviews 2, 7, 8, 9, 10), suggesting that veterinarians could be aware of veterinary assistance programs and refer clients to them when they share about their state of low-income.

Participants spoke about making payments more feasible, suggesting that veterinarians could offer lower costs (interviews 1, 7) for low-income pet guardians and offer them the opportunity to pay off services over time (interviews 1, 2, 4, 8). A payment plan might not only reduce low-income pet guardian's financial stress but also releases their immediate mental stress, contributing to their overall well-being. Although payment plans and compassionate pricing are not feasible for all private veterinary operations, large-scale veterinary providers that benefit from economies of scale may be able to offer more flexible pricing and payment options. Veterinary clinics can also consider using a spectrum of care treatment or incremental care options to increase access to care for low-income animal guardians (45). For more recommendations related to cost, Mattson compiled suggestions for veterinarians to better provide access-to-care options during the COVID-19 pandemic (46).

Participants (interviews 4, 9, 12) also suggested that prices could be regulated between veterinarians and the government authorities (interview 2) in providing support that recognizes the mental health benefits of the human-animal bond for low-income individuals. This points toward the role that regulatory bodies and government can have in supporting low-income pet guardians.

Collaboration, collective decision-making, and compassionate care go a long way in establishing trust, so does having cultural competence (24). Trust leads to better understanding and compliance, resulting in a better animal welfare outcome. As demonstrated through the findings, [Kogan et al. (22), p5] expertly outline, "pet owners who feel respected and heard are more likely to seek out care and follow medical recommendations."

Veterinary clinics and animal service agencies can also benefit from this positive experience. They may feel more understanding and receive more kindness from clients. Low-income pet guardians may have limited prior veterinary medicine experience. For example, Wiltzius et al. (17) found that nearly 1 out of 4 respondents in their study, who were disproportionately low-income, shared that they were unable to access preventative veterinary care for at least one of their pets in the recent past, and faced this barrier at an average frequency of 2.4 times in the past year (17). This emphasizes the importance of each visit being a positive experience such that veterinary care is valued and prioritized in the future.

Another benefit that veterinary and other animal service providers may experience is that animals are likely to come in sooner when there are subtle signs of being in need rather than later when the situation may be at a crisis point. Seeing the animals when an issue first occurs may decrease the likelihood of euthanizing animals for reasons related to their owner's financial status, which can take an emotional toll on veterinary workers.

CONCLUSION

This study explored the experiences of low-income pet guardians regarding accessing veterinary care during the COVID-19 pandemic. The study found that participants who experienced pandemic-related barriers that were related to and compounded by their low-income status can be categorized in three aspects: the barriers to accessing veterinary care before and during COVID-19, the emotional impact of compounding barriers related to accessing veterinary during COVID-19, and the human-animal bond and resilience in the context of the COVID-19 pandemic.

The global COVID-19 pandemic has created an opportunity to evaluate existing support services, especially those programs that were developed for low-income pet guardians. To prepare for future disaster situations, this study suggests that animal services and veterinary clinics could increase their financial capacity to support people needing assistance, undergo training to learn how to better work with people experiencing financial and emotional stress, and gather

more information and resources that can be easily shared to better distribute knowledge about animal needs and available financial assistance programming. From a One Health and One Welfare perspective, these recommendations could positively impact pet guardians, their pets, and the service providers.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of privacy and ethical concerns. The interview data will be shared at reasonable request to the corresponding author. Requests to access the datasets should be directed to Haorui Wu, Haorui.wu@dal.ca.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Social Sciences and Humanities Research Ethics Board at Dalhousie University (Certificate No: 2020-5371). The participants provided their verbal informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AM and HW conceived the study design, analyzed the data, and drafted the manuscript. CM conducted interviews and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Assessing the Impact of a Virtual Shelter Medicine Rotation on Veterinary Students' Knowledge, Skills, and Attitudes Regarding Access to Veterinary Care

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Strong bonds commonly form between companion animals and people of all socio-demographic backgrounds, yet many pet owners face numerous barriers to accessing veterinary care for their companion animals. For example, they may have difficulties paying for care; they may lack veterinary practices in their community; and they may experience language barriers that impede their ability to utilize veterinary services. Various strategies exist that can help veterinarians address the diverse needs of pet owners in their communities, but these techniques are not commonly covered in the veterinary school curriculum. This study explored how including in-depth, purposefully curated information about access to veterinary care issues within a required shelter medicine rotation impacted fourth-year veterinary students' knowledge, skills, and attitudes regarding the problems clients commonly face when seeking access to veterinary care. Students participated either in a control group of a virtual, four-week rotation delivered via Zoom meetings and self-study, or in an experimental group that additionally completed an interactive online learning module. The online module heavily featured issues surrounding access to veterinary care. Irrespective of which version of the rotation students enrolled, their opinions grew more favorable from pretest to post-test regarding the role of not-for-profit veterinary clinics in communities, as did their expectations that veterinarians should provide affordable treatment options. Additionally, students in the experimental group demonstrated from pretest to post-test increased awareness of the potential for implicit bias toward pet owners within veterinary practice and showed a reduction in their tendency to be judgmental of veterinary clients. By the end of the study, students in the experimental group also expressed greater confidence in their ability to offer incremental care treatment options to veterinary clients. These findings suggest that providing content that focuses on increasing access to veterinary care enhances students' awareness of the need to offer a variety of treatment and payment options to clients. Findings from this study can inform curriculum design in veterinary schools and continuing education programs for veterinary professionals.

Keywords: cultural competency, veterinary medicine, access to veterinary care, veterinary student, veterinary education, spectrum of veterinary care, human-animal bond

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INTRODUCTION

People of all socio-demographic backgrounds keep and care for pets, and the strong attachment bonds that commonly form between humans and pets do so irrespective of an owner's income (1, 2). Pet owners with higher incomes and cash liquidity have easier access to veterinary care compared to pet owners with lower incomes and/or less cash liquidity (3). Indeed, individuals in the latter category face numerous challenges to meeting their pets' needs for veterinary care (4, 5). Potential obstacles include the cost of care, accessibility of care, veterinary-client communication difficulties, cultural or language barriers, and a lack of client education (6). Additionally, social determinants of health that influence the delivery of human medical care (e.g., transportation, housing, internet access) also influence the delivery of veterinary care (7). Challenges associated with accessing veterinary care create burdens not only for pet owners and their pets but also for veterinary care providers, who struggle to treat animals effectively when owners lack the resources necessary for treatment.

When preventative veterinary care (e.g., vaccinations and anti-parasitic agents) is not widely available and accessible, viral, bacterial, parasitic, and vector-borne diseases may increase in companion animal populations and compromise human health through the spread of zoonotic disease (8). A recent, intervention-based study demonstrated that by making preventative veterinary care available to low-income pet owners, veterinary visits increased both for wellness and for disease/injury, and monthly heartworm preventative use and vaccination rates increased (9). As pet illness is a common reason pets are relinquished to shelters, often specifically for the purpose of euthanasia (10), veterinary interactions that succeed at educating clients about routine vet care and preventing, or detecting and treating, pets' medical conditions may have an enormous impact on companion animal welfare.

Caring for a sick pet is often a stressful experience for owners, as it can be emotionally draining, time consuming, and costly (11). Additionally, many pet owners live in communities that are not served adequately by veterinary services. Such locations where pet owners have very limited access to veterinary care are referred to as "care deserts" (12) or "veterinary deserts." While some of these underserved communities are in rural locations where there is a recognized shortage of veterinarians, many underserved communities are located in urban and suburban socio-economically depressed neighborhoods where veterinarians choose not to locate clinics due to financial pressures (6).

Regardless of their clinic's location, veterinarians routinely encounter clients who are struggling to meet their pets' healthcare needs. A survey of over 1,000 small animal practitioners in the United States and Canada indicated that 57% of veterinarians believe that owners' economic limitations affect the care that they are able to provide at least once per day (13). Furthermore, a 2018 survey of over 700 veterinarians in the United States found that 55% perceive the problem of underserved pet populations to be severe (3). The 2018 survey also indicated that veterinarians hold a broad range of views regarding who should own a pet and whether society bears any responsibility for caring for vulnerable people and their pets. For instance, nearly half of participants in that study believed poor people and their pets should be provided with a safety net, yet more than a quarter disagreed with that sentiment. Some participants indicated that changes to the veterinary curriculum could better equip veterinarians with the skills needed to offer effective, lower-cost treatment options (3).

As one of the key stressors veterinarians face is difficult relationships with clients (14) and many low-income individuals have a general distrust of healthcare providers (15), expanding veterinarians' exposure to cultural competency training has the potential to improve the well-being of pets, human clients, and veterinary staff. Cultural competency entails using various interventions in an effort to enhance how effective and accessible services are for individuals from diverse backgrounds (16). Indeed, the North American Veterinary Medical Education Consortium has highlighted diversity and multicultural awareness as a core competency that should be incorporated into veterinary education (17). Such training is not widely implemented within North American veterinary schools; however, integrating cultural competency training into the Australian veterinary curriculum positively affected veterinary students' behaviors and attitudes (18).

Given that obstacles impeding access to veterinary care affect pets, owners, and the veterinary community, there is a need not only for cultural competency training but also for identifying a variety of strategies that enhance access to veterinary care for poor, underserved, and diverse populations. Importantly, such methods must be feasible for staff and clients, favorable to the patient, and financially sustainable for veterinary practices. Veterinary practices have limited ability to offer free or discounted care because doing so can be detrimental to practice sustainability. However, they can offer hospital-based payment plans and partner with third-party services, such as Scratchpay and VetBilling, to provide alternative payment methods for their struggling clients (13).

Another approach is for veterinary practices to encourage the utilization of incremental care and/or spectrum-of-care treatment options. Incremental care is a strategy for delivering care progressively over time using a case-management approach (3). Spectrum of care is a related strategy for providing a variety of care options that might have good outcomes but differing costs and intensity of diagnostics or treatment plans (19). Incremental care and spectrum of care options offer alternatives to doing nothing other than providing the highest level (or gold standard) of treatment. An example of incremental care is the conservative management of a fracture in the distal extremity of select patients with a splint or cast and analgesics at an initial visit. This allows for radiographs, assessment of healing, and reassessment of the treatment plan at a follow-up visit. As another example of incremental care, researchers at Colorado State University have demonstrated that an outpatient treatment protocol for select puppies diagnosed with parvovirus may be a reasonable and less costly alternative to inpatient hospitalization (20). A spectrum of care treatment option might be to manage a feline obstruction case by performing a perineal urethrostomy earlier in the disease course rather than conservatively managing the problem with

multiple costly emergency visits (21). Another spectrum of care treatment option is the timely referral of pyometra cases to spay-neuter clinics rather than performing emergency surgery in full-service clinics (22). Such examples allow veterinarians to provide quality care while minimizing expenses for clients. These efforts can thereby strengthen relationships between veterinary team members and the clients they serve.

Currently, most veterinary education programs in the United States emphasize "gold standard" care delivery options over spectrum of care or incremental care treatment options. This is partly because veterinary educators often work in tertiary-care, referral facilities with boarded veterinary specialists rather than in general veterinary practices (3). As a result, veterinary school training at many institutions currently underrepresents the challenges that general practitioners may face and the strategies veterinarians can implement to address these challenges.

The veterinary curriculum is already extensive, yet increasing veterinary students' exposure to cultural competency training, the challenges pet owners face when trying to access veterinary care, alternative payment plans, and incremental or spectrum of care strategies has the potential to improve the lives of pets, their owners, and the veterinary community. Therefore, the goal of this project was to determine how incorporating an interactive, online educational module on issues surrounding access to veterinary care into a virtual shelter medicine rotation would impact veterinary student knowledge, skills, and attitudes toward access to veterinary care issues.

METHODS

Participants

Fourth year veterinary students at Lincoln Memorial University's College of Veterinary Medicine (LMU CVM) participated in this study during their "Small Animal Primary Care and Shelter Medicine" rotation during the summer of 2020. This rotation, which LMU CVM offers multiple times each year, is required of all veterinary students at this institution, and during the rotation, the students typically spend four weeks onsite at an animal shelter. Due to the novel coronavirus (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19), students enrolled in the summer 2020 rotations completed their entire rotation virtually. The rotations that occurred after summer 2020 included some in-person components for students. Consequently, data for this study were only collected from the 51 students who were part of the virtual rotations during summer 2020. Whether students were in the experimental or control condition was determined by the rotation to which they were assigned. All students in the first rotation that was part of this study were in the control condition, and all students in the second rotation were in the experimental condition. As students were assigned to their rotation before the study team determined which rotation would be the experimental condition and which would be the control condition, students' assignments were not impacted by the study design.

This study received Institutional Review Board approval from Lincoln Memorial University (IRB #919) and the University of Florida (UF IRB #202001847). Student completion of study-related surveys was optional, and students completed an informed consent document prior to completing the study's pretest survey.

Measures and Procedures

Students in the control condition were presented with a variety of resources (synchronous learning sessions, webinars, peer reviewed research, program websites, written information, and a video) to improve their understanding of barriers that may prevent clients from seeking veterinary care. The rotation also briefly introduced incremental care treatment strategies, safety net programs, third party payment options for veterinary services, and the role of private practitioners in preventing animal surrender to shelters. Importantly, the control condition did address these issues related to access to veterinary care because such issues naturally arise in a rotation focused on shelter medicine. Therefore, it would have been a disservice to the veterinary students had these topics not been covered. **Table 1** identifies the objectives of the shelter medicine rotation.

In addition to completing a virtual rotation that included the same resources as presented to students in the control condition, students in the experimental condition completed an asynchronous, online learning module that covered in detail the objectives described in **Table 2**. Students in the experimental condition were presented with a variety of resources (required readings, recorded lectures, and videos) as well as interactive discussions and assignments where they designed incremental treatment care plans and proposed treatment options that fit within patients' budgets. In addition, students in the experimental condition practiced identifying examples of implicit bias, investigated the economic factors on which means testing is based, researched options in their local communities for both for-profit and not-for-profit veterinary care, and considered how social determinants of health impact a client's ability to access veterinary care. The online module did not explicitly introduce spectrum of care but did discuss how veterinary medicine allows for a variety of standards of care that are acceptable practices in different communities and practice settings.

Study participants in both the control and experimental groups completed a survey measure at the beginning and end of their shelter medicine rotation. Some of the survey questions were derived from the 2018 CARE Veterinary Service Providers Survey (3), and others were developed specifically for the purposes of the current study. Survey questions were drafted and modified based on feedback received from the rotation instructor (KVM) and the online learning module developer (TGS). Due to time constraints, the survey was not formally piloted; however, an additional veterinary educator with expertise on the topic of access to veterinary care in underserved communities reviewed the survey questions and offered feedback that was incorporated into the survey.

Each study participant created a unique identification code that they entered at the start of both the pretest and post-test so that their responses remained anonymous but their pretest and post-test data could be matched. For the control

TABLE 1 | Student Learning Objectives (SLOs) associated with the virtual shelter medicine rotation and experienced by all students regardless of their assigned study condition.

SLOs common to control and experimental groups	Knowledge	Attitudes/beliefs	Skills
Demonstrate clinical skills using provided performance opportunities.	X		X
Create and maintain accurate medical records for simulated patients.	X		X
Utilize appropriate communication and professional skills during all interactions with others.	X		X
Assess the unique challenges faced by animal shelter and rescue organizations.	X	X	
Demonstrate understanding of relevant veterinary guidelines.	X		
Know the veterinarians' role in preventing the surrender of animals to shelters or rescue groups.	X	X	
Know about Access to Veterinary Care issues and options for clients who have difficulty paying for veterinary care.	X		
Know evidence-based strategies to provide incremental veterinary care.	X		X

TABLE 2 | SLOs associated with the supplemental module and experienced only by students assigned to the experimental condition.

SLOs unique to experimental group	Knowledge	Attitudes/beliefs	Skills
Compare major differences and similarities between for-profit, not-for-profit, and municipal governmental veterinary business models.	X	X	
Know how different types of veterinary practices view the issue of access to veterinary care.	X		
Explain how different veterinary business models operating in the same location might affect one another.	X	X	
Recognize the effects that competition and collaboration can have on access to veterinary care.	X	X	
Define "veterinary deserts."	X		
Define "social determinants of health."	X		
Recognize how social determinants of health can affect the human-animal bond.	X		
Recognize instances of implicit bias in the practice of veterinary medicine.	X	X	X
Recognize why cultural competence is important for the practice of veterinary medicine.	X	X	
Recognize the range of treatment and financial options available when practicing the veterinary standard-of-care.	X		
Create a treatment plan that allows for incremental care.	X		X
Appreciate the role of low-cost, reduced-cost, and pro-bono veterinary practices in serving the needs of the under-served.	X	X	

condition, the pretest and post-test versions of the survey were nearly identical, except participants only entered answers to demographic questions in the pretest survey. The experimental condition surveys included the questions that comprised the control condition surveys. In addition, participants were asked in the experimental post-test survey how much time they spent on the educational module and whether they completed any of the optional module materials (e.g., suggested readings on the module topics). They also were asked to describe their overall observations about the content and activities that comprised the module and to indicate what more they would like to learn about access to veterinary care.

In all versions of the survey, participants answered numerous closed-ended questions. Unless otherwise noted, answer choices were presented on a 7-point Likert scale, which provided a "neutral" option. The first question asked participants to indicate how knowledgeable they were on the topic of access to veterinary care, with answer choices ranging from extremely incompetent to extremely competent. They also were asked to describe in up to 250 words their knowledge on the topic of access to veterinary care for low-income and underserved populations. Participants then expressed their level of agreement with statements that captured their opinions regarding not-for-profit veterinary practices (e.g., "A not-for-profit veterinary clinic should only be allowed to start up in areas where there are currently no for-profit veterinary clinics"), with answer choices ranging from strongly disagree to strongly agree.

Participants indicated how likely they would be to provide veterinary services in a community that lacked veterinary care (i.e., a veterinary desert) in each of the following scenarios: as a veterinarian working at a for-profit clinic; as a veterinarian working at a not-for-profit clinic; and as a veterinarian working at a municipal shelter. Additionally, they were asked about their willingness to volunteer in a veterinary desert. Participants' answer options for these questions ranged from extremely unlikely to extremely likely. They were also asked to indicate how likely they were to be working at a not-for-profit veterinary clinic during the first five years after graduating from veterinary school.

Participants indicated how much they agreed with statements regarding factors that influence pet attachment and the impacts of pets on human well-being (e.g., "Pets can positively impact their owner's health"). Next, they indicated their level of

agreement with statements about the association between pet owners' practices and lifestyles and their relationship with their pet and their right to keep a pet (e.g., "People who keep their pets outdoors do not love their pets very much"; "People who surrender their pet to an animal shelter because the pet is sick or injured should not be able to adopt the same pet once treated and recovered").

The section that followed evaluated students' abilities to identify examples of implicit bias. Students were presented with twelve statements and had to indicate which statements were examples of implicit bias (e.g., "If the client can afford to drive a BMW, she can afford to spay her cat"). These examples were modeled after—but not identical to—examples of implicit bias highlighted in the online module that students in the experimental condition completed. For analysis purposes, the number of times students correctly identified whether a statement was an example of implicit bias was calculated. As there were twelve questions, a student who answered all questions correctly earned a score of twelve on that measure.

Following the implicit bias questions, participants were asked to rate their level of agreement with statements regarding how veterinarians should engage with low-income clients (e.g., "When a client's financial resources are limited, a veterinarian at a for-profit clinic should be willing to provide some care at a level the client can afford rather than providing no care"). Participants then indicated their level of agreement with statements about the value of collaborations between veterinary services and social services organizations. Next, participants rated their confidence in their ability to treat animals using incremental care and affordable treatment options (e.g., "To diagnose an animal's medical condition without the use of high-tech equipment") on

TABLE 3 | Measures and the questions that comprised them.

	α
Judgement of clients (higher score indicative of more judgmental attitude)	0.85
Pet ownership is a privilege and not a right	
People who keep their pets outdoors do not love their pets very much	
People commonly use poverty as an excuse for neglecting their pets	
Some pet owners are more likely than others to face obstacles when seeking veterinary care for their pets (Reverse scored)	
People who surrender their pets to shelters should not be allowed to adopt a pet in the future	
People who surrender their pets to shelters lack compassion	
If a family is not on any form of public assistance (e.g., Supplemental Nutrition Assistance Program, formerly known as Food Stamps), they should be willing and able to pay for the best possible treatment option for their pet	
People who surrender their pet to an animal shelter because the pet is sick or injured should not be able to adopt the same pet once treated and recovered	
Regard for not-for-profit veterinary clinics (higher score indicative of higher regard, meaning all items were reverse-scored)	0.82
Not-for-profit veterinary practices should be required to qualify their clients by income (i.e., perform means testing)	
Not-for-profit veterinary clinics negatively impact revenue for for-profit veterinary clinics that are in the same community	
A not-for-profit veterinary clinic should only be allowed to start up in areas where there are currently no for-profit veterinary clinics	
Not-for-profit veterinary practices should lose their not-for-profit tax status if they do not qualify their clients by income (i.e., perform means testing)	
Effects of pets on health	0.67
Pets can positively impact their owner's health	
Pets can reduce owners' stress levels	
Pets can impact individuals' physical activity levels	
Expectation that veterinarians provide affordable treatment options	0.76
When a client's financial resources are limited, a veterinarian at a for-profit clinic should be willing to provide some care at a level the client can afford rather than providing no care	
There are financially sustainable ways in which for-profit veterinary clinics can treat sick pets that belong to low-income clients	
There are ethically sound ways in which for-profit veterinary clinics can treat sick pets that belong to low-income clients	
Providing access to veterinary care is part of the "social ethic" mandate and therefore the responsibility of those in the veterinary profession	
Providing some care at a level the client can afford (i.e., incremental care) can positively impact an animal's quality of life	
Confidence in ability to provide incremental care	0.90
To diagnose an animal's medical condition without the use of high-tech equipment	
To create effective care plans that utilize alternatives to the best possible treatment options	
To present economically disadvantaged clients with alternative, more affordable treatment options when their pets are ill	

a slider scale ranging from 0 to 100, with 100 representing the highest level of confidence.

In the last part of the survey, participants provided information regarding their age; gender; history of volunteering at for-profit and not-for-profit veterinary clinics and municipal animal shelters; their experiences taking college-level courses on animal shelters and/or human social services; whether they had participated in a shelter medicine club; and their race and ethnicity.

Data Analysis

To assess the internal consistency of each measure, Cronbach's alphas were calculated (see **Table 3**). Responses to eight questions were averaged to develop a composite judgment of clients score ($\alpha = 0.85$), and scores on four questions were averaged to characterize students' attitudes regarding not-for-profit veterinary clinics ($\alpha = 0.82$). Responses to three questions were used to characterize participants' opinions regarding how pets affect owner health, stress, and physical activity ($\alpha = 0.67$), while responses to five questions were averaged to characterize students' expectations regarding whether veterinarians should help clients whose financial resources are limited ($\alpha = 0.76$). Answers to three questions were averaged to assess students' confidence in their ability to offer incremental care plans ($\alpha = 0.90$).

All analyses were conducted using R version 3.6.3 (21). Linear mixed models assessed whether there were main effects of study condition and test timing (i.e., pretest or post-test) on study measures. Statistical models also tested for interactions between study condition and test timing. Participant was treated as a random factor in all models because each participant provided pretest and post-test data. Outcomes that were based on each participant's averaged scores on the measures described in **Table 3**, or on the total number of implicit bias questions answered correctly, were assessed using a Gaussian distribution unless the distribution of residuals was skewed. In such cases, a median cutpoint was determined and analyses were conducted using a binomial distribution. Each participant's self-reported assessment of how knowledgeable they were on the topic of access to veterinary was comprised of a single question with Likert scale response options. Similarly, individual questions with Likert scale response options assessed how likely participants were to work or volunteer in a veterinary desert in the future under a variety of contexts. In these cases, a median cutpoint was utilized by categorizing each score as being above or below/equal to the median to make the dependent variable binary, and analyses were conducted using a binomial distribution.

TGS reviewed and analyzed participants' responses to four pre- and post-rotation, open-ended survey questions. The four questions are listed below this paragraph. TGS was not an instructor for the rotation and was not privy to student names. She only had access to the anonymized identifiers associated with the students. However, there is some potential for bias, as TGS was the primary author of the online module presented to the experimental group. TGS used a deductive, content analysis approach to identify patterns in the written student responses. The content analysis was managed using NVIVO software. An iterative process was followed, and this involved reading and coding the student responses about their learning experience multiple times in order to categorize the details students reported.

- **Question 1 (Pretest) and Question 2 (Post-test) were asked of those in both groups:** *What do you know regarding the topic of Access to Veterinary Care for low-income and underserved populations?*
- **Question 3 (Post-test, asked of those in the experimental group only):** *Please describe your overall observations about the content and activities that comprised the Access to Veterinary Care module.*
- **Question 4 (Post-test, asked of those in the experimental group only):** *What more would you like to learn about Access to Veterinary Care?*

Student responses to questions 1 and 2 were initially rated according to students' levels of familiarity with the subject of access to veterinary care, as indicated by the quantity and level of details they voluntarily included within their answers (23). That is, a more detailed response was considered to be associated with more familiarity with the subject. Classifications used included minimal familiarity, moderate familiarity, and familiar. In addition, a key word search was used to determine the frequency at which students mentioned within their responses to questions 1–4 specific topics or concepts presented in their learning activities. The topical codes that were identified within the student responses included the following: veterinary deserts, social determinants of health, liquidity, implicit bias, human-animal bond, cost of care, pro-bono-care, pet insurance, pet food pantry, payment plans, incremental-care, grants and subsidies, and communication skills.

RESULTS

Twenty-five individuals completed the pretest and the post-test surveys as part of the control condition, and 26 completed the pretest and post-test surveys as part of the experimental condition. No Lincoln Memorial University students who were enrolled in the study's shelter medicine rotations during summer 2020 opted out of participating in the study. Participants in the control group ranged in age from 23 years to 31 years ($M = 26.4$, SD $= 1.83$). Those in the experimental group ranged in age from 24 years to 38 years ($M = 26.9$, SD $= 3.05$). Twenty-three of the 25 participants in the control group identified as female, and two identified as male. In the experimental group, 23 participants identified as female, and three identified as male. Additional details about the participants and their educational and experiential backgrounds are included in **Table 4**. On average, those in the experimental condition spent 7.71 h (SD $= 2.94$, range: 3–15 h) working through the online access to veterinary care module.

At the beginning of the pretest and post-test surveys, participants were asked to rate their knowledge on the topic of access to veterinary care for low-income and underserved

TABLE 4 | Description of study participants.

	Control group	Experimental group
n	25	26
Number of females	23 (92%)	23 (88%)
Race		
African American	0 (0%)	1 (4%)
Asian	0 (0%)	1 (4%)
Biracial	1 (4%)	1 (4%)
White	24 (96%)	22 (85%)
Did not disclose	0 (0%)	1 (4%)
Ethnicity		
Of Latino, Hispanic, or Spanish origin	3 (12%)	3 (11%)
Not of Latino, Hispanic, or Spanish origin	22 (88%)	22 (85%)
Did not disclose	0	1 (4%)
Work/volunteer experience		
For-profit veterinary clinic	25 (100%)	26 (100%)
Not-for profit veterinary clinic	11 (44%)	4 (15%)
Municipal animal shelter	13 (52%)	13 (50%)
Veterinary clinic that provided free or reduced cost care	17 (68%)	14 (54%)
Coursework		
Course on animal shelters	2 (8%)	1 (4%)
Course on human-focused social services	3 (12%)	3 (12%)
Participated in a shelter medicine club	12 (48%)	9 (35%)

populations. There was no effect of condition on how participants rated their knowledge ($\beta = 0.58$, SE $= 4.19$, $p = 0.89$), and the interaction between condition and test was not significant ($\beta = -2.76$, SE $= 6.01$, $p = 0.65$). Participants did indicate their knowledge increased from pretest to post-test, however ($\beta = 24.54$, SE $= 6.10$, $p < 0.001$).

Ability to Detect Examples of Implicit Bias

Participants in the control condition answered 10.7 (SD = 1.46) of the 12 implicit bias questions correctly during the pretest and 10.6 (SD = 1.66) during the post-test. Those in the experimental condition answered 9.7 (SD = 1.78) correctly in the pretest and 11.6 (SD = 0.99) during the post-test. When a regression was performed using a Gaussian distribution, the residuals were not normally distributed; thus, a binomial logistic regression was performed using the median number correct on the implicit bias assessment as the median cut point. The main effects of study condition and test were not significant (condition: $\beta = -0.70$, SE $= 0.69$, $p = 0.31$; test: $\beta = 0.37$, SE $= 0.62$, $p = 0.55$), but the interaction between condition and test was significant ($\beta = 2.30$, SE $= 1.00$, $p = 0.02$). Individuals in the experimental condition showed an improvement on the implicit bias assessment from pretest to post-test whereas individuals in the control condition did not.

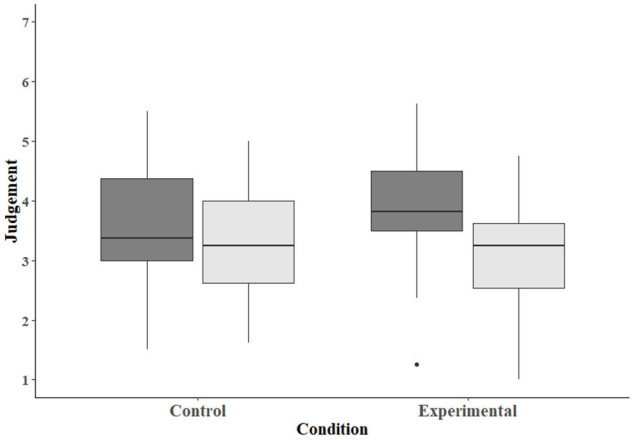

FIGURE 1 | Box plot depicting the scores assessing tendencies of participants in the control and experimental conditions to judge clients. Dark-gray bars represent scores on the pretest, and light-gray bars scores on the post-test.

Judgment of Clients

Participants responded to questions regarding their judgments about clients' behaviors and whether their behaviors should impact their ability to adopt pets in the future. Those in the control condition scored 3.60 (SD = 1.09) on the pretest and 3.28 (SD = 0.97) on the post-test (**Figure 1**). Those in the experimental condition scored 3.89 (SD = 1.01) on the pretest and 3.02 (SD = 0.95) on the post-test. There was no main effect of condition ($\beta = 0.30$, SE $= 0.27$, $p = 0.27$), but the main effect of test was significant ($\beta = -0.33$, SE $= 0.13$, $p = 0.01$). The interaction between condition and test also was significant ($\beta = -0.53$, SE $= 0.19$, $p = 0.006$). That is, the decrease in judgment scores was greater from pretest to post-test for those in the experimental condition than for those in the control condition.

Regard for Not-for-Profit Veterinary Clinics

Regarding participants' opinions about not-for-profit veterinary clinics, the average participant scores for those in the control condition was 4.92 (SD = 1.35) on the pretest and 5.38 (SD = 1.37) on the post-test (**Figure 2**). For those in the experimental condition, the average score was 4.40 (SD = 1.06) on the pretest and 5.29 (SD = 0.86) on the post-test. The main effect of condition was not significant ($\beta = -0.50$, SE $= 0.32$, $p = 0.12$), but the main effect of test was ($\beta = 0.45$, SE $= 0.20$, $p = 0.03$). The interaction between condition and test was not significant ($\beta = 0.42$, SE $= 0.28$, $p = 0.13$), meaning that regard for not-for-profit veterinary clinics increased significantly from pretest to post-test, regardless of study condition.

Importance of Social Work Partners

Participants in both conditions, irrespective of whether they were taking the pretest or post-test, indicated they highly valued collaborations between the veterinary community and human social services agencies. Out of a maximum score of 7, with 7 representing the highest possible regard for partnerships between veterinarians and social services agencies, the average scores for

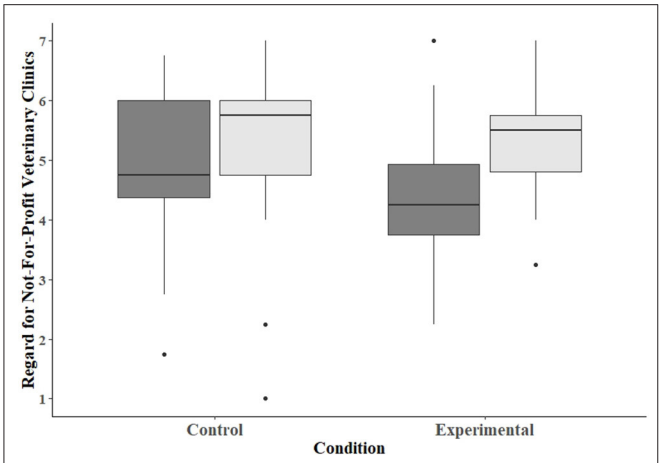

FIGURE 2 | Box plot depicting the scores assessing participants' regard for not-for-profit veterinary clinics. Dark-gray bars represent scores on the pretest, and light-gray bars scores on the post-test.

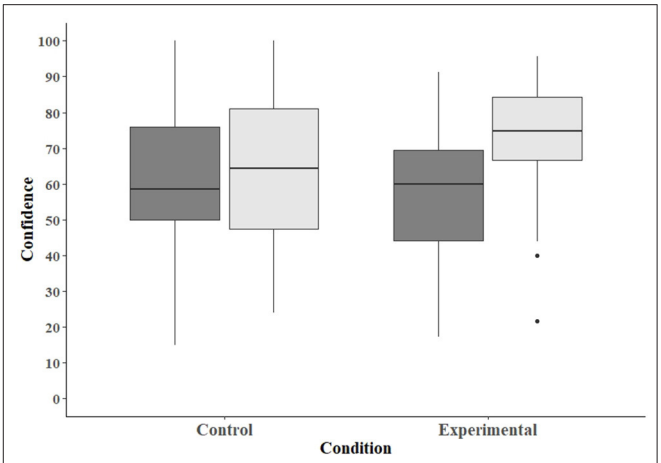

FIGURE 3 | Box plot depicting the scores assessing participants' confidence in their ability to offer incremental care. Dark-gray bars represent scores on the pretest, and light-gray bars scores on the post-test.

participants in the control condition were 6.09 (SD = 1.28) on the pretest and 6.39 (SD = 0.74) on the post-test. The average scores for participants in the experimental condition were 6.43 (SD = 0.71) on the pretest and 6.49 (SD = 0.69) on the post-test. When a regression was performed using a Gaussian distribution, the residuals were not normally distributed; thus, a binomial logistic regression was performed using the median score on the importance of social work partners measure as the median cut point. Neither the main effects of condition nor test were significant (condition: $\beta = 0.80$, SE = 0.91, $p = 0.38$; test: $\beta = 0.43$, SE = 0.75, $p = 0.57$). Furthermore, the interaction between condition and test was not significant ($\beta = -0.43$, SE = 1.04, $p = 0.68$). That is, neither test, condition, nor the interaction between test and condition were associated with beliefs about the importance of social work partners.

Belief That Pets Affect Owner Health

Participants rated their agreement with statements suggesting that pets positively impact owner health, stress, and physical activity levels, with a score of 7 indicating strong agreement with these statements. Those in the control condition had a mean of 6.83 (SD = 0.29) on the pretest and 6.80 (SD = 0.29) on the post-test. Those in the experimental condition had a mean of 6.64 (SD = 0.47) on the pretest and 6.73 (SD = 0.39) on the post-test. When a regression was performed using a Gaussian distribution, the residuals were not normally distributed, and so a binomial logistic regression was performed using the median score for the belief that pets positively impact health measure as the median cut point. Neither the main effects nor the interaction term were significant (condition: $\beta = -1.02$, SE = 0.78, $p = 0.19$; test: $\beta = -0.46$, SE = 0.68, $p = 0.50$; condition × test interaction: $\beta = 1.08$, SE = 0.96, $p = 0.26$). That is, neither test, condition, nor the interaction between test and condition were associated with beliefs about how pets impact owner health.

Expectation That Veterinarians Provide Affordable Treatment Options

Participants rated their level of agreement with statements regarding veterinarians' responsibility to provide affordable treatment options, with 1 indicating they strongly disagreed with the statements and 7 indicating they strongly agreed. Participants in the control condition had an average score of 5.87 (SD = 0.85) on the pretest and 6.13 (SD = 0.66) on the post-test. Those in the experimental condition had an average score of 5.69 (SD = 0.74) on the pretest and 6.10 (SD = 0.77) on the post-test. The main effect of condition was not significant ($\beta = -0.18$, SE = 0.21, $p = 0.39$), but the main effect of test was ($\beta = 0.26$, SE = 0.12, $p = 0.03$). The interaction between condition and test was not significant ($\beta = 0.12$, SE = 0.17, $p = 0.47$). Thus, participants showed increases in their expectations that veterinarians provide affordable treatment options from pretest to post-test, regardless of study condition.

Confidence in Ability to Offer Incremental Care

Participants could rate their confidence in their ability to provide incremental care on a scale of 0 to 100. The average confidence scores for participants in the control condition were 60.3 (SD = 19.5) on the pretest and 64.2 (SD = 20.9) on the post-test (**Figure 3**). For individuals in the experimental condition, the average pretest score was 56.2 (SD = 18.4), and the average post-test score was 71.7 (SD = 17.8). The main effects of condition and test were not significant (condition: $\beta = -4.23$, SE = 5.23, $p = 0.42$; test: $\beta = 3.87$, SE = 3.02, $p = 0.20$); however, the interaction between condition and test was significant ($\beta = 11.60$, SE = 4.26, $p = 0.006$). That is, there was a greater increase in confidence scores from pretest to post-test for those in the experimental condition than for those in the control condition.

Likelihood of Working or Volunteering in Veterinary Desert

Participants were asked to indicate the likelihood they would work or volunteer as a veterinarian in a veterinary desert under a variety of circumstances. Participants were more likely to indicate they would volunteer in a veterinary desert after completing the shelter medicine rotation ($\beta = 1.33$, SE $= 0.61$, $p = 0.03$). There was no effect of experimental condition on the likelihood of volunteering in a veterinary desert ($\beta = 0.27$, SE $= 0.58$, $p = 0.65$), and the interaction between condition and test was not significant ($\beta = -1.33$, SE $= 0.83$, $p = 0.11$). There was no effect of condition or test on the likelihood of working in a for-profit veterinary clinic in a veterinary desert (condition: $\beta = -0.22$, SE $= 2.06$, $p = 0.92$; test: $\beta = 0.78$, SE $= 1.29$, $p = 0.55$), and the interaction between condition and test was not significant ($\beta = -2.31$, SE $= 2.36$, $p = 0.33$). Additionally, there was no effect of condition or test on likelihood of working in a not-for-profit veterinary clinic in a veterinary desert (condition: $\beta = -0.08$, SE $= 0.75$, $p = 0.91$; test: $\beta = 0.87$, SE $= 0.69$, $p = 0.21$), and the interaction between condition and test was not significant ($\beta = -1.59$, SE $= 1.01$, $p = 0.12$). Similarly, the main effects of condition and test and the interaction between condition and test failed to reach significance in relation to likelihood of working in a municipal shelter located in a veterinary desert after graduation (condition: $\beta = -1.10$, SE $= 0.87$, $p = 0.21$; test: $\beta = 0.47$, SE $= 0.70$, $p = 0.50$; interaction: $\beta = -1.32$, SE $= 1.08$, $p = 0.22$).

Participants' impressions of the likelihood that they would be working at a not-for-profit veterinary clinic during the first five years post-graduation were not affected by condition ($\beta = -1.08$, SE $= 1.03$, $p = 0.29$), and the interaction between interaction and test was not significant ($\beta = -0.57$, SE $= 1.10$, $p = 0.60$). The effect of test, however, approached significance ($\beta = 1.44$, SE $= 0.83$, $p = 0.08$). That is, there was a non-significant trend for participants to be more likely to indicate they would work at a not-for-profit veterinary clinic when they took the post-test compared to when they took the pretest, regardless of study condition.

Responses to Open-Ended Questions

Student responses on the pretest and post-test questions 1 and 2 regarding knowledge on the topic of access to veterinary care indicated that students in both shelter medicine rotations varied widely in terms of their initial familiarity with access to veterinary care issues, and many demonstrated more familiarity after completing the rotation. Both the control and experimental groups' answers were more detailed in 50% of the post-rotation responses to the questions. The following examples are reflective of statements representing differences in students' pre- and post-rotation knowledge:

- **Participant R_6JMJEXumLEL8s2l (Pretest):** *"I do not know much about this at all."* (rated as minimal familiarity)
- **Participant R_6JMJEXumLEL8s2l (Post-test):** *"During this rotation I have learned more resources for clients who may not have the funds to pay for their pets' medical expenses such as, Scratch Pay, Vet Billing,* & *Vitus Vet Vitus Pay."* (rated as moderate familiarity)
- **Participant R_1LYfiGtzSybSP7q (Pretest):** *"I know there are some clinics that offer lower cost vet care."* (rated as minimal familiarity)
- **Participant R_1LYfiGtzSybSP7q (Post-test):** *"There are things like Scratchpay, VetBilling, Vitus VetVitusPay, CareCredit, GoFundMe, fundraisers, and many other options out there to look into for low-income populations. This will allow the pet to get the care they need, give your client more time to pay back the expenses, and your business gets paid and does not risk the client not paying the clinic back. But the limitation is, the client has to have good enough credit to be approved. The second option is that your hospital could partner with the AVMF's veterinary care charitable fund or other charitable foundations. These foundations provide funds to their partnering veterinary clinics so they can offer free or discounted care. This would help the clients that could not afford the care and they were not approved for the credit line. You could partner with a local veterinary school and offer your clinic up for their rotational year. This is a great option because you bring in students who have a good foundation of knowledge but there is no monetary cost to the clinic. This does put a lot of extra stress on the veterinarians and the staff because you are now responsible to help teach and mentor these students while making sure all the work gets done but, it does offer a low cost more hands-on deck option! The last option and the one I would only mention to my most loyal and trusted clients are personalized payment plans with the clinic. However, this is risky and the clinic has to be able to afford it.*" (rated as familiar)

A key word search of the topics or concepts that students mentioned in their responses to the open-ended questions revealed students in the two groups focused on different types of information on the post-test. The control group of students more commonly mentioned economic issues. For instance, 60% mentioned payment plans in the control group vs. 40% in the experimental group, and 100% mentioned pro-bono care in the control group vs. 0% in the experimental group. The experimental group, by contrast, tended to mention more social concepts related to access to veterinary care. For example, they commonly mentioned the existence of veterinary deserts (80% in the experimental group vs. 20% in the control group), implicit bias toward low-income clients (100% in the experimental group vs. 0% in the control group), and incremental treatment plans (75% in the experimental group vs. 35% in the control group). No difference was observed between groups in terms of the prevalence of mentioning the human-animal bond or using grants and subsidies to pay for veterinary care. The examples that follow are reflective of statements representing differences in focus between the two groups of students post-rotation.

- **Participant R_3ssH1WzNZ4Hh6hl (Control Group):** *"More areas than you think are encompassed in low-income care. Overall, they try to do things as low cost as possible. Financial issues are major reasons that animals end up at shelters."* (coded as cost-of-care)

- **Participant R_ug2aJ1qR0mUQlep (Experimental Group):** *"Just because someone is unable to afford veterinary care currently, doesn't mean that they have been unable to afford it in the past or future. We as practitioners need to learn to recognize implicit bias when it occurs and modify our thinking/actions away from it. Our interaction with our client is a snapshot of that client's life and we have no right to judge what they can/cannot afford or how much they love their animal based on the little information we are provided. Furthermore, a lot of animal surrenders, euthanasia, and untreated animal cases are related to a lack of owner information regarding other options such as pet insurance, outside payment plans, fostering, cheaper procedures at shelters, etc. It is imperative that we as veterinarians open up a dialogue with our clients so that we can provide them with this information which in turn will help our patients."* (coded as cost-of-care, implicit bias, pet insurance, payment plans, communication skills, incremental care)

Finally, coding of questions 3 and 4, which were asked only to students in the experimental condition, revealed that 32% ($n = 8$) of the respondents desired additional training and resources to use for communicating effectively with clients about access to veterinary care issues. These are some examples of their responses:

- **Participant R_86VVe1bA1LzuHSh:** *"I would have liked to learn how to approach financial conversations with clients. I know this is a skill we will learn in practice but having an example of a difficult conversation would have been helpful for me."* (coded as communication skills)
- **Participant R_5C2Nzj6n2KzIMHT:** *"I would like to learn more about how to give clients information about alternative payments, euthanasia options, etc. without making them feel like I am judging them or am giving them charity. I personally would also like to learn more about how to start and keep a relationship with the surrounding clinics and shelters."* (coded as communication skills)
- **Participant R_2ZJ2eJyGnn1bytG:** *"I would like to learn more about what is available in my area. A google search brings up some options but it would be nice if there was a general website that lists known organizations by region."* (coded as need for additional resources)
- **Participant R_0B96Tyn6pznp7QR):** *"I wish there was a database that is updated with programs in each area of the country. This would make access to them easier for vets who have clients who cannot afford care for their pets."* (coded as need for additional resources)

DISCUSSION

Findings from this study demonstrate that veterinary students' knowledge, skills, and attitudes regarding access to veterinary care issues evolved following exposure to content about this topic during a virtual shelter medicine rotation. Some of these changes were observed regardless of whether participants were in the control condition or in the experimental condition that included a specialized, interactive, online learning module that provided in-depth instruction on issues associated with access to veterinary care. At the end of the rotation, participants in both conditions indicated they felt more knowledgeable about the topic of access to veterinary care for low-income and underserved populations. Their opinions about not-for-profit veterinary clinics grew more favorable, and their expectations that veterinarians provide affordable treatment options increased from pretest to post-test. While participants' thoughts regarding whether they would work in a veterinary desert after graduation did not change across the study for either group, participants in both groups were more likely to indicate after the rotation that they would volunteer their professional services in a veterinary desert. Furthermore, there was a non-significant trend suggesting that participants were more likely at the end of the rotation to consider working at a not-for-profit veterinary clinic.

Inclusion of the online learning module for the experimental group did lead to some differences in what students learned about access to veterinary care issues. Students in the experimental group were more likely to describe concepts other than financial factors by the conclusion of the rotation, and they recognized a need for more training on communication skills and for additional easy-to-access web resources. These students were more cognizant of the existence of veterinary deserts, implicit bias, and incremental treatment plans. Furthermore, they showed a reduction in their tendency to be judgmental of veterinary clients from pretest to post-test, and by the end of the study, they expressed greater confidence in their ability to offer incremental care options to veterinary clients. These findings suggest that the online module increased students' understanding of access to veterinary care issues and broadened their mindset beyond traditional "gold standard" of care options. These differences observed between the experimental and control group results might be due to variation between the student learning objectives taught to the two groups, as well as to additional time spent on learning tasks by the students who completed the online module in the experimental condition.

These findings suggest that exposure to the module's content in this virtual shelter medicine rotation may have enhanced students' awareness of how a variety of socio-demographic factors affect the ability of pet owners to access veterinary care. Furthermore, the online module appears to have increased students' confidence in their ability to help pets even when financial resources are constrained. Such knowledge, skills, and attitudes are likely to have favorable impacts on the well-being of pets, their owners, and veterinary staff. That is, putting an access to care perspective into practice may protect companion animals from unnecessary suffering or premature death and enhance the human-animal bond. Additionally, it may buffer veterinarians from stressors associated with discussing the cost of care with clients and performing economic euthanasia. Given the prevalence of burnout, compassion fatigue, and suicide among veterinary professionals (14, 24), any training that leads to a reduction in workplace stressors for those in the veterinary community has the potential to save careers and lives.

Participants' beliefs that pet ownership positively affects health and that partnerships between those in veterinary and

social work fields are important did not change from pretest to post-test, regardless of whether participants were in the control or experimental condition. Mean scores on these measures indicate that from the outset of the study, participants held strong, positive beliefs about the relationship between pets and human health and the importance of collaboration between members of veterinary and social work fields. Based on these findings, it seems that veterinary students require little convincing about the importance of these topics, at least at a basic level. Thus, when addressing the human-animal bond and access to veterinary care for poor and underserved individuals, educational modules might focus on concrete ways that veterinarians can support human-animal relationships. For example, they can develop collaborations with social workers and create incremental care plans for clients with limited financial resources.

Limitations and Future Directions

We found that exposure to content on access to veterinary care clearly resulted in some changes in veterinary students' knowledge and attitudes regarding this topic. While findings from this study are based on self-reported information, which could have introduced social desirability biases, differences observed between the control and experimental groups suggest this bias did not confound study findings. Furthermore, our findings echo those reported by Gongora et al. from their study of cultural competency training opportunities for Australian veterinary students (18). Importantly, participants in our study's control condition did receive some content about access to care and cultural competency as part of the standard shelter medicine rotation offered by Lincoln Memorial University. Removing this standard content from the control condition would have diminished the study's ecological validity. Nevertheless, we still observed that the addition of purposefully curated information about these topics in the experimental condition enhanced student learning in these domains. The differences that were observed between groups may have been due to variation between the study conditions in terms of time spent on learning tasks. Furthermore, it may have been due to the cognitive level at which the learning objectives associated with the access to veterinary care content were presented in the experimental condition as compared to the control condition.

Important questions on this topic remain to be answered. For instance, how long do veterinary students retain the information learned from the online module? Do students' attitudes regarding work with poor and underserved clients persist as they move into their professional careers? Will they have the decision-making ability in their practices to implement strategies that increase access to veterinary care in their communities? Furthermore, as the sample size was relatively small and all students were enrolled at a single institution, the extent to which these findings generalize to other groups of veterinary students is unknown. Further research is needed to determine how long the effects of this training persist and whether these findings are consistent across cohorts of students from a variety of colleges of veterinary medicine. Studies of how this type of training impacts the physical health of companion animals and the mental health of their owners and veterinary staff also are needed.

Additionally, it will be important to evaluate the costs and benefits associated with providing students with an online learning module vs. hands-on opportunities that bring veterinary students face-to-face with the challenges pet owners from underserved communities experience. Indeed, one of the original aims of this study was to make this comparison; however, COVID-19 stymied efforts to provide students with opportunities to participate in wellness clinics in underserved communities. Findings from a qualitative assessment of veterinary students' experiences volunteering at a community veterinary outreach clinic indicate the activity provided opportunities for students to gain more knowledge and acceptance of underserved human populations (25). Likewise, participating in subsidized clinics helps students develop their communication and physical examination skills and feel more comfortable working with clients from underserved communities (26, 27). Comparing the outcomes and efficiencies of classroom-based or online learning modules with those that result from experiential learning opportunities will be necessary to determine what practices are both feasible and effective within contemporary veterinary medical education.

CONCLUSIONS

Access to veterinary care has implications for both companion animal and human health and well-being. The American Medical Association (AMA) includes health equity and access to health care as competencies for medical education and professional ethics (28); however, while strategies and resources exist to improve access to veterinary care in underserved communities, this information typically is not covered in veterinary school curricula in the United States. We found that providing fourth year veterinary students completing a four-week, virtual shelter medicine rotation with an interactive online module, which focused on issues surrounding access to veterinary care, cultural competency, incremental care strategies, and options for payment of veterinary services, increased their awareness of the need to offer a variety of treatment and payment options to veterinary clients. Results from our study can inform curriculum design in veterinary schools and continuing education programs for veterinary professionals.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

This study received Institutional Review Board approval from Lincoln Memorial University (IRB #919) and the University of

Florida (UF IRB #202001847). Participants provided informed consent electronically.

AUTHOR CONTRIBUTIONS

CLH conducted the quantitative analyses and wrote the original draft of the manuscript. TGS conducted qualitative analyses and reviewed and edited the manuscript. KVM secured funding for the study, supervised all aspects of the study, collected the data, and reviewed and edited the manuscript. All authors contributed equally to the conceptualization of the study and subsequent study design.

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A Measurement Equivalence Study of the Family Bondedness Scale: Measurement Equivalence Between Cat and Dog Owners

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About 38.4% of U.S. households include a dog, and 25.4% a cat, as pets, and a recent poll suggested over 90% of pet owners feel their companion animal is a family member. Numerous studies have suggested pet ownership has physical, mental, and social health benefits, though much of this research has yielded mixed results. Results of a recent review suggested significant measurement problems in human-animal interaction (HAI) and human-animal bond (HAB) research, including the absence of validity evidence, overly long measures, lack of evidence for measurement equivalence across species of pets, and measures lacking a basis in important psychological, family, and attachment theories. This article describes the development and results of a measurement equivalence study of a new measure of the HAB called the family bondedness scale (FBS). This scale, and the research results, address multiple gaps in HAB measurement. Results of multi-group confirmatory factor analyses with multiple covariates indicated the scores on the FBS showed equivalence between cat and dog owners. The use of the FBS in both veterinary research and practice, as well as in research and practice in other disciplines, such as social work and psychology, are considered.

Keywords: human-animal bond, measurement of HAB, comparing attachment to cats and dogs, measurement equivalence of HAB measures, family bondedness scale

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INTRODUCTION

According to (1) American Veterinary Medical Association statistics (https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics), about 38.4% of U.S. households include a dog, and 25.4% a cat, as companion animals. About 2.8% include birds, and fewer include such exotic companion animals as fish, snakes, rabbits, and other animals. The 2017-2018 American Pet Products Association (APPA) survey (https://www.mceldrewyoung.com/wp-content/uploads/2018/08/2017-2018-Pet-Survey.pdf) found 68% of U.S. households included a pet: 48% one or more dogs, 38% a cat, 10% fresh water fish, 6% a bird, 4% reptiles, 2% small animals, and 2% a horse. A recent Harris poll found 95% of U.S. respondents felt their pets to be members of their family (2), for example, dogs are often referred to as "fur babies" by owners who see themselves as their dog's "parents" (3). These numbers hint at the importance of human-animal interaction (HAI) and the human-animal bond (HAB) for persons and families in the U.S.

There is evidence of potential benefits of animals, the so-called "pet effect," for physical, mental, and social health. Talking to and/or petting a companion animal has been found to lower blood pressure (4), even when the companion animal is a snake (5). Research has found children exposed to pets early in life tend to have lower levels of asthma and allergic rhinitis (6, 7), increased abundance of bacteria negatively associated with childhood atopy and obesity (8), and Kates et al. (9) found pets may influence gut microbiota so as to reduce atopic diseases. Pet ownership may be associated with reduced loneliness, anxiety, depression, and increased exercise (10), associated with such health benefits as lower blood pressure (11–13), and may be associated with longer survival after discharge from a coronary care unit and decreased heart attack mortality (14, 15). A recent critical literature review and meta-analysis of 10 studies between 1950 and 2019, involving 3,837,005 persons, found dog ownership associated with a 24% risk reduction for all-cause mortality as compared with non-ownership (13). A second recent meta-analysis (16) of 12 studies, involving 488,988 persons, found in subgroup analyses pet ownership was associated with lower cardiovascular disease mortality in the general population, and found pet ownership associated with lower adjusted cardiovascular disease risk in patients with established cardiovascular disease. There may be other benefits associated with pet ownership and the human-animal bond (17, 18).

The research in many of these areas of health and mental health has, however, been mixed and inconsistent and further research is needed to resolve the varied results (19–21). For example, a study of 425 heart-attack victims found pet owners were more likely than non–pet owners to die or suffer remissions within a year of a heart attack [22 vs. 14%; (22)]. Other research found that doing a stressful task in the presence of a dog had no short-term effect on blood pressure (23). The problems of inconsistent results led Herzog (19) to argue that (p. 236), "… the existence of a generalized "pet effect" on human mental and physical health is at present not a fact but an unsubstantiated hypothesis." Herzog (19) urged further research on the effects of companion animals with greater methodological rigor.

As the definition of family has evolved in the United States, some pet owners now consider themselves as "pet parents" (24–26). There has been recent interest in pet parenting and the effects of different parenting styles on the relationships and bonds pet owners have with their pets, as well as on pet behavior and health. There has been speculation that the ways in which pet owners interact with their pets can influence the bond they have with their companion animals (27, 28), though few studies have investigated this hypothesis. The relationship between parenting and human-dog interaction styles and canine obesity has been studied, and the relationship between parenting styles and the way dogs respond to the threatening approach of a stranger has been investigated (29, 30). It has also been inferred that owner-dog interaction and human caregiving styles may have implications for avoiding undesired dog behaviors associated with relinquishing a canine pet (31). Thus, pet parenting and interaction styles may influence the bond owners have with their pet, and vice versa, the bond may influence owner behavior toward their companion animal. This is another area of needed research.

Rodriguez et al. (32) reviewed measures used in HAI and HAB research. They argued measurement problems have significantly hindered HAI and HAB research, a view echoed by Dwyer et al. (33). Rodriguez et al. (32) identified the scarcity of measures with strong evidence of validity for measuring important constructs in HAI and HAB research; the lack of evidence for reliability; the lack of brief measures; and the lack of measures with grounding in attachment, family, and psychological theories as problems. They noted a recent study (34) identified numerous measures for use in HAI research, including measures of attitudes toward animals, attachment to animals, and bonding measures. However, they concluded there was a critical scarcity of validity research on the scores from these measures. Many of these measures are long and the need for short, rapid assessment measures of the HAB has been underscored (35). Dwyer et al. (33) recommended psychometric research was needed on measures of the HAB that included reliability estimates, validity studies, studies demonstrating adequate factor loadings on the latent construct represented by scores on the measure, and measurement equivalence studies focusing on among other forms of equivalence, equivalence across different species.

As Wilson and Netting (34) found, numerous measures of the HAB exist, and Anderson (36) gathered a number of these measures into a book. Several have been developed for use with children, such as the CENSHARE Pet Attachment Scale (37), the Companion Animal Bonding Scale [CABS; (38)], and the Pet Attachment Scale [PAS; (39)]. The Pet Bonding Scale [PBS; (40)] was developed for use with pre-adolescents. The Lexington Attachment to Pets Scale (LAPS) was developed using items from pet attitude scales and from the CABS and was intended for use with both owners of dogs and owners of cats (41). More recently the Monash Dog Owner Relationship Scale (MDORS) was developed for use in measuring facets of owner's relationships with their dogs (33). Howell et al. (42) used the MDORS as a base for development of the Cat-Owner Relationship Scale (CORS).

Perhaps the most commonly used measure of the human-animal bond in research has been the Lexington Attachment to Pets Scale [LAPS; (41, 43)]. This scale has been used in a number studies on the HAB [see (36), for a partial listing]. Zaparanick (43) conducted a psychometric study of the LAPS, with findings that challenged the validity of scores from this scale. While most items appeared to represent some aspect of an emotional bond, content validity challenges were raised about some items. For example, content validity issues can be raised about items c, "I believe that pets should have the same rights and privileges as family members," and item n, "Pets deserve as much respect as humans do," both of which appear to measure beliefs about animal welfare or animal rights as opposed to the HAB. The LAPS also includes reverse-scored items, a structural aspect shown to introduce scoring factors and adversely affect validity (44). Zaparanick's (43) results also raised questions about the factor structure of the LAPS. She argued that scores on the LAPS were not equivalent in the sense needed for valid comparisons of bondedness to animals of different species.

Among other recommendations, she suggested placing the name of a pet/companion animal in items might help increase validity.

The MDORS is a multidimensional scale, based on social exchange theory, with three sections, or subscales: a factual section (example item: How often do you groom your dog?), a second component that the authors view as reflecting "perceived emotional closeness" (example item: How traumatic do you think it will be when your dog dies?), and a third section "perceived costs" (example item: My dog makes too much mess). The second of these sections contains items that on the face of it represent the degree to which a respondent feels an emotional bond with their dog, and the reliability estimate for scores on this section of the MDORS was 0.84 in Dwyer et al. (33) study. One limitation in this subscale is that it contains multiple Likert type scoring rubrics. One scoring metric is a 5-point agree/disagree scaling for items such as, "My dog helps me get through the tough times." A second is a 5-point frequency of occurrence scaling for items such as, "How often do you tell your dog things you don't tell anyone else?" The third is a 5-point degree of trauma scaling for items such as, "How traumatic do you think it will be for you when your dog dies?" Here is how this is a problem. Imagine the response to an item on the agree/disagree scaling is four, and a response to an item on the frequency of occurrence scaling is four, and the response to an item on the degree of trauma scaling is four, giving a sum over these items of 12. Interpreting this overall score as representing the level of magnitude of a single latent construct is logically problematic. The three different scaling metrics do not appear to be conceptually equivalent. The assumption that a score of four means the same thing in terms of agreement, frequency of occurrence, and degree of trauma makes no conceptual sense. There could therefore be construct irrelevant variance introduced into the total scale scores over the items, a threat to construct validity (45). The MDORS was created for use with dog owners.

The CORS was developed for use with cats (42). If the MDORS and CORS were to be used in an effort to compare the HAB between dog and cat owners, an equating study would need to be done in order to enable direct comparison of scores (46). This limits the use of these scales in studies comparing the HAB between cat and dog owners.

Branson et al. (47) noted the LAPS and other measures of the HAB do not producing scores valid for specifically comparing bonded levels between dog and cat owners. Zasloff (48) made this same argument but in general for comparing HAB levels across different animal species. Zasloff pointed out that wording matters in these measures, as the inclusion of the species of the pet (cat or dog) in items influenced the scores from the measures. This issue is a lack of measurement equivalence between responses from dog and cat owners specifically, and between owners of different species of pets in general. Measurement equivalence concerns the extent to which a scale or measure works the same for different groups (49). Pendergrast et al. (50) emphasized the critical role of measurement equivalence studies as part of instrument development and the essential role of measurement equivalence as a form of validity evidence. As far as the authors of the current study have been able to determine, no studies have investigated the measurement equivalence of scores from measures of the HAB for scores from dog and cat owners or for comparing scores from owners of any different species. This deficiency makes it more difficult to do research in which the HAB is compared between dog and cat owners, or between owners of pets of any different species (49, 50).

These limitations of extant measures of the HAB, along with the growing evidence pet owners feel their companion animal is a family member, stimulated the development of a new scale to measure the HAB. The current study focused on (1) the creation of a scale, the Family Bondedness Scale, measuring the degree to which a person feels emotionally bonded to a companion animal as an integral part of their family, a concept referred to as "family bondedness," defined below, and (2) investigation of the measurement equivalence of the scores from the scale for responses from persons concerning their family bondedness to cats and dogs.

SCALE CREATION

Family bondedness is defined as the condition in which a person feels a positive valence emotional bond to a pet in a manner approaching, if not equivalent to, their positive valence emotional bond to a human family member. This positive emotional bond is characterized by love and affection and an emotional sense the pet is a member of their immediate family. The Family Bondedness Scale (FBS) was designed to be used with adults 18-years-old and older. It was designed to be a unidimensional scale the scores from which represent the degree to which a person is emotionally and affectionately bonded to a pet as a member of their family. It was designed to be a rapid assessment scale (51) suitable for use in HAI and HAB research by veterinarians, psychologists, social workers, and others, and simultaneously convenient for use by professionals in a wide range of fields for assessing the degree to which persons feel emotionally bonded to a companion animal in a manner equivalent with their emotional bond to human family members. It was also intended to be applicable in studies comparing the family bondedness of pet owners who own pets of different animal species.

Content validity was emphasized from the beginning of development of the FBS. Existing scales for measuring the human-animal bond were reviewed for examples of item content, in particular the LAPS, CABS, and PBS scales. These reviews were used to generate potential item content. While no items reviewed were used verbatim on the FBS, some FBS items had wording similar to that on other scales. For example, item two on the FBS reads, "I feel [pet's name] is a member of my family," while item t on the LAPS reads, "I feel that my pet is a part of my family." A focus group was conducted in which experienced veterinarians, veterinary technicians, and other employees of veterinary clinics were asked what kinds of indicators they observed that, in their experience, suggested persons were emotionally bonded with their pets in a manner commensurate with the pets being family members. The results of this focus group also led to the generation of possible item content.

Following recommendations by Zaparanick (43), the scale was designed so that the names of pets were included in each scale item. Use of the pet's name in items theoretically would

TABLE 1 | Bonded family scale items.

I love [pet's name].
I feel [pet's name] is a member of my family.
I feel [pet's name] is like a child of mine.
I sometimes hesitate to move when sitting by [pet's name] because I do not want to disturb her/him.
I would feel lost without [pet's name].
[Pet's name] brings happiness to my life.
I dread [pet's name] dying.
I talk to [pet's name] as if she/he is a person.
I think [pet's name] knows what I am feeling.
[Pet's name] being in my family makes me happier.
[Pet's name] makes my family feel more complete.
Having [pet's name] in my life makes me feel less lonely.
I call [pet's name] by affectionate nicknames.
I love to pet [pet's name].
When I am away from home I worry about [pet's name].
[Pet's name] comforts me when I have bad feelings.
I tell others that [pet's name] is a member of my family.
Being with [pet's name] makes me happier.
[Pet's name] means as much to me as others in my family.
I feel emotionally close to [pet's name].
I feel [pet's name] loves me.
I am more likely to get needed medication for [pet's name] than for myself.
I feel having [pet's name] around makes me healthier.

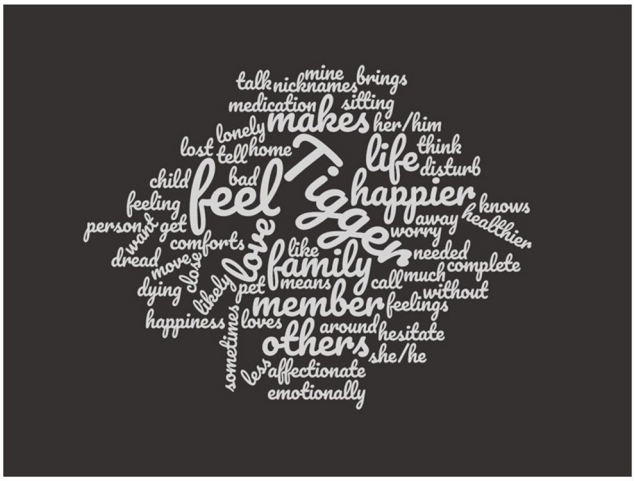

FIGURE 1 | Word cloud of words in items on the Family Bondedness Scale. Larger font words are those appearing more frequently in Family Bondedness Scale items, and vice versa. It was assumed in the creation of this cloud that the name of the pet was "Tigger," so this word is largest in the word cloud.

evoke the emotional bond persons have with the pet (52). Following Zasloff (48), all items were species non-specific, that is, there no words such as "dog" or "cat" in the items. These two characteristics of items were believed to help insure the construct measured by the items was the degree of emotional bonding in a manner commensurate with their emotional bondedness to human family members. No reverse scored items were created in order to avoid construct irrelevant factors (44). These items were reviewed for good item quality by a Ph.D.-level psychometrician. Based on their recommendations, the 42-items were revised to meet criteria for psychometrically sound items.

A total of 43 items were created, and then the 42 items were reduced in number to 23 by removing items that appeared to be duplicative in terms of specific content. The result was a Likert-type scale with 23 items, a number consistent with the numbers of items on rapid assessment instruments (51), scored on a 5-point agree/disagree category partition. The scaling was such that higher scores were indicative of higher family bondedness with a companion animal, and vice versa, with possible scores ranging from 23 to 115. This wide range of possible scores was designed to ensure the possibility of a wide range of scores in research. A wide range of scores would help increase the reliability of scores and reduce the possibility that restriction of range of scores would inhibit the ability to detect correlations between scores on the FBS scale and other variables of interest (53).

Table 1 shows the items on the FBS, while **Figure 1** shows a word cloud of the words in the items on the FBS assuming the pet's name is "Tigger." The larger words in the cloud are the most frequently occurring, and vice versa. This visualization is a form of evidence of content validity (54).

Readability

The readability of the final 23-item scale was assessed following methods used by Paasche et al. (55) in their assessment of readability of informed consent documents. Ten online readability calculators were used to assess the readability of the scale and its items. The Flesch-Kincaid grade level index was used as the readability index. The estimated mean Flesch-Kincaid grade level score was 3.4, $t_{(9)} = 6.8$, $p < 0.05$, 95% CI (2.3–4.6). These results were consistent with the easy readability of the scale and its items.

METHODOLOGY

Human Subjects

Researchers obtained IRB approval for the current study from the University of Tennessee IRB on April 20, 2020. The study number assigned was UTK IRB-20-05773-XM.

Sampling

The objective of the purposive sampling plan was to obtain a cross-sectional national sample. Quotas were established to ensure responses from a stratified sample based upon gender and age of the pet owner and by type of pet. Three age strata were created for male and female dog and cat owners. The sample goal was a minimum of 200 responses on the family bondedness scale from each of the following groups: female cat owners, male cat owners, female dog owners, and male dog owners. This would give an overall sample size of at least 800, enabling analyses testing measurement equivalence across these different groups with a minimum of 200 per group (56). The study was completed utilizing a web panel provided by the market firm Dynata.

TABLE 2 | Comparisons of sample and U.S. income distributions.

Income range	Sample percentages	U.S. percentages*
<$15,000	6.8	9**
$15,000–$29,999	10.2	12
$30,000–$44,999	11.1	12
$45,000–$59,999	10.6	11
$60,000–$74,999	10.8	9
$75,000–$99,999	16.1	12**
$100,000–$149,999	17.3	16**
$150,000 and greater	13.2	19**

*Percentages from https://dqydj.com/average-median-top-household-income-percentiles/. **Differences between column percentages statistically significant.*

TABLE 3 | Comparisons of sample and U.S. racial percentages.

Race	Sample percentages	U.S. percentages*
White	84.3**	76.3**
Black/African-American	8.5**	13.4**
Native American	1.8	1.3
Asian	5.3	5.9
Native Hawaiian	0.8**	0.2**
Mixed	0.6**	2.8**
Hispanic	12.8**	18.5**

*Percentages from https://www.census.gov/quickfacts/fact/table/US/PST045219. **Differences between column percentages statistically significant.*

Measurement

Respondents were asked to complete the family bondedness scale with respect to their bond to the pet they had owned the longest. The name of this pet/companion animal was inserted into each item on the FBS scale, for example, the first item on the scale would read, "I love "pet's name,"" or as an illustration, "I love Tigger." The logic for this methodology was that including a companion animal's name in the item stem would more strongly arouse the respondent's emotional bondedness to the animal than the more affectively neutral word "pet." Respondents were also asked to give demographic information on their gender identity, type of housing they lived in, type of setting in which they lived (rural, suburban, or urban), ethnicity (Hispanic or non-Hispanic), self-identified race, education level, and marital status. These variables were to be used as covariates in a latent variable regression that was a part of the Multiple-Group Confirmatory Factor Analysis/Multiple Indicators Multiple Causes (MGCFA-MIMIC) analysis, as described below. The survey was created using Qualtrics.

Research Design

The study employed a cross-sectional national web survey.

Data Analyses

Multi-Group Confirmatory Factor Analysis with Covariates, or MGCFA-MIMIC, analysis methods were used as described by Brown (56) using Mplus version 7. This involved fitting a multiple group Confirmatory Factor Analysis (CFA) model, with a regression of the family bondedness latent construct on the following independent variables: self-identified gender identity, region where respondents lived (rural, suburban, urban), self-identified race, marital status, education level, income, type of housing respondents lived in, and ethnicity (Hispanic, non-Hispanic). This analysis was done using weighted least squares mean-variance adjusted (WLSMV) estimation, which is appropriate for ordinally scored items such as on the FBS, and the Theta parameterization was employed (50). This method provided a test of measurement equivalence between FBS scores for family bondedness between cats and dogs controlling for the relationships between the independent variables and the latent construct (56). The suggestion of statistically significant paths from any of the independent variables to FBS items would indicate, in this analysis, the existence of lack of measurement equivalence for the item as a function of the independent variable, a condition referred to as differential item functioning, or DIF. The possibility of these paths would be indicated by statistically significant modification indices (56). The measurement hypothesis was the FBS is a unidimensional scale. Consistent with the multi-evidence approach to measurement equivalence recommended by Pendergast et al. (50), reliability estimation, using Chronbach's coefficient alpha, and corrected item-total correlations using SPSS version 27 that focused on measurement equivalence were also conducted.

RESULTS

Characteristics of Sample

There was a total of 836 responses to the survey that were obtained from persons in 49 states. In response to a query about respondent's gender identity, 51.3% identified themselves as female, 46.7% as male, 1.0% as non-binary, 0.5% as third gender, 0.2% preferred to not describe their gender identity, and 0.4% preferred to not respond to this question. Fifty-four-point-eight percent of respondents were married, 6.9% were living with a partner, 9.0% were divorced, 1.3% were separated, 2.5% were widowed, 25% were single, and 0.5% refused to answer the question about marital status. Thirty-two-point-eight percent had a bachelor's degree, 22.5% a graduate degree, 26.1% had 1–3 years of college, 15.7% had completed high school or had a GED, 2.3% had 11-years or less of education, and 0.7% refused to answer the query about education.

The mean number of dogs and cats owned by respondents was 2.03 (SD = 2.0), with a range from 1 to 31. A test of normality of this distribution showed it non-normal and highly right-skewed, with 94% owning four or less cats and dogs. A length of pet ownership item revealed 47.8% of respondents had owned a cat the longest, while 52.2% reported they had owned a dog the longest.

Tables 2, **3** show sample percentages of respondent's income brackets, and racial and ethnic breakdowns, respectively, as well as comparisons with U.S. population values. There were no missing data on income or race and ethnicity, though 0.8% responded they were not sure about income, and 3.0%

TABLE 4 | Educational attainment of study respondents as compared with 2020 U.S. Census values*.

Level of education attainment	U.S. according to 2020 Census data	Current study data
High school	45.4%	15.7%
Bachelor's degree	36.1%	32.8%
Graduate/Professional degree	18.4%	22.5%

**Census values from https://www.census.gov/data/tables/2020/demo/educational-attainment/cps-detailed-tables.html.*

refused to answer this question, and 1.3% were not sure about their Hispanic origin, and 1.1% refused to answer this ethnicity question. Statistical tests showed the sample of pet owners differed with respect to income and racial/ethnic make-up as compared with U.S. population figures as Indicated by the asterisks. Notably, the sample was comprised of a greater percentage of White respondents, a lower percentage of Black/African-American respondents, and a smaller percentage of Hispanic respondents relative to U.S. population percentages. There were also statistical differences in percentages of respondents in the lowest and highest income brackets relative to percentages in the U.S. population. The implications of these differences are considered later.

Table 4 shows a comparison of the educational attainment in the study sample and that in the U.S. according to 2020 census data (https://www.census.gov/data/tables/2020/demo/educational-attainment/cps-detailed-tables.html). This comparison suggested the educational attainment level in the study sample was higher than that in the general U.S. population in that about 84.3% of the study sample had an educational attainment greater than high school level as compared with about 54.6% of the general U.S. population.

There was no relationship between the pet (cat or dog) respondents reported their bond with and gender identity, $\chi^2_{(5)} = 4.8$, $p > 0.05$; with where respondents lived (rural, suburban, urban), $\chi^2_{(4)} = 4.5$, $p > 0.05$; or with type of housing, $\chi^2_{(6)} = 10.99$, $p > 0.05$. There was no relationship between marital status and whether the respondent reported their bondedness with a cat or a dog, $\chi^2_{(6)} = 8.6$, $p > 0.05$; and no relationship between income and whether the respondent reported their bondedness with a cat or a dog, $\chi^2_{(9)} = 15.6$, $p > 0.05$.

Cat or Dog?

Of the 836 respondents, 400 responded to the FBS concerning their bondedness with a cat, while 436 responded with respect to their bondedness with a dog. The mean bondedness score for cat owners was 94.5 (SD = 17.33) and for dog owners 97.3 (15.9). The difference between FBS scores for cat and dog owners was, $t_{(663)} = -2.24$, $p < 0.05$. While these results suggested dog owners were slightly more bonded to their companion animal than cat owners, this statistically significant difference represented an extremely small effect size, Cohen's d = −0.18 (95% CI−0.33,−0.02), accounting for only about 0.5% of the total variation in bondedness scores. The mean item scores and standard deviations are shown in **Table 5**.

TABLE 5 | Item score means and standard deviations (SD).

Item	Mean score cat	Mean score dog	SD cat	SD dog
I1	4.52	4.64	0.79	0.66
I2	4.46	4.52	0.83	0.77
I3	3.93	4.10	1.21	1.07
I4	3.99	3.85	1.13	1.11
I5	4.01	4.19	1.12	1.02
I6	4.45	4.52	0.78	0.74
I7	4.32	4.36	0.96	0.92
I8	4.17	4.15	0.95	1.01
I9	3.80	4.09	1.07	0.96
I10	4.36	4.38	0.83	0.84
I11	4.19	4.34	0.94	0.88
I12	4.14	4.26	0.98	0.92
I13	3.89	3.92	1.18	1.22
I14	4.42	4.43	0.79	0.85
I15	3.77	3.99	1.13	1.03
I16	3.94	4.09	1.04	0.98
I17	4.05	4.14	1.10	1.05
I18	4.32	4.38	0.84	0.91
I19	3.82	4.03	1.21	1.12
I20	4.17	4.28	0.95	0.94
I21	4.30	4.45	0.91	0.84
I22	3.40	3.56	1.20	1.20
I23	4.07	4.15	0.96	0.99

Missing Data

Only one FBS item on the survey had missing data, and that question had only a single missing value. Any responses of "not sure" or "refused" were treated as missing data. **Table 6** shows the percentages of respondents who responded with "not sure" or "refused," and hence treated as missing item data, for those reporting their attachment to cats and dogs. The mean percentage of missing item data for those reporting attachment to cats was 1.7% (SD = 0.82), and those reporting attachment to dogs was 1.1% (SD = 0.66). There were no missing data on gender identity or race. There was 1.2% missing data on the region where respondents lived (urban, suburban, rural), 1% missing on what type of dwelling respondents lived in, and 0.4% missing on marital status. There was 0.5% missing data for education, 3.7% on income, and 2.4% on ethnicity. In data analyses, missing data were handled using Full Information Maximum Likelihood (FIML) in Mplus.

Reliability

The coefficient (Chronbach's) alpha estimate of reliability of FBS scores for the full sample was 0.962, with a standard error of measurement (SEM) of, +/- 3.23. The coefficient alpha reliability of FBS scores for dog owners was, 0.96, with an estimated SEM of, +/- 3.18. The coefficient alpha estimate of reliability of scale

TABLE 6 | Missing data for items.

Item	% missing data for cats	% missing data for dogs
I1	0.5	2.1
I2	1.3	0.7
I3	2.8	1.4
I4	1.0	0.7
I5	2.3	2.3
I6	1.8	1.4
I7	2.0	2.1
I8	1.3	0.9
I9	4.1	2.3
I10	2.0	0.2
I11	1.0	0.2
I12	0.5	0.5
I13	1.0	0.9
I14	2.3	0.5
I15	1.5	0.5
I16	1.3	0.7
I17	1.8	1.2
I18	1.3	0.5
I19	1.5	0.9
I20	1.5	0.9
I21	2.3	1.4
I22	2.8	1.9
I23	1.3	1.2

TABLE 7 | Corrected item-total correlations for cat and dog owner item responses.

Item	Cat ($n = 391$)	Dog ($n = 428$)
I1	0.710	0.785
I2	0.817	0.756
I3	0.762	0.772
I4	0.599	0.651
I5	0.751	0.730
I6	0.744	0.817
I7	0.596	0.655
I8	0.683	0.593
I9	0.589	0.675
I10	0.757	0.803
I11	0.756	0.797
I12	0.741	0.750
I13	0.596	0.582
I14	0.746	0.731
I15	0.713	0.666
I16	0.703	0.781
I17	0.765	0.761
I18	0.805	0.801
I19	0.731	0.750
I20	0.764	0.803
I21	0.658	0.788
I22	0.629	0.627
I23	0.691	0.759

scores for cat owners was, 0.95, with an estimated SEM, +/- 3.37. The differences between these reliability coefficients for dog and cat owners (0.01) and SEMs (0.19) are minor and of no practical significance, and these findings consistent with measurement equivalence.

Item Analysis

The corrected item-total correlations for items reporting family bondedness to cats and to dogs are shown in **Table 7**. The results of a test of the equivalence of the distributions of the corrected item-total correlations for cats and dogs was statistically non-significant, Mann-Whitney U = 322.50, standardized test statistic = 1.27, $p > 0.20$. The median corrected item-correlation for cats was 0.73, and for dogs 0.76. The results of a test of equality of medians between the corrected item-total correlations were also statistically non-significant, test statistic (1 df) = 2.17, $p > 0.10$, Yates continuity correction, $\chi^2\,(1) = 1.39$, $p > 0.20$. An analysis of variance test of equality of means was also statistically non-significant, $F_{(1,44)} = 1.24$, $p > 0.25$. The mean corrected item total correlation for cats was 0.71, and 0.73 for dogs. Levine's test for equal variances of corrected item-total correlations was statistically non-significant, $p > 0.50$. These results were consistent with measurement equivalence.

MGCFA-MIMIC Analysis Results

The overall model Chi-square for the full invariance MGCFA-MIMIC model was, $\chi^2_{(1249)} = 1568.1$, $p < 0.001$. The fit indices were, RMSEA = 0.025, 90% CI: 0.021 - 0.029; and CFI = 0.99; TLI = 0.99. The narrow 90% CI for the RMSEA suggested a reasonably accurate estimate of this fit index (56). These results were consistent with a close-fitting model (50, 56). The results of Chi-square tests were consistent with metric invariance, $\chi^2\,(23) = 20.90$, $p > 0.50$, and a similarly statistically non-significant test for invariance of thresholds was consistent with threshold equivalence. The factor loadings, shown in **Table 8**, were all statistically significant and ranged in value from 0.75 to 1.78. The mean factor loading was 1.22 (SD = 0.30). The R^2 values for the proportion of item score variance accounted for by the family bondedness latent construct for owners of cats ranged from about 38 to 0.78 (mean = 0.60, SD = 0.12), and for dog owners 0.36 to 0.74 (mean = 0.59, SD = 0.11). There was no evidence suggesting any differential item functioning (DIF) between cat owners and dog owners.

The most discriminating items, in the sense of largest factor loadings, were:

- I1 [I love (pet's name)], factor loading (FL) = 1.78;
- I6 [(Pet's name) brings happiness to my life], FL = 1.50;
- I10 [(Pet's name) being in my family makes me happier], FL = 1.70;
- I11 [(Pet's name) makes my family feel complete], FL = 1.69;
- I17 [I tell others that (pet's name) is a member of my family], FL = 1.37;

TABLE 8 | Raw score factor loadings and R^2 estimates for item scores.

Item	Factor loading	SE	z	*p*-value	R^2 cat R^2 dog
I1	1.78	0.196	9.10	<0.001	0.78 0.64
I2	1.31	0.108	12.14	<0.001	0.65 0.74
I3	1.22	0.087	14.08	<0.001	0.62 0.59
I4	0.94	0.072	13.01	<0.001	0.49 0.44
I5	1.10	0.076	14.50	<0.001	0.57 0.64
I6	1.50	0.131	11.44	<0.001	0.71 0.71
I7	1.00	0.076	13.20	<0.001	0.52 0.44
I8	0.88	0.067	13.10	<0.001	0.46 0.52
I9	0.87	0.061	14.34	<0.001	0.45 0.44
I10	1.70	0.140	12.11	<0.001	0.76 0.73
I11	1.69	0.116	14.55	<0.001	0.76 0.68
I12	1.27	0.091	13.91	<0.001	0.64 0.65
I13	0.80	0.064	12.45	<0.001	0.41 0.44
I14	1.21	0.094	12.92	<0.001	0.61 0.70
I15	0.84	0.060	14.03	<0.001	0.43 0.54
I16	1.30	0.087	15.02	<0.001	0.65 0.60
I17	1.37	0.095	14.34	<0.001	0.67 0.65
I18	1.51	0.127	11.91	<0.001	0.71 0.71
I19	1.11	0.078	14.17	<0.001	0.57 0.62
I20	1.41	0.103	13.78	<0.001	0.68 0.69
I21	1.25	0.098	12.72	<0.001	0.63 0.53
I22	0.75	0.059	12.83	<0.001	0.38 0.36
I23	1.22	0.087	14.06	<0.001	0.62 0.55

- I18 [Being with (pet's name) makes me happier], FL = 1.51; and
- I20 [I feel emotionally close to (pet's name)], FL = 1.41.

The content of these items focuses on both degree of bonding with the companion animal, via love and emotional closeness, happiness, and with the feeling the pet/companion animal is a member of the family in the same way as other human family members. These results are consistent with content validity of the items indicative of family bondedness.

A test of the equivalence of the latent variable regression of the independent variables on the family bondedness latent construct across cat and dog owners was statistically non-significant, $\chi^2_{(15)} = 12.85$, $p > 0.60$, results consistent with invariance of the latent variable regression model between cat and dog owners. The latent variable regression analysis, the results of which are shown in **Table 9**, suggested males were slightly less bonded with their pets than females, b = −0.24, z = −2.99, $p < 0.005$. Persons living in urban areas were more bonded with their pets than those living in rural areas, b = 0.51, z = 4.47, $p < 0.001$; those living in suburban areas were more bonded than those living in rural areas, b = 0.29, z = 2.88, $p < 0.005$; and those living in urban areas were more bonded than those living in suburban areas, b = 0.23, z = 2.52, $p < 0.05$. Single persons were more bonded with their pets than married persons, b = 0.28, z = 2.81, $p < 0.01$. The estimated R^2 for the latent construct for cats was 0.08, z = 3.66, $p < 0.001$, and for dogs was 0.06, z = 3.62, $p < 0.001$. Education level, income, and type of housing were found to be unrelated to the degree of family bondedness.

TABLE 9 | Results for latent variable regression, HAB the dependent variable.

IV	B	SE	z	*p*-value
Gender	−0.24	0.079	−2.99	<0.005
Education	−0.01	0.041	−0.33	>0.05
Income	<0.001	0.020	0.012	>0.05
Urban vs. rural	0.51	0.114	4.47	<0.001
Suburban vs. rural	0.29	0.100	2.88	<0.005
Urban vs. suburban	0.23	0.093	2.52	<0.02
Apartment vs. house	0.14	0.122	1.17	>0.05
Condo vs. house	0.29	0.191	1.51	>0.05
Duplex vs. house	−0.07	0.252	−0.275	>0.05
Mobile home vs. house	0.30	0.216	1.38	>0.05
Living with partner vs. married	−0.03	0.156	−0.16	>0.05
Divorced vs. married	0.02	0.152	0.11	>0.05
Separated vs. married	−0.005	0.313	−0.02	>0.05
Widowed vs. married	−0.31	0.270	−1.13	>0.05
Single vs. married	0.28	0.099	2.81	<0.01
Hispanic vs. non-Hispanic	0.02	0.098	0.20	>0.05

Results suggested there was no statistically significant difference between family bondedness of Hispanic vs. non-Hispanic pet owners, b = 0.02, z = 0.20, $p > 0.50$. However, these findings should be taken as tentative given the small sample size of Hispanic respondents, $n = 105$, 12.8% of the sample (56). Future research needs to address the measurement equivalence of FBS scores across Hispanic and non-Hispanic populations as well as further investigation of the degree of bondedness between Hispanic and non-Hispanic populations. There were no statistically significant paths indicated from any of the independent variables to FBS items, results consistent with absence of DIF with respect to these independent variables (56).

Overall, these findings were consistent with measurement equivalence of FBS scores for those reporting family bondedness with cats and dogs. The results suggested that for a given value of the family bondedness latent construct, the expected observed scores on the FBS will be the same for those reporting on family bondedness with cats and dogs, controlling for the observed variables in the latent construct regression.

DISCUSSION AND CONCLUSION

Results were consistent with configural, metric, and scalar invariance; with the absence of differential item functioning as implied by the MGCFA-MIMIC model results; with comparable reliability coefficients and standard errors of measurement; and with comparable corrected item-total correlations for FBS item scores. These results provide multiple forms of evidence for measurement equivalence of person's scores for their family bondedness to cats and dogs (50). The results were also consistent

with the FBS being a unidimensional scale. These results, pending further results of validity relevant research, support the use of the FBS in HAI and HAB research by veterinarians, social workers, psychologists, and others investigating the relationships between family bondedness and other relevant variables. These results also suggest the FBS addresses important limitations in HAI and HAB measurement scales discussed by Rodriguez et al. (32), and Branson et al. (47). The addressed limitations include evidence for measurement equivalence across different animal species, specifically cat and dogs; and the need for short-form scales.

A strength of the current study results is that the findings of measurement equivalence controlled for the relationships the independent variables in the latent regression had with the family bondedness latent construct. There are also limitations. These concern the significant differences between sample income levels, racial percentages, and education levels as compared with U.S. population values. These differences raise questions about the generalizability of the results of this study to the broader U.S. population. Future research on FBS scores should entail an emphasis on obtaining more representative samples of respondents with respect to these variables.

The current study is only a first step in building a case for validity of scores on the FBS representing the degree to which a pet owner is emotionally bonded with their pet in a manner equivalent to their emotional bond with other human family members. Much research needs to be done to build a strong case for validity of scores on this scale, as elaborated by Kane (57). Further research on measurement equivalence of FBS scores across different types of companion animals is needed to build a more complete case for use of this scale in research focusing on family bondedness with a range of companion animals and human populations. Measurement equivalence evidence is needed to confirm the results of the current study, as well as evidence for equivalence of measurement between various populations of persons, including equivalence between those self-identifying as male or female, Black and White, as well as other racial groups; and Hispanic and non-Hispanic ethnic groups, among other comparisons. Age-related measurement equivalence studies also need to be done. For those interested in investigating differences between bondedness with unusual companion animals such as birds, snakes, and other exotics, further measurement equivalence studies of the FBS need to be conducted before carrying out such research. If the items on this scale are to be translated into different languages, then measurement equivalence studies of these different forms will need to be conducted.

Further research is also needed to provide different forms of validity evidence (57). Criterion-related validity evidence and convergent/divergent validity evidence, in particular, are needed. Psychometric research on FBS scores using a variety of different measurement theories also needs to be conducted. For example, studies of FBS scores using Item Response Theory need to be conducted. Consistency in results across these studies would help confirm the validity of results of the current study as well as these other investigations.

With further validity evidence, the brevity of this scale, its easy readability level, and the evidence for measurement equivalence would make the FBS useful for research, program evaluations, and other forms of practical application involving HAI and HAB research involving the degree to which pet owners are emotionally bonded to their companion animals as family members. Potential uses of the FBS include its use for any research comparing family bondedness of persons to companion animals that are cats or dogs. It also shows promise for use in outcome research, and for research investigating the possible mediating and/or moderating effect of family bondedness on outcomes of programs and interventions, such as animal-assisted therapy. It also shows promise for use in research on pet parenting styles, in particular on how emotional bonding with the pet may influence pet parenting, and vice versa, how pet parenting styles may impact the emotional bond pet owners have with their pets.

Finally, the results of the current study suggest that, contingent on further validity evidence, the FBS could be used in veterinary practice, as well as practice in social work, psychology, and other relevant disciplines. The FBS could be used as a part of any complete assessment of a veterinary case in which the degree of family bondedness with a pet plays an important role. For example, veterinarian's approach to euthanasia discussions with persons with very high family bondedness may also need to be different than with those with lower family bondedness. Grief work by veterinary social workers with persons whose companion animals have died might need to be different for those with high FBS scores than for those with low FBS scores. If clinical evidence suggests a pet owner with a higher degree of family bondedness with their companion animal might be more likely to faithfully carry out a post-surgery plan of care than an owner with a lower level of family bondedness, then knowledge of FBS scores would be useful in not only formulating the plan of care but also in explaining and persuading the pet's owner to implement the plan. In cases in which a supplementary professional is involved, such as a veterinary social worker or other social service professional, the FBS could be used as a part of a comprehensive psychosocial assessment of the family of which the companion animal is a part.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data were approved for access by the two authors only. Requests to access the datasets should be directed to William R. Nugent, wnugent@utk.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of Tennessee-Knoxville Institutional Review Board. Written informed consent for participation was not required for this study

in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

WN created the Family Bondedness Scale and conducted the data analyses. LD designed and conducted the survey. WN and LD both contributed to the writing of the article. All authors contributed to the article and approved the submitted version.

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Grooming-Related Concerns Among Companion Animals: Preliminary Data on an Overlooked Topic and Considerations for Animals' Access to Health-Related Services

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Grooming is an essential health maintenance activity that is fundamental to the welfare of many companion animals. Despite the potentially serious consequences of inadequate grooming for pets and their caregivers, few studies have examined the role of access to pet grooming services and supplies in promoting and maintaining companion animal health and welfare. The goal of this paper was 2-fold: (1) To provide preliminary findings demonstrating the scope of grooming and matting concerns among animals served by a large, non-profit animal welfare organization and (2) to provide a call for research to guide effective prevention of and responses to grooming-related omissions of care. We retrospectively extracted data from five American Society for the Prevention of Cruelty to Animals (ASPCA) programs serving the New York City area: ASPCA Animal Hospital (AAH), Community Medicine (CM), One ASPCA Fund, ASPCA-NYPD (New York City Police Department) Partnership, and the Community Engagement (CE) Program. The prevalence of grooming–related concerns was relatively consistent across all three veterinary service programs (AAH: 6%; CM: 4%; One ASPCA Fund: 6%). Thirteen percent of the ASPCA-NYPD Partnership's cruelty cases involved general hair matting concerns and/or strangulating hair mat wounds (93% were long-haired dog breed types). Five percent of CE cases received grooming-related supplies to support pet caregivers' in-home grooming capabilities. Our findings underscore the need to understand the scope of grooming-related concerns among animals served by veterinarians and other community programs to improve animals' access to health-related services.

Keywords: grooming, matting, companion animals, access to care, pet owners, animal welfare, animal cruelty

INTRODUCTION

Pet grooming is a health maintenance activity that is fundamental to the welfare of companion animals. Most companion animals require some degree of grooming, which can include basic hygiene care such as brushing, clipping, and trimming hair, bathing, cleaning the ears, and trimming claws. Inadequate grooming can lead to pain and discomfort for the animal and other

threats to animal health and wellbeing. For example, when animals' claws are not adequately trimmed, they may alter the gait of the animal and make walking uncomfortable or challenging. In extreme cases, the claws may grow in a circular pattern and penetrate the paw pads on the underside of the feet causing painful wounds. Overgrown claws can alter the normal anatomic position and function of the feet (1). Additionally, some companion animals, such as long-haired dog breeds or mixes (e.g., Maltese, Shih Tzu, and Poodle), are particularly vulnerable to severe hair matting (2). Chronically matted hair can contribute to and cause medical conditions such as skin irritation and infection, recurrent or chronic ear and ocular infections and disease, anal soiling and obstruction, fecal constipation and impaction, urine scalding, and parasitic infestations (1–4). In some cases, chronically matted hair can encircle the lower limb(s) and constrict blood flow and lymphatic drainage resulting in soft tissue death, bone injury, and potentially amputation of the affected limb (2).

There are diverse reasons why a pet owner may not maintain their pet's grooming needs, some of which may be unintentional (e.g., lack of access to services, lack of knowledge regarding pet's grooming needs) and/or due to circumstances beyond their control [e.g., financial hardship, disability, mental illness, aging; (5, 6)]. Still, grooming-related omissions of care may meet legal definitions of animal neglect and have serious consequences for individuals who are unable or unwilling to provide adequate grooming-related care (7, 8). For example, if animal neglect is reported to law enforcement, these pet owners may face criminal charges. Yet these owners could be willing to provide grooming if barriers to care are addressed, making the need to understand the scope of grooming-related concerns among animals served by veterinarians, animal welfare organizations, and other community programs an important priority for advancing animal welfare and improving animals' access to health-related services.

Pet Grooming in the U.S.

Nationally representative studies suggest that nearly 60% of U.S. households report having at least one pet, with dogs and cats being most prevalent (9). Lack of access to veterinary care, particularly for pets and people living in poverty, has gained increasing attention as an animal welfare issue in recent years (10). In this paper, we define access to veterinary care as the belief that, universally, companion animals should equitably receive compassionate, respectful, and considerate care that improves animal welfare, decreases suffering, and considers the needs of individual pets and family circumstances. Lack of access to veterinary care is a social problem that takes on many forms, including, but not limited to, pet owners' financial and physical barriers to care. Although grooming pets is essential to maintaining their health, access to grooming services and supplies, and access to related knowledge and professional advice, have typically been omitted from these conversations. During the COVID-19 pandemic, mainstream media highlighted debates as to the status of pet grooming services as an essential health-related service, with numerous media articles, news stories, and organized petition campaigns arguing that grooming services are essential to maintaining pets' health and wellbeing (11).

There is limited empirical data on pet grooming in the U.S. However, a recent report from the American Pet Products Association (12) indicates that in 2020, 81% of U.S. dog owners had groomed their pet in the past 12 months. Results of this survey suggest that at-home grooming is the most prevalent form of grooming (41%), followed by taking dogs to a full-service salon (30%), mobile grooming service (9%), retailer (8%), and self-service center (6%). On average, dogs were groomed professionally about four times during the past year, with the average number ranging from 3.2 (<$45K) to 4.6 ($125K+) across household income quartiles (i.e., <$45K, $45K-74.9K, $75K-124.9K, $125K+). Households in the two lowest income quartiles reported at-home grooming more often (i.e., <$45K: 44%, $45K-74.9K, 47%) than the higher income quartiles ($75K-124.9K: 38%, $125K+: 37%). Households in the two lowest income quartiles also reported using full-service salons less often (i.e., <$45K: 23%, $45K-74.9K: 28%) than the higher income quartiles (i.e., $75K-124.9K: 30%, $125K+: 36%). Although most dog owners engage in at-home grooming, ∼23 and 57% of U.S. dog owners report that they do not own a brush or nail clippers, respectively, with low-income households reporting the lowest rates of owning these grooming tools (12).

Information regarding grooming practices of U.S. cat owners is limited despite evidence that brushing cats' hair is an important practice that serves to remove dead hair, aerate the skin, and disentangle knots that can cause pain and discomfort such as skin tightness and pruritus (an itching sensation), particularly in long-haired breeds (13). The APPA's recent report suggests that 32% of U.S. cat owners report that they do not have a brush or other grooming tool for their cat (12). Self-grooming is a typical feline behavior and, therefore, professional grooming is not essential for most cats, particularly short-haired breeds (14–16); however, recent data suggest that 17% of U.S. cat owners report that their pet has been groomed professionally in the past 12 months (12). Consistent with data on dog owners, utilization of professional grooming services among cat owners varies across income groupings, with only 13% of households with incomes under $25K reporting having had their cat groomed in the past 12 months vs. nearly a quarter of households with incomes over $125K (i.e., <$25K: 13%, $25K-44.9K: 14%, $45K-74.9K: 13%, $75K-124.9K: 19%, $125K+: 23%). To our knowledge, data regarding cat owners' methods of grooming (e.g., at-home vs. professional) and/or the type of grooming services accessed (e.g., mobile vs. full-service salon) are not available, nor are data on grooming practices by coat length or breed.

Current Study

It is important that veterinary and animal welfare professionals and researchers consider access to grooming services and supplies when discussing animals' access to health-related services. This is of particular importance at the current time given that a recent nationally representative study suggests that one in five households acquired a new pet during the COVID-19 pandemic (13%). Moreover, "designer breeds" (e.g., Labradoodles), some of which require more intensive at-home

and professional grooming for coat maintenance, are increasing in popularity (17–20). To advance this understudied area of animal welfare research, the goal of this paper is 2-fold. First, utilizing service data from a large, non-profit animal welfare organization, we provide preliminary data demonstrating the scope of need for grooming services across five service programs. Second, we provide a call to action for research on grooming-related omissions of care and outline future directions for research and practice in this area.

METHOD

Study Design and Sources of Data

This study was retrospective in design. All data reported on in the current paper were collected between 2018 and mid-2021 and reflect animals served in the New York City area. For the current study, we extracted data stored in electronic databases maintained by the ASPCA. Specifically, we examined data from five ASPCA program areas, which were stored in two databases (CiviCore and ImproMed). Each of the programs is described below.

Program Descriptions

ASPCA Animal Hospital

AAH accepts cat and dog patients who require urgent or emergency care and belong to pet owners who are New York City residents and are experiencing financial hardships or constraints. Pet owners can schedule an appointment for their pets for veterinary care and/or be referred by other ASPCA programs in New York City and private veterinarians in the area. Services are either low or no-cost.

Community Medicine

CM provides high quality, high volume spay/neuter and primary veterinary care via the ASPCA's Community Veterinary Centers (CVCs) and mobile clinics in communities that experience barriers to veterinary care. Focus areas include the Bronx and Brooklyn. In addition to this work, CM, Community Engagement (described below), and the ASPCA Adoption Center collaborated to conduct a soft launch of grooming services at the CVCs and at weekly vaccine events in May 2021. Services available included basic grooming and nail trims, educational demonstrations for owners, and supplies (e.g., brushes and nail clippers). These appointments were exclusively for clients who had brought their pet(s) in for vaccines or preventive care. All services provided by CM are partially or fully subsidized. For grooming services rendered as part of the soft launch, we examined data from May 26, 2021 through July 28, 2021.

One ASPCA Fund

The One ASPCA Fund is a subsidy program for veterinary care facilitated by the ASPCA's Client and Member Support team to support and improve welfare for as many animals as possible. This program provides services for medical conditions that have a good prognosis and require short-term care. Clients qualify if they are referred by the ASPCA's Community Engagement or CM teams, the NYPD, or social service agencies (e.g., domestic violence shelters, food bank organizations).

ASPCA-NYPD (New York City Police Department) Partnership

The ASPCA partners with the NYPD to prevent and respond to animal cruelty in New York City. The NYPD responds to animal cruelty complaints, and the ASPCA directly cares for the animal victims by providing forensic evaluations, medical treatment, housing and placement, behavior assessments and treatment.

Community Engagement

The CE team works with New York City residents who lack access to vital care, services, and supplies for their pets. Often, these pet owners are referred to the team by the NYPD as cases that would benefit from receiving services rather than criminal justice action. CE provides families with resources to help them create and sustain a safe and healthy environment for their pet(s). The team also accepts referrals from social service and other allied agencies and conducts outreach throughout the community to increase awareness and access to the ASPCA's veterinary care and spay/neuter services, among other pet-related resources.

Identification of Grooming-Related Appointments and Cases

To identify grooming-related appointments among our veterinary medicine programs, we examined all appointments with medically necessary grooming or nail trim noted in the animal's record. When a grooming service was not explicitly captured in the appointment data as a distinct field, we identified grooming-related appointments by reviewing the appointment reason as reported by the client, reviewing the DVM's appointment notes, and/or searching for phrases and words including medical grooming, sedated grooming, matting, matted, strangulation, unkempt, overgrown, ingrown, embedded, curled, curling, and other variations of these words and phrases. Cases and appointments involving ear cleaning and infections were not included because it was not possible to determine whether these appointments were related to grooming-related omissions of care. For data from the ASPCA-NYPD Partnership, cruelty cases that included any version of the words "matting" (e.g., mat, matted) or "strangulation" (e.g., strangulating wound) in the case description were included. A detailed overview of the procedures for identifying strangulating hair mats is provided in Watson and Niestat [(2), p. 28]. Approximately 15% of AAH appointments with medical grooming and/or nail trims involved animals that were served in association with an ASPCA-NYPD Partnership case. Therefore, some animals may be counted in both AAH and ASPCA-NYPD program estimates; however, we are unable to produce a precise estimate due to differences in data entry and storage across programs. For CE Program case data, cases that included any provision of grooming-related supplies to the client were included.

Analysis

Data were exported to Microsoft Excel, which was used to produce descriptive statistics on grooming and matting-related cases and appointments for each program.

RESULTS

The number of cases and appointments per ASPCA program and the corresponding percentage involving grooming and/or hair matting concerns are provided in **Table 1**. Our data reflect more than 52,000 veterinary appointments from AAH, CM, and the One ASPCA Fund and 2,600 cases from the ASPCA-NYPD Partnership and the CE Program. Six percent of AAH's 2018–2021 appointments involved medically necessary grooming or nail trims. Four percent of appointments seen by CM veterinarians included grooming-related observations and/or service provision. Six percent of appointments scheduled via the *One* ASPCA Fund included grooming-related observations by the DVM and/or provision of grooming services.

Since 2018, more than 1 in 10 (13%) of the ASPCA-NYPD Partnership's cruelty cases have involved general hair matting concerns and/or concomitant strangulating wounds. Five percent of CE cases received grooming-related supplies to support in-home grooming capabilities (e.g., grooming kit, brushes, nail trimmers, shampoo). During the soft launch of the grooming services pilot program, 204 grooming appointments were provided at CVCs and weekly vaccine events; moreover, all available appointments were filled. At least 47% of these appointments served long-haired dog breeds or mixes (e.g., Maltese, Poodle, Shih Tzu, Pekingese); 20% of appointments did not capture the breed.

DISCUSSION

To our knowledge, this is the first paper to provide preliminary findings demonstrating the scope of grooming-related concerns among animals served by a large, non-profit animal welfare organization. We found that the prevalence of grooming–related concerns was relatively consistent across all three veterinary service programs (between 4 and 6%). Our results suggest that for many pet owners served by our animal welfare organization, especially by programs that aim to improve access to veterinary care through fully or partially subsidized services, earlier access to grooming care can help promote animal health and welfare. The level of need for medical grooming identified across these programs suggests that preventable issues, such as hair matting, likely diverts limited resources that could be better positioned for other veterinary care. For example, grooming is not on the menu of services provided by the ASPCA's veterinary programs. Thus, pets are typically brought in for another medical concern, and yet the animals' grooming need cannot be ignored and must be addressed by the veterinary staff at the same time. This could divert doctors' and staffs' time and resources away from treating other patients, which is of particular concern given the current veterinary staff shortage (21, 22).

Consistent with Watson and Niestat's (2) research, we found that small, long-haired dog breed types were overrepresented among appointments that involved grooming-related omissions of care, particularly medical grooming appointments. However, it is important to consider that the current study and Watson and Niestat's (2) relied on a sample of companion animals in the New York City area. It is possible that people in this region are more likely to own small dogs due to space limitations and restrictions associated with urban housing and therefore, these cases are overrepresented in our sample. We are not aware of any comparative data on rates of ownership by species and breed (e.g., long- vs. short-haired or single- vs. double-coated breeds) in New York City vs. nationally.

Our findings suggest that the provision of basic grooming services, facilitating clients' access to grooming services and supplies, and increasing clients' knowledge of their pet's grooming needs should be considered an important aspect of veterinary and animal welfare professionals' ability to provide a spectrum of care. Increasing clients' access to basic grooming may help to prevent more expensive and advanced care in the long-term and is particularly important for pet owners with financial limitations and those from underserved communities (23, 24). Access to veterinary care is essential so that companion animals can receive vaccinations (e.g., rabies, Bordetella) that are typically required for pets to receive professional grooming services. Moreover, veterinarians can play an important role in helping animals that are averse to grooming, such as making anxiolytic medications available to pet owners. When applicable, it is important that veterinarians assist clients in viewing the maintenance of pets' grooming needs as a viable and desirable choice for maintaining their pet's health and preventing negative health and behavioral outcomes. If grooming services and supplies are not available or cannot be accessed outside of veterinary settings, the consequences have the potential to become a burden on the veterinary community (e.g., medically necessary grooming), with potentially more serious implications for the non-profit veterinary community who likely encounter a disparate number of these cases.

This study also identified that the prevalence of grooming-related cases among animals served by the CE team was consistent with those served via the ASPCA's veterinary care programs (5%). This comparable rate is interesting to consider given that individuals who receive CE services and supports are often referred by social service and other allied agencies and by the ASPCA-NYPD Partnership in situations where non-criminal interventions can improve the health and safety of the animal. In contrast to the other ASPCA programs examined in this study, the rate of grooming-related concerns among animals served by the ASPCA-NYPD Partnership was notably higher and nearly double the rate found among the other programs at 13%. In addition, 97% of the ASPCA-NYPD Partnership's related cases involved dogs. The low rate of cases involving cats could be explained by prior evidence that cases of cruelty are more likely to receive prosecutorial attention if they involve dogs, despite other evidence that cats are the species most often involved in these cases (25–27). The higher rate of grooming-related omissions of care among the ASPCA-NYPD Partnership cases is not

TABLE 1 | Number of appointments or cases per ASPCA program and the percentage involving grooming-related omissions of care and/or related services.

Program	Percent of grooming-related appointments or cases	Species, services, and coat-type	Total appointments or cases
AAH	6% (n = 1,230)	• 858 dogs, 372 cats • 421 medical grooming, 809 nail trim services ○ 77% (n = 324) of medical grooming services were for long-haired breed types	19,327
ASPCA-NYPD Partnership	13% (n = 127)	• 97% (138) of the 142 animals involved in these cases were dogs ○ 93% (n = 128) of dogs were identified as long-haired breed types	981
CE	5% (n = 79)	• 65 cases involved dogs only or both cats and dogs • 14 cases involved cats only • Breed-specific data not available	1,652
CM	4% (n = 1,266)	• 1,013 dogs ○ 80% (n = 808) of dogs were identified as long-haired breed types • 252 cats ○ 18% (n = 46) of cats were identified as long-haired breed types • 1 small mammal	31,047
Grooming at CVCs and Vaccine Events	100% (n = 204)	• 191 dogs ○ 47% (n = 90) of dogs were identified as long-haired breed types ○ 20% (n = 39) of dogs had no breed listed • 13 cats	204
OAF	6% (n = 119)	• 95 dogs ○ 78% (n = 74) of dogs were identified as long-haired breed types • 23 cats • 1 turtle	2,154

AAH, ASPCA Animal Hospital; CE, Community Engagement; CM, Community Medicine; CVC, Community Veterinary Center; OAF, One ASPCA Fund. Small, long-haired dog breeds and breed mixes represented in our data included: Bichon Frise, Brussels Griffon, Cavalier King Charles Spaniel, Cocker Spaniel, Coton de Tulear, Chinese Crested, Goldendoodle, Havanese, Lhasa Apso, Long-Haired Chihuahua, Maltese, Papillon, Pekingese, Pomeranian, Poodle, Scottish Terrier, Shih Tzu, Silky Terrier, Tibetan Terrier, West Highland Terrier, Wheaten Terrier, Yorkshire Terrier.

surprising given that these represent the most severe cases that have been recognized and reported by community members and service professionals (e.g., veterinary hospitals, animal welfare organizations) as animal cruelty or welfare concerns. Still, the percentage of cruelty cases involving matting or strangulation is likely underreported as only the case description was considered in the identification of cases included in our analysis. Moreover, omissions of care involving claws and other medical issues, such as myiasis, were not included in this estimate.

Findings from our examination of CE and ASPCA-NYPD Partnership cases suggest that programs aimed to improve access to health-related care among pet owners and those that provide direct human services would benefit from developing collaborative relationships with animal welfare organizations that can connect pet-owning clients with supplies and resources that help foster their ability to groom their pets. In addition, animal welfare organizations can be proactive in efforts to prevent grooming-related omissions of care. Examples of proactive efforts include providing trainings for allied professionals (e.g., child welfare workers, social services), educational materials for staff and clients (e.g., facts about pets' grooming needs, grooming demonstration videos, a list of community grooming services), and no- and low-cost services for their clients, as these populations likely face increased barriers to accessing health-related information and services for their pet. With more proactive support to meet pets' grooming needs, pet owners may intervene before hair matting or other identified medical problems significantly impact the animal's quality of life.

To prevent grooming-related omissions of care, it is important that the veterinary science and animal welfare fields consider how the social determinants of health that impact human health and wellbeing (e.g., transportation, neighborhood characteristics, income, education, discrimination) have a direct and indirect effect on pet owners' ability to groom their pets, particularly among marginalized communities. Pet owners may not be able to provide basic grooming care due to the conditions of the environment in which they live (28). For example, nationally representative data suggest that ∼11.2 million dogs and 8.3 million cats in the U.S. live in under-resourced homes below the poverty line (29). In 2020, U.S. dog owners spent, on average, $197 on professional grooming at a salon, $161 on professional grooming from a mobile service, $47 on at-home grooming aids (e.g., brushes), and $40 on non-medicated shampoo and conditioner (12). For low-resourced individuals in low-resource

economic conditions, pet grooming-related costs could lead to considerable financial strain and/or may not be a priority compared to providing the animal and other family members with basic needs such as food, water, and shelter. People may face additional barriers to pet grooming due to their lack of physical proximity to grooming services and supplies; commonly termed "animal resource deserts," these communities often lack access to veterinarians, pet supply stores, and/or have little to no animal welfare infrastructure (30). Further, transportation to a professional grooming appointment, self-service salon, or pet supply store may be an additional barrier to grooming pets. Some people do not have access to a personal vehicle, pet-friendly public transportation, and/or equipment needed for traveling with pets (e.g., carrier, leash). For example, recent estimates suggest that 76 and 19% of U.S. dog and cat owners, respectively, do not have a crate or kennel for transportation of their pet (12). Research is needed to understand the independent, cumulative, and interactive effects of various forms of human adversity on pet owners' access to grooming services and supplies and ability to provide grooming-related care. We elaborate on opportunities for research in this area below, in our call for research.

It is common for private, for-profit veterinary practices to include non-medical services (i.e., grooming) within their business model as both an additional means of profit and as a convenience for pet owners. Our findings suggest that grooming services warrant consideration in the non-profit model as well, particularly in communities that lack access to pet care and/or have been historically excluded from vital pet care services. Given that many animal welfare organizations and shelters offer emergency sheltering and/or pet food pantries, it is conceivable that no- and low-cost pet grooming services could be added to expand the continuum of care and services provided for underserved animals and their caregivers. In addition to providing grooming services and supplies, programs that provide grooming demonstrations for pet owners and teach them to groom pets could be an effective way to prevent grooming-related omissions of care. Furthermore, it is possible that animal welfare organizations could partner with existing non-profit organizations that provide hygiene kits, access to mobile showers, and self-care resources for individuals who are housing insecure and expand the scope of services to provide animal-inclusive services that help to preserve the bonds between marginalized and underserved people and their pets.

Collectively, our results suggest that improving access to grooming services and supplies and improving caregivers' knowledge of their pets' grooming needs may improve the welfare of a significant number of companion animals served by programs that aim to improve underserved pet owners' access to veterinary care. Previous work has explored the concept of social determinants of animal health, a model that emphasizes health determinants that are important or unique to animals. For example, Card et al. discussed the intersection of human and animal social determinants of health and the importance of access to veterinary services in pet health equity (28). As social determinants of animal health continue to be discussed and envisioned by the veterinary field, we encourage veterinary and animal welfare scientists and professionals to consider and identify the significance of access to grooming services and supplies as a social determinant of animal health. Access to grooming is vital to the wellbeing of some companion animals, especially long-haired dogs and cats. Therefore, more equitable access to pet health services should include access to pet grooming and related supplies (28).

Study Limitations

There are several limitations of our study that warrant consideration. First, our study was retrospective in design. Due to differences and changes in services, client eligibility parameters (e.g., income), and data entry and storage programs across ASPCA programs, our data points (i.e., timeline) vary slightly across programs. Second, we did not evaluate all aspects of grooming-related care, such as ear cleaning, or related medical issues such as myiasis. This was not possible due to inconsistencies in how programs collect these data. Third, it is important to note that there may be overlap between clients served through our veterinary services and those served by CE and the ASPCA-NYPD Partnership. Although we were able to identify the number of appointments, cases, and organizational resources serving animals who present with grooming-related concerns, we cannot identify the exact number of animals served as it is possible that some animals were double-counted due to how many times they were seen, both within and across programs. Fourth, our data reflect clients of a large non-profit organization in a large, urban city. Thus, our data may not generalize to other regions of the U.S. or animals served by organizations with fewer resources. Moreover, there is little marketing for the ASPCA's programs, and the services are limited, which likely makes the rates reported in this paper an underestimate of the scope of need. Finally, our datapoints span the time periods prior to, during, and after the height of the COVID-19 pandemic, which had major impacts on the operations of animal welfare organizations, veterinary practices, and law enforcement agencies.

Call for Research

We conclude this paper with a call for research that aims to prevent and adequately respond to grooming-related omissions of care. First, to prevent grooming-related omissions of care and increase animals' access to health-related services, it is important to understand the scope of these concerns in general veterinary practice and in community and shelter medicine settings. We encourage other animal welfare professionals and researchers to examine and report on the scope of grooming-related concerns within animal care services. Such data will be critical to informing programs and policies that enhance grooming-related care. Furthermore, future work should aim to identify whether there are shared characteristics (e.g., neighborhood, poverty, age, culture) among pet owners whose animals are at risk for grooming-related omissions of care. Relatedly, understanding pet caregivers' beliefs and knowledge about grooming is essential to developing resources and programs that can successfully prevent and adequately respond to grooming-related omissions of care. Such information could help identify who may be most likely to benefit from knowledge and resources on grooming-related

care and access to no- or low-cost services and/or how services and resources can be adapted to be culturally appropriate and responsive. Understanding discrepancies between veterinarian-identified grooming concerns and pet owners' awareness and concerns about these issues is also an important direction for future research.

As previously discussed, several individual and contextual factors likely serve as obstacles to adequate pet grooming, such as the owners' financial resources, proximity to grooming services, and access to pet-friendly transportation. Research is needed to understand these barriers and how they can be prevented, eliminated, and/or mitigated by non-profit animal welfare organizations, private veterinary clinics, and allied professionals. There is also a need to understand how pets' behavior impacts caregivers' ability to groom pets. For example, transporting pets to grooming appointments and/or attempting to groom them at home may be particularly difficult when animals have behavioral problems and behavioral conditions, such as aggression, anxiety, reactivity, and/or fear of being handled (31). Moreover, behavioral problems may be brought on or exacerbated by at-home and professional grooming. A recent evaluation of housed Maine Coon cats found that owners' grooming of cats (i.e., brushing) often elicited behaviors from the cat that are indicative of stress, such as aggressive behaviors, withdrawal, and facial discomfort, even when cats were habituated to brushing early in life (13). For novice pet owners, behavior problems and pets' reactions to grooming may present obstacles to meeting the pets' needs. Furthermore, prior research shows that pet owners may experience negative emotions (e.g., annoyance) and stress associated with their pets' behavioral problems; in turn, they may spend less time with pets (32, 33). If pet owners reduce the amount of time spent with pets due to the animal's behavioral problems, this may also impact the likelihood of consistently grooming the animal and retention of the pet. Future research should examine potential associations between pets' behaviors, grooming, and pet retention, as well as the role of the client-pet dynamic in grooming-related omissions of care.

Finally, the physical, mental, and cognitive health of pet owners and characteristics of their social relationships also have implications for the quality of care that animals receive and there is substantial need to understand how the psychological and physical health of pet owners may contribute to grooming-related animal welfare issues. For example, it may be unsafe for older pet owners and/or those with physical limitations or disabilities to groom pets at home. These owners may require assistance with traveling to grooming appointments and/or purchasing grooming supplies and performing grooming activities, such as bathing and nail trimming (34). Regarding mental and cognitive health, it is well-known that cognitive dysfunction, memory loss, depression, and trauma are associated with poor self-hygiene behaviors and neglect of child and adult dependents among adults (35–37). Adult humans' relationships with pets are often akin to a parental relationship with a child; therefore, these individual-level risk factors are important to consider in relation to inadequate grooming of pets (38–41). Lockwood found that 92% of respondents to a national survey of adult protective service workers had experienced animal neglect co-occurring with a client's inability to care for themselves (42). Household dysfunction (e.g., domestic violence, substance use) may also contribute to animal neglect (43–45). Indeed, there is some evidence that failure to groom pets' matted hair, seek veterinary care, and other forms of animal neglect are prevalent among households experiencing family violence (45, 46). Understanding how these individual and family-level factors impact pet owners' access to grooming services and supplies and ability to provide adequate grooming-related care is essential to establishing effective and sustainable programs. Therefore, we recommend research on the intersection of human and animal social determinants of health to guide future work in this area.

SUMMARY AND CONCLUSION

Companion animals' grooming needs are an important aspect of their health-related care. Our findings provide preliminary evidence that improving access to grooming services and supplies and improving caregivers' knowledge of their pets' grooming needs is likely to improve the welfare of a significant number of companion animals. As few studies have examined pet owners' knowledge of their pet's grooming needs and/or barriers and facilitators of access to grooming services and supplies, we strongly advocate for continued research in this area. In addition, there is a great need for research aimed at establishing best practices for implementing programs that provide no- and low-cost grooming-related services and supplies for animals and their owners, particularly among underserved and low-resourced populations and communities. Consistent with prior work, our findings suggest that improved inter-agency and cross-services collaboration can help to ensure the health and welfare of multispecies families (5, 47).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

SM and JS: conceptualization and methodology. JS: analysis. SM, JS, LN, and CD: writing, review, and editing. All authors contributed to the article and approved the submitted version.

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Putting Access to Veterinary Care on the Map: A Veterinary Care Accessibility Index

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Access to veterinary care is a complex problem that sits at the intersection of a number of societal factors including income inequality, access to transportation, language and cultural differences as well as the spatial distribution of veterinary care providers. This research aims to create an index evaluating accessibility of veterinary care across the contiguous United States and thus fill an important gap in the literature. The location and number of employees of veterinary clinics were aggregated at the county level. Projected pet population and household counts were used to normalize the number of employees to provide a relative assessment of the distribution of care access. Existing US Census data was used as percentile rankings to identify counties which may experience additional, non-spatial, barriers to care. By combining the percentile rankings of each of the variables, an overall index was created, evaluating the relative accessibility of veterinary care in each of the counties of the contiguous US. This work can be used by organizations looking to improve access to care or by policymakers considering legislation that impacts this issue. It may also be of use to individuals in human health care as they consider the intersection of human wellness and companion animal wellness.

Keywords: access to care, veterinary geographic distribution, veterinary shortage, veterinary care index, veterinary staffing, veterinary care desert

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INTRODUCTION

Over time, there has been a steady increase in the number of companion animals that are not receiving veterinary care with cats being the most affected (from 32 to 45% in the period between 1998 and 2011) (1). During this same period, the cost of veterinary medical care has been rising faster than wider inflation but also faster than the rapidly increasing costs of human health care (2). The average American spends 47% more on equivalent veterinary care today than a decade ago (3). The functional impact is that a lower proportion of people are seeking care for their pets (4) resulting in what is considered the greatest current threat to companion animal welfare in the US (5).

Cost of veterinary care is an often cited barrier to veterinary care (3, 6). It was also cited as the most common reason individuals chose to use nonprofit spay and neuter clinics over private practice clinics (7). A major study by Bayer in 2011 highlighted an alarming decrease in the demand for veterinary care (6) with a follow up study completed in 2014 which showed increasing client citing of cost and stress to animals as reasons for not visiting veterinarians, especially for preventative care (8). A full review of the articles published over nearly two decades indicated that fully 61% of articles published on access to care issues included cost as part of their article (9).

Challenges of discussing financial issues with pet caregivers is also cited as a primary source of job-related stress for veterinarians (10). What results is a conflict for veterinarians who have to consider the suffering and impacts to an animal's quality of life and a client's ability to pay for needed care (10).

The issue of cost as a barrier is also not limited to low income individuals. Researchers have found economic barriers to care existing at poverty, low income and mid income levels (5) and across racial and ethnic groups (11, 12). The AVCC (5) report identifies the most common barriers to veterinary care as self-reported through a survey. Distance to the vet clinic, veterinary care cost and transportation in general all emerged as significant barriers in this research (5). Additionally, barriers to affordability of care are reported in urban regions as well as remote, rural regions where care centers are sometimes not available at all (13). Lack of veterinary facilities, or an inability for individuals to physically access facilities is cited as an additional barrier to care (3).

Cultural differences or a lack of awareness of the need for companion animals to receive veterinary care is another possible barrier that might co-occur with economic barriers in low-income communities (7, 14). Language barriers are also commonly cited as a barrier in provision of care in human health (15) and it is likely that similar challenges exist in other care settings, such as veterinary care. In a recent survey, only 8% of veterinary clinics reported having staff that could speak Spanish fluently and that language challenges decreased satisfaction with veterinary experiences (16). Considering income/poverty status alone in determining who faces access to veterinary care (hereafter A2C) barriers thus is an inadequate measure of needs assessment (7).

When caregivers are unable to access veterinary care for their companion animals, they may be forced to rehome/surrender them to a shelter (17), euthanize them (18), or avoid obtaining a pet in the first place and thus lose out on the benefits of having a companion animal (19). For example, Weiss et al. (17) found that upwards of 40% of individuals rehoming animals indicated that access to free or low cost veterinary care would be something that would've helped them retain their pet.

There is an identified lack of geographic research that explores access to veterinary care issues (9). Geographic Information Systems is a powerful tool to visualize the distribution of veterinary facilities relative to the socio-economic status and other barriers to care. This research aims to fill the existing gap in the literature through the creation of a spatial index that incorporates the main variables impacting access to veterinary care.

MATERIALS AND METHODS

The objective of this research is to introduce a spatial index that assesses the relative risk of experiencing barriers to accessing veterinary care for companion animals across the contiguous United States at the county level. An aggregate percentile rank variable was derived for each county using the data and methods described below. Variables for entry in the index were chosen based on the existing research around barriers in access to veterinary care as discussed in the introduction.

Scope and Scale

The geographic unit of analysis is at the county level. Counties are a familiar unit of analysis for communicating data to the public. Access to Care for human populations is often measured and reported at the county level in this context providing a comparative justification for this unit. The Robert Woods Johnson County Health Rankings is one example (20). As some organizations move toward a One Health model that includes companion animal wellness as part of the human wellness continuum of care, using a similar geographic unit of analysis will add value in how the results of this analysis can be used as part of existing human based A2C maps and datasets. One Health acknowledges the link between non-human animal wellness and human wellness including the psychosocial value of the human-animal bond, zoonotic disease transmission and other factors (21). The proposed index covers the contiguous United States because the pet demographic data used in the analysis did not include values for Alaska and Hawaii.

Data

Socioeconomic Variables

The Centers for Disease Control (CDC hereafter) originated the Social Vulnerability Index (SVI hereafter) as a tool for evaluating the relative vulnerability of populations across the United States during times of disaster (22). The index contains a number of different variables organized under four main themes. Variables, expressed as percentile ranks, were chosen for this research using the 2018 version of the SVI. The variables were chosen based on their relevance to barriers to veterinary care identified in the extant literature as discussed in the introduction. The rank percentiles of the number of people in poverty, the per capita income, the number of people with no access to a vehicle and the number of people who speak English less than well were selected to enter into our analysis. The 2018 SVI was accessed through Living Atlas in ArcGIS Online at the county level. The SVI data is built using Census derived data, see Flanagan et al. (22) for a detailed discussion of the variables and the methods used to calculate them (22).

Veterinary Coverage Variable

The coverage of veterinary care is conceptualized as the aggregate number of veterinary clinic employees normalized by the predicted pet population in any given county in the US and expressed as the number of clinic employees per 1,000 pets. The number of employees is used in lieu of the number of clinics due to the range of sizes of veterinary clinics that would impact their functional capacity to provide coverage for any given population. This includes all type of employees, ranging from administrative support staff to veterinary assistants and technicians. While not all clinic staff are engaged in delivery of direct care, additional supporting staff may increase the capacity for care through efficiency gains [see for example (23)]. Clinics can range in size from small, single veterinarians with limited support staff to large corporate-owned facilities with several veterinarians and

numerous support staff (24). This composite variable was created using the data described in the following two subsections.

Veterinary Employees

Veterinary clinic locations and number of employees were obtained using ESRI's GIS online suite of applications. Veterinary clinics were defined using the North American Industry Classification System. The North American Industry Classification System (hereafter NAICS) provides a standardized method for classifying industries across the continent of North America (25). For purposes of this research, the NAICS code 541940 was used which captures all types of veterinary clinics. According to the NAICS definition: "This industry comprises establishments of licensed veterinary practitioners primarily engaged in the practice of veterinary medicine, dentistry, or surgery for animals; and establishments primarily engaged in providing testing services for licensed veterinary practitioners (26)". While they are technically part of the 541940 code, businesses listed as laboratory testing services facilities were removed from the results since they do not provide direct services to companion animals and may serve a large geographic area.

The database that the business info drawn from is maintained by ESRI through data gathered by Infogroup (27). Infogroup sources authoritative business data on a large number of industries in the US which are then geocoded for mapping purposes (27). The vintage of the data accessed are January of 2020 for the clinic employee counts and April of 2020 for the clinic locations (28).

Pet Population

For purposes of this research, "pets" are defined as household cats and dogs. Estimating the population of companion animals at the county level can be challenging. There is not one single approach to doing this that is standardized and broadly agreed upon (29). A number of pet demographic surveys have been completed, most notably the routine surveys conducted by the American Veterinary Medical Association (AVMA hereafter) and the American Pet Products Association. Other smaller scale social science surveys have been completed [see Applebaum (29), for a detailed comparison and discussion]. Using the General Social Survey as one additional approach that was recently advanced (29).

For purposes of this research, the 2017–2018 AVMA Pet Demographic survey was used because it is generally recognized within the veterinary industry, accessible through the AVMA and periodically repeated to update the data. The AVMA survey reports, among other things, estimates of pet ownership rates and total estimated population of cats and dogs at the state level. State total pet populations were directly extrapolated for use at the county level in this research. While this is imperfect it provides a first step toward understanding the spatial variability in the proposed index. See the AVMA Pet Demographic Sourcebook for a detailed discussion of their methodology (executive summary publicly available at: AVMA-Pet-Demographics-Executive-Summary.pdf with full report available through the AVMA).

The household count estimate from 2016 (to match the vintage of the AVMA survey) at the county level was obtained through ArcGIS online [see ESRI documentation for explanation of methodology and data sources (30)]. The 2019 household count was also obtained from the same source.

Methods

Ratio of Veterinary Employees to Pet Population

The AVMA total pet population estimate for each state was divided by the state's Census estimate 2016 household count and then multiplied by the 2019 household count at the county level. This was used to represent the projected pet population at the county level in order to have a method to normalize the number of veterinary employees. Normalized Intensive Statistics provide a way to present data in comparative form by dividing the raw value by a given basis, a common tool in mapping (31). Further, normalization is recommended when the resulting visualization is symbolized as a choropleth map (31).

Ranking Scores

Rank percentiles were calculated for each of the variables entered into the index. Rank percentile is defined as the proportion of scores in a distribution that an individual score is greater than or equal to. Already calculated values for the variables obtained from the SVI were used. For the veterinary employee to pet population ratio, the values were ranked in order from lowest to highest since lower levels of employees are equated with higher vulnerability to keep ranking logic consistent with the Social Vulnerability Index. For county level aggregated index ratings, the scores were ranked in order from highest to lowest. Percentile ranks were calculated with the following equation:

$$Percentile\ Rank = \frac{Rank - 1}{N - 1}$$

where N = the total number of data points. For the veterinary employee to pet population variable, all sequences of ties are assigned the average of the corresponding ranks so as not to underweight the more frequent zero value. For the county level percentile ranks the smallest of the corresponding ranks was used for any sequences of ties.

Once percentile rank calculations were completed for the veterinary coverage all of the percentile ranking values were summed at the county level. Then a composite percentile ranking was calculated for a final index value that was visualized in ArcGIS online. As such, the resulting index values are relative and not absolute. This approach is used because of the lack of research around the level of veterinary employee coverage that is optimal and the complex relationship between income and absolute affordability of care. In the resulting index, values approaching one have the highest access to veterinary care while those approaching zero have the lowest access to veterinary care. For ease in communicating the data, the fractional output was then multiplied by a factor of 100 such that 100 is the most accessible ranking and 0 the least. The resulting index represents the Veterinary Care Accessibility Score (VCAS, hereafter). Lastly, a state overview was created by compositing the values of all of the VCAS within each state and calculating a simple average.

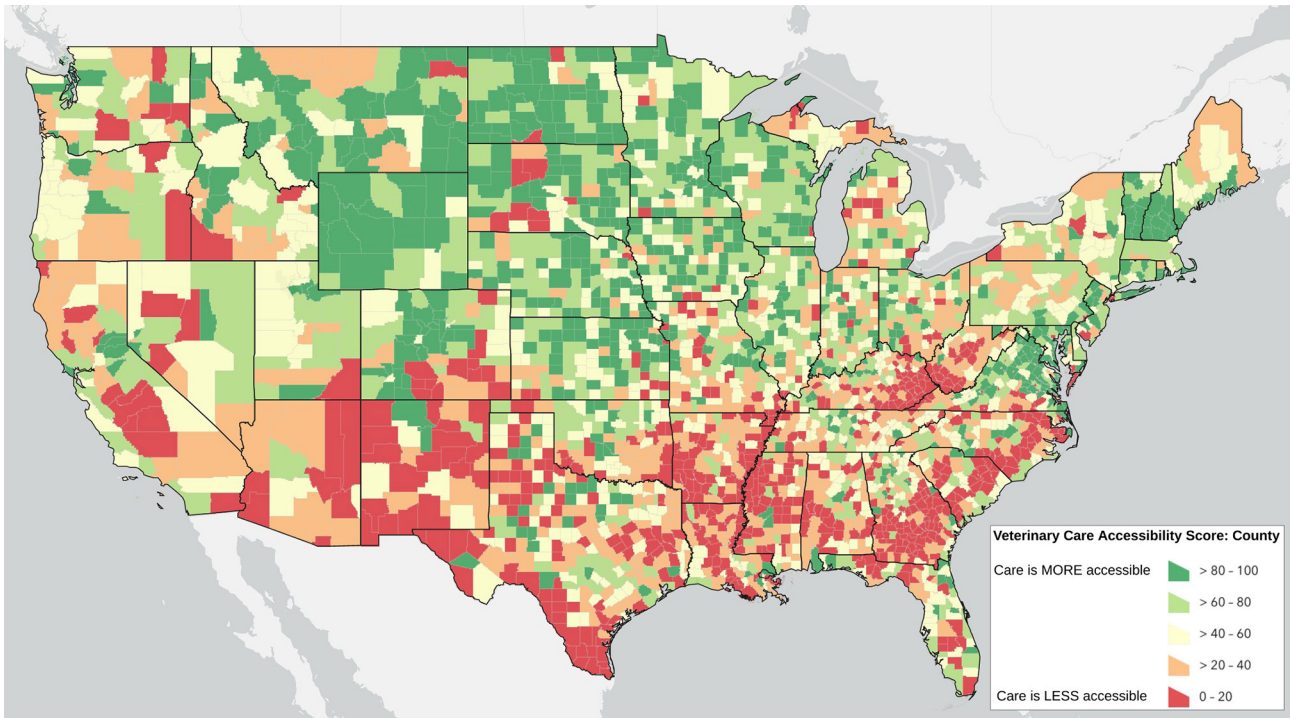

FIGURE 1 | The Veterinary Care Accessibility Score: a relative measure of accessibility to veterinary care across the contiguous US. An online interactive and routinely updated map is available at: www.accesstovetcare.org

RESULTS

Veterinary Care Accessibility Score

As discussed, the Veterinary Care Accessibility Score combines the percentile rankings for five factors that have been identified in the extant literature as impacting access to veterinary care. The resulting VCAS are displayed in **Figure 1** as a choropleth map at the county level as quintiles.

Counties do not operate in isolation, however, and so there may be an added effect when there are multiple counties in a region that have lower levels of accessible veterinary care. **Figure 2** shows the results of the state average VCAS symbolized by quintiles.

Similarly, the proportion of counties that fall within the lowest quantile of the VACS can also given insight in to the challenges confronted at the state level. **Figure 3** displays the proportion of counties in each state that fall at the lowest quartile of the national VCAS.

Lastly, the raw number of households located within each state that have among the lowest quartile of access to veterinary care at the county level is a final way to view the results. Some counties with low access may also have a small population while others may have very high populations. This way of viewing the data can help to quantify the relative order of magnitude of need in any given state relative to other states. **Figure 4** summarizes the count of households that are located in counties within the lowest quartile of the VCAS aggregated by state.

DISCUSSION

There are noticeable regions that have low access to veterinary care as visible on the previous figures. These areas may be optimal opportunities to expand access to care services. The results can also help bring attention to a few different aspects of the challenges surround access to veterinary care. For example, considering the confluence of the factors used to assign scores is indicative of the complexity of the access to chare challenge. It also can be used to show the magnitude of the problem. For example, the results have identified that there are just over 21 million households residing within counties ranked in the lowest (least accessible) quantile, representing an estimated 25.2 million companion animals. As such, the VCAS represents an important snapshot into the challenges of access to veterinary care across the contiguous US. It highlights places of opportunities for programs aimed at increasing access for underserved populations. It also provides a tool for policymakers as they consider how policies could be used to encourage better access to veterinary care.

While the VCAS could be used in a variety of contexts, it lends itself to four potential use cases by different stakeholders in the access to veterinary care arena: (1) Animal welfare funding agencies could use the VCAS to help focus efforts and resources in areas the greatest potential for impact; (2) Service providers (for-profit and nonprofit) could use the VCAS to identify potential markets for new or expanded services; (3) Policymakers could use the VCAS to gain insight into the accessibility of veterinary care in their communities, and address deficiencies through

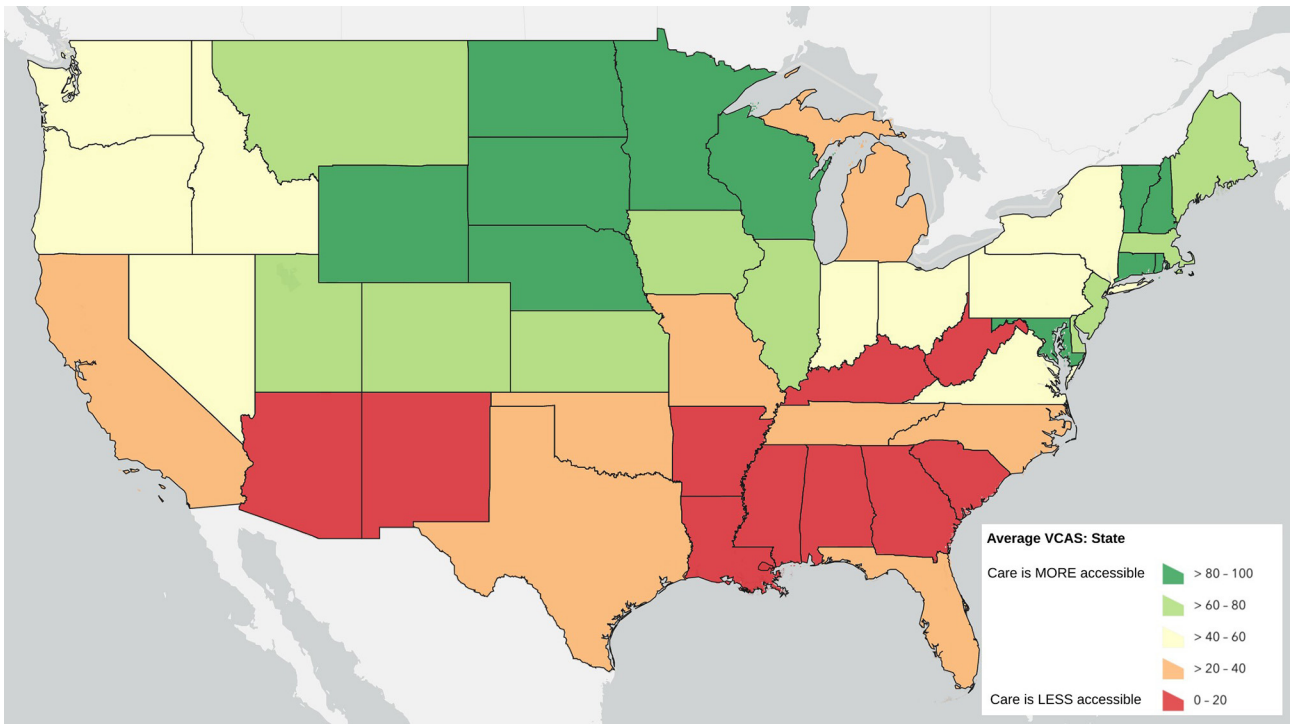

FIGURE 2 | State Average Veterinary Care Accessibility Score by quintile.

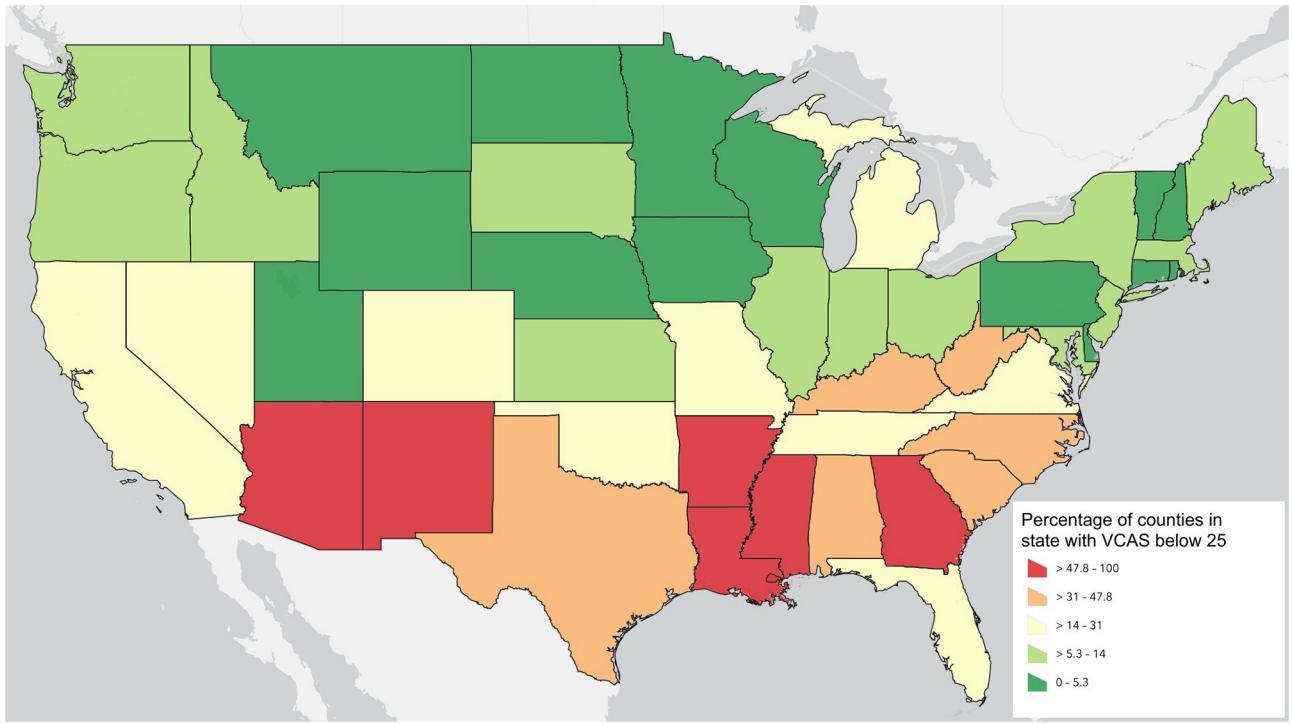

FIGURE 3 | Proportion of counties falling in the lowest quartile of the national VACS by symbolized by quintiles.

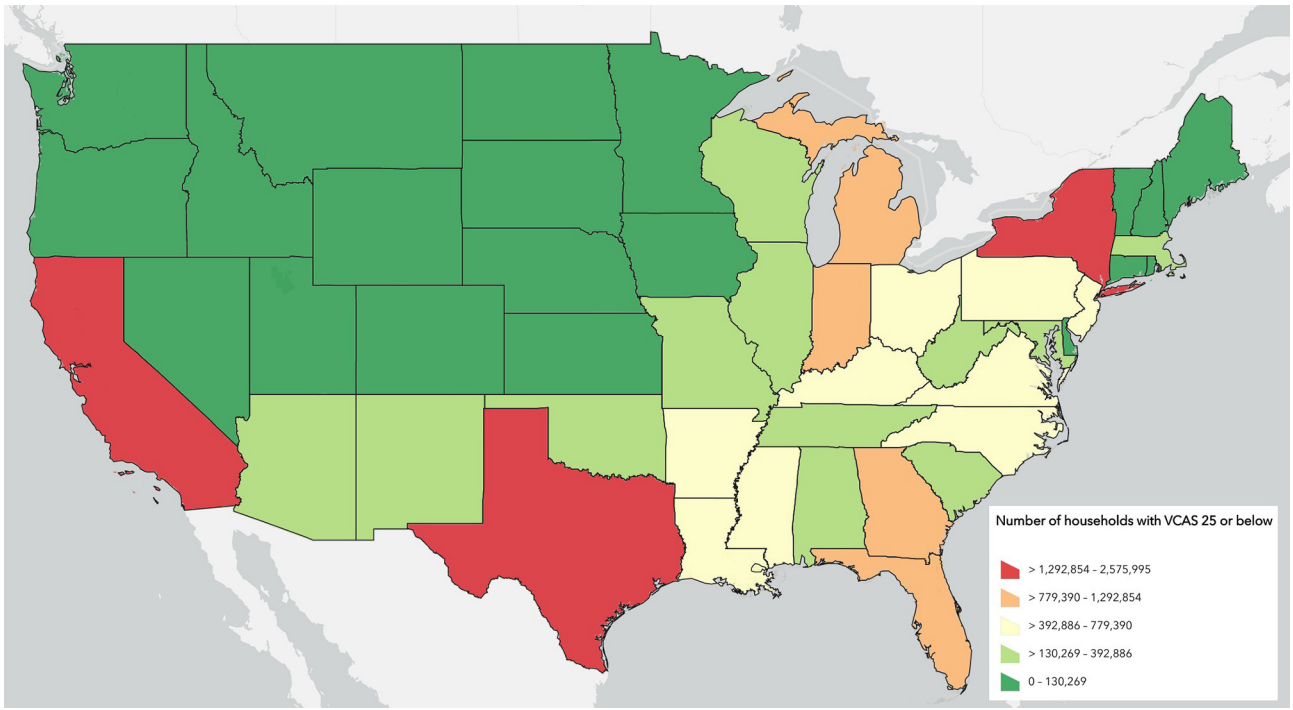

FIGURE 4 | Count of Households in each state that fall within counties in the lowest quartile of the Veterinary Care Accessibility Score.

policy changes and other programs; (4) Researchers could use the VCAS to inform further explorations into the topic of veterinary access to care as well as intersections with human healthcare and other "one health" topics. The rankings could also be helpful for animal shelters who are interested in understanding the needs of their communities as it relates to access to care service. Further, shelters may be able to use deficiencies in access to veterinary care in their communities to seek support for programs that increase access as part of initiatives to keep animals in their homes and avoid shelter surrender.

Many questions remain about what an optimal distribution of veterinary clinics would be. This is confounded by the fact that simply having physical access to a clinic does not actuate true access due to the other variables discussed in the index formulation. Different communities would likely need different solutions. The problem of access to care is enormous and the solutions will thus need to take different forms dependent on available resources and the socioeconomic conditions in the individual communities. The VCAS represents a starting point in conceptualizing potential solutions based on the unique traits of individual communities.

There are some distinct limitations to this study. Any choice of a political geographic unit does present a modifiable areal unit problem because the shape and size of the unit of analysis can impact the results of the spatial analysis (32). An ecological fallacy can be also be a concern, particularly when considering access to care in aggregate. For example, one cannot assume that everyone in a county has high access to care, despite the county as a whole having high access. Some counties may have very significant levels of income disparity and clinics are not distributed evenly across the landscape in a county. Pockets of very low access may thus nest within even high access communities and vice versa. So what is true for the county is not necessarily true for every individual household in that county. This research treated all clinics as having equal contribution to the capacity for care in the area of analysis. This is an additional limitation as different types of clinics (specialty, emergency and general care) contribute differently to the access to veterinary care in a community as do hours of operation. State policies regarding the scope of practice of veterinary technicians may also influence how much service is provided per unit of employees. Lastly, mobile clinics may provide service to a broader geographic area.

The likelihood of sharing the home with a companion animal (and the number of animals per home) is not stable over space and can vary by the rural/urban character of a region, family size, income and other factors (29, 33). Thus, the actual number of companion animals in any given county could likely deviate from the estimates used in the index. The explanatory impact of these trends on the density of clinics could be explored in future research.

Lastly, this research presents one picture in time. The socioeconomics, pet populations as well as the locations of clinics and numbers of employees will shift over time necessitating an update of the analysis. Routine updating of the map will be important to maintain its usefulness

There are many opportunities to advance understanding of the geographic distribution of access to care through future research. Advances in understanding the distribution of pets across the landscape would be one important example. Additional understanding of the barriers to access to care could

also improve the index particularly as it relates to differing levels of care (preventative, sick, emergency etc) or income and education levels of pet guardians. Examining the geography at other units of analysis, such as census tract, would refine understanding of the distribution and the functional impact of spatial disparities. Understanding the optimal number of employee to pet ratio would not only allow the index to be conceptualized more absolutely, and less relative, it would also provide important parameter specification for other geographic approaches to evaluation access to care, particularly at finer scales. Further research into the distribution of different types of clinics, such as emergency care, would also add to the understanding of this complex issue.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: data from AVMA and ESRI are owned by those entities and so cannot be shared. Requests to access these datasets should be directed to sue@accesstovetcare.org.

AUTHOR CONTRIBUTIONS

SN: project conceptualization, data extraction and analysis, and manuscript writing. MG: project conceptualization, edited manuscript, and created the figures. Both authors contributed to the article and approved the submitted version.

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Opportunities for Expanding Access to Veterinary Care: Lessons From COVID-19

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The COVID-19 pandemic impacted people and professions around the world, including veterinary medicine. The epidemiology of SARS-CoV-2 broadened the definition of vulnerability in human populations, and the virus' economic impacts exacerbated well-established financial barriers to providing equal access to medical care. The objective of this study was to explore how the pandemic was impacting access to companion animal care in the months March-September of 2020, with a focus on traditionally vulnerable as well as newly vulnerable populations. Additionally, this study sought to identify areas on which the veterinary profession can focus in order to help increase access to veterinary care, including the veterinary school curriculum, continuing education, and telemedicine. We conducted surveys and interviews with animal owners (n = 1009), veterinarians and clinic staff (n = 516), and access to veterinary care organizations (n = 17). Collectively, these responses highlighted how the COVID-19 pandemic created new, and amplified existing, issues with accessing and providing veterinary care. Three critical themes arose; (1) opportunities for further learning for the veterinary profession; including curricula around telemedicine, financially resilient business models and understanding health disparities and vulnerable populations; (2) a need for a network of collaboration and communication across veterinary clinics and access to care organizations and (3) future preparedness for health, economic or other crises response. Overall, the pandemic emphasized the complexity of access to care, as well as the role of veterinarians in public health. This information can be used to develop strategies to aid in increased access to veterinary care now and in the face of future disasters.

Keywords: access to veterinary care, pandemic (COVID19), vulnerable population, telemedicine, veterinary

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INTRODUCTION

When attempting to access veterinary care, some pet owners experience barriers which prohibit them from supporting the health of their pet. The most common barriers include cost, accessibility of care (including location and transport), veterinarian-client communication, culture or language, and lack of client education (1, 2). The inability of pet owners to receive veterinary care for their animals can have a direct negative impact on animal welfare (3). Lack of veterinary care also presents a public health threat, as poor animal health can directly affect

human health by increasing the risk of zoonotic and vector-borne diseases (4, 5). Finally, pet ownership has a significant and positive impact on mental health, and threats to the health of pets can impact pet owners negatively (5, 6). The barriers to accessible veterinary care and the complexity of their impact and origin have been well-described by Lem et al. through a framework that shows the interrelated nature of human, animal, environmental and socioeconomic factors (2). Work has also been done to begin the process of associating the social determinants of human health to social determinants of animal health (5). Despite this established framework and other work in the field, barriers persist and there is a continued need for further empirical research on how to provide accessible veterinary health care (1).

As with all health and economic disparities, certain populations of vulnerable people experience the burden of these barriers to veterinary care more than others. Vulnerable human populations have traditionally been considered as groups and communities that experience barriers to economic, political, social, and environmental resources, leaving them at higher risk for health issues (7). These same barriers to resources may place their pets at higher risk for health inequalities as well (5). The lack of resources that these populations experience results in decreased resilience and increased adversity in the face of extreme events (8). Vulnerable populations suffer greater consequences during economic downturns as well as health crises (9, 10). Abandonment of pets is common when owners are faced with socio-economic challenges, (11) eviction and disaster situations (12). Additionally, economic recessions have been shown to have direct implications for companion animals (13, 14). These findings suggest that companion animals in vulnerable populations are at higher risk of negative outcomes during disaster situations and extreme events.

On March 11, 2020, the World Health Organization declared Coronavirus disease 19 (COVID-19) caused by the virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) a global pandemic (15). During its course, this health and economic crisis has exacerbated the underlying health, economic, and social disparities that vulnerable populations already faced. Widespread reporting showed early on that ethnic minorities, Native Americans, and low-income communities have been disproportionately affected by the virus compared to the United States' population at large (16, 17). COVID-19 has also triggered the emergence of groups of "newly" vulnerable people who were not considered so at the onset of the pandemic. These newly vulnerable groups are now struggling in their abilities to shoulder the financial and physical burdens brought about by this crisis, thus reshaping how vulnerability is being defined (18). Some of the individuals who are now defined by their "newly" vulnerable status are people who are considered high risk for severe COVID-19 illness, including adults over 65 and people with certain pre-existing health conditions (19). These as well as individuals who lack health insurance and/or employment, may or may not have been deterred by the common hurdles to accessing veterinary care prior to the pandemic. However, in the face of COVID-19, these newly vulnerable groups may now additionally face the unique barriers of the personal health risk and financial hardships of going into a veterinary clinic. We hypothesized that the pandemic caused additional, and some unexpected, stressors for those in need of, and providing, veterinary care. The objective of this study was to explore how the pandemic has impacted access to companion animal care in the United States of America, with a focus on traditionally vulnerable as well as newly vulnerable populations. We assessed this through inquiries with three stakeholders, pet owners, veterinarians and clinic staff and access to care organizations. Additionally, this study aimed to identify areas on which the veterinary profession can focus in order to help increase access to veterinary care, including the veterinary school curriculum, continuing education, and telemedicine. This information can be used to inform strategies to aid in the increased access to veterinary care.

MATERIALS AND METHODS

To better understand the impact of the pandemic on pet owners, including vulnerable populations, a series of surveys and key informant interviews were conducted. All surveys and interview scripts were reviewed by Colorado State University's Institutional Review Board and determined to be exempt, meaning that the studies posed no more than minimal risk to human participants and fell into a category of exempt research. All studies began with obtaining either written or verbal consent, and all research data collected was published anonymously. Descriptive and comparative statistics were conducted using commercially available software. As most survey questions did not require a response, individual unanswered questions were excluded from analysis.

Pet Owners

An anonymous online survey (**Supplementary Material 1**) was developed using Qualtrics software and disseminated through Amazon's Mechanical Turk (MTurk). MTurk is an online platform designed for people ("workers") to sign up to complete virtual tasks for compensation. Participants were compensated one dollar for completion of the survey. Inclusion criteria were that the respondents were 18 years or older, the primary caretaker of a dog and/or cat that needed veterinary care during the pandemic, and that in the past 3 years prior to the COVID-19 pandemic, they had taken this dog and/or cat to the veterinarian. Income groups were divided based on methods used in the 2018 Access to Veterinary Care report published by the University of Tennessee (20) which used guidelines that determine eligibility for certain federal aid programs. Household income categories included those below 138% of federal poverty level (criteria for Medicaid and the Supplemental Nutritional Assistance Program qualification), those between 138 and 250% of federal poverty level (criteria for Cost Sharing Reduction Subsidies qualification), and those above 250% of federal poverty level. The 2020 federal poverty level guidelines were used, and incomes were rounded to the nearest $500 for simplicity. The definition for people at high risk for severe COVID-19 illness was taken from the Center for Disease Control and Prevention (CDC) website on June 4, 2020 (19).

The survey had 22 questions spanning 4 broad categories: demographics, impact of the pandemic on the ability to care for pets, owners' perceptions, and telemedicine. Responses were required for consent and inclusion criteria only. Certain data was analyzed by categorizing vulnerable vs. non-vulnerable pet owners and looking at differences in answers. People were considered vulnerable if they met ANY of the following criteria: self-identified as high risk for severe COVID-19 illness based on CDC definition as of June 4, 2020, household income fell below 250% of the federal poverty level, race/ethnicity was reported as either Black/African American, Hispanic/Latino, or Native American (21), employment was lost during the pandemic, respondent did not have health insurance, or only had it during part of the study period, and respondents who reported that inability to use public transportation or inability to access a car made it more challenging to go to the veterinarian during the pandemic. The survey was dispersed on MTurk in 3 batches, on July 10, 2020, July 16, 2020, and July 17, 2020. If multiple responses were recorded by a single MTurk user, only the first response was included in analysis. When questions allowed for an "other" answer option to be written in, answers were recategorized into existing options or reported separately if 10% or greater of write-ins reported a similar answer.

Veterinarians

An anonymous online survey (**Supplementary Material 2**) was developed for small animal veterinarians, technicians, and office managers and shared through opportunistic dissemination of the survey link through veterinary associations (ex. Veterinary Medical Associations, specialty colleges and social media groups targeting animal health professionals). The survey consisted of 25 questions divided into 4 categories: demographics, access to veterinary care for traditionally vulnerable populations, access to veterinary care for clients at high risk for COVID-19, and telemedicine. Participation in the survey was incentivized by offering the opportunity to win one of ten $50 gift cards available to the first 200 respondents. The survey was accessible from June 24-September 24, 2020. When questions allowed for an "other" answer option to be written in, answers were recategorized into existing options or reported separately if more than 10% of write-ins reported a similar answer. Fully open-ended questions were analyzed for similar answers/themes, and if 10% or greater of the answers fell into a similar theme, the answer was reported. Survey participants were provided with the following definition for "traditionally" vulnerable populations, "Vulnerable human populations have traditionally been considered as groups and communities that experience barriers to economic, political, social, and environmental resources, leaving them at higher risk for health issues for themselves and their pets. These include, but are not limited to, people experiencing homelessness, the elderly, and low-income communities." Additionally the survey outlined the definition for "newly" vulnerable populations; "The CDC defined higher risk populations for severe illness from COVID-19 as people 65 years and older, people who live in a nursing home or long-term care facility, people with chronic lung disease or moderate to severe asthma, people with serious heart conditions, people who are immunocompromised, severely obese people, people with diabetes, people with chronic kidney disease undergoing dialysis, and people with liver disease" (**Supplementary Material 2**).

Access to Care Organizations

A series of key informant interviews were used to explore the challenges the organizations and the vulnerable communities they serve were facing and provided an opportunity to potentially capture responses not available through the use of online survey tools (see limitations). Professionals involved with organizations that focus on providing access to veterinary care (i.e., Spay/neuter, preventive, or emergency services) or animal-assisted therapy to vulnerable populations and communities were contacted. Contacts were made through a network of professional connections or by reaching out through contacts listed on websites, with emphasis on a variety of types of vulnerable populations being represented. Twenty-six organizations were contacted, and 17 professionals, representing 20 groups, were ultimately interviewed about the impact of the COVID-19 pandemic on their ability to provide companion animal care to the communities they support. Several professionals were a part of more than one organization and therefore the number of organizations represented (20) was larger than the number of interviewees. Two organizations were represented by two different interviewees. The interview questions were divided into four broad categories: barriers to care and pandemic services; resources and support; challenges experienced and concerns; and successes and opportunities for future. The first question of the interview was meant for introduction and context; therefore, responses were not included in the analysis. There were 18 open-ended questions overall (**Supplementary Material 3**). Interviews were conducted by a single author over video or telephone calls typically lasting from 30 min to 1 h. Interviews were conducted from July 24 to September 27, 2020. Answers to the interview questions were transcribed by the interviewing author. Two authors then independently analyzed the responses for common, broad topics and met to reach consensus on emergent themes.

RESULTS

Pet Owner Survey

Demographics

After eliminating repeat responses and those that were <25% completed, a total of 1,009 responses were included in the final analysis. Respondents were asked to identify the state they live in, and then the regional definitions put forward by the U.S. Census Bureau were used to group respondents into four regions: Northeast, South, Midwest, and West. The South had the most respondents with 40% (406/1009), followed by the West (22%, 221/1009), the Midwest (19%, 192/1009), and the Northeast (19%, 190/1009). The majority of respondents were White (78%, 785/1009), followed by Black or African American (8%, 83/1009), Asian or Pacific Islander (7%, 70/1009), Hispanic or Latino (4%, 44/1009), and Native American or Alaska Native (1%, 9/1009). Additionally, 1% (12/1009) of respondents listed their ethnicity as "other" and 1% (6/1009) preferred not to say. When asked, 71% (717/1009) of respondents were not at high risk for severe

COVID-19 illness, 27% (274/1009) were at high risk, and 2% (18/1009) preferred not to say.

Based on the number of respondents reported to be living in their household, they were asked about their household income. The majority of the respondents (58%, 581/1,007) reported being at the highest income level listed (above 250% of the federal poverty level), 30% (300/1,007) were in the middle-income level listed (between 138 and 250% of the federal poverty level) and 13% (126/1,007) were in the lowest income level listed (below 138% of the federal poverty level). The majority of respondents (86%, 865/1,008) had not lost their employment at the time the survey was distributed, while 12% (125/1008) reported being unemployed and 2% (18/1,008) preferred not to say. Most (79%, 792/1,009) respondents had health insurance during the entire study period, 5% (48/1,009) had health insurance for part of the study period, 15% (147/1,009) did not have health insurance during the study period and 2% (22/1009) preferred not to say. In the remaining analysis we additionally assessed responses in vulnerable vs. non-vulnerable respondents. People were considered vulnerable if they met any of the following criteria: self-identified as high risk for severe COVID-19 illness based on CDC definition as of June 4, 2020, household income fell below 250% of the federal poverty level, race/ethnicity was reported as either Black/African American, Hispanic/Latino, or Native American, employment was lost during the pandemic, respondent did not have health insurance, or only had it during part of the study period and respondents who reported that inability to use public transportation or inability to access a car made it more challenging to go to the veterinarian during the pandemic, under this definition, 71% (716/1,009) of respondents were categorized as vulnerable.

Impact of the Pandemic on Owners' Ability to Care for Their Pets

Most pet owners (72%, 717/1,003) indicated that their pet needed routine wellness care during the study period, while 38% (376/1,003) reported that their pets needed sick/emergency care, and 9% (91/1,003) reported the need for elective surgery. Of those who wrote in an answer (3%, 31/1,003), 26% (8/31) said their animal needed to be humanely euthanized and 23% (7/31) said they needed a medication consult or refill. When their pet needed veterinary care during the pandemic, 87%, (869/1,004) of respondents indicated that their pet received care from a veterinarian, while 13% (126/1,004) indicated that their pet did not receive care and 1% (9/1,004) preferred not to say. There was no statistically significant difference (Chi square test; $p > 0.05$) in the frequency of pets of non-vulnerable pet owners receiving veterinary care vs. the pets of vulnerable pet owners.

The top three reasons for which owners did not seek veterinary care when their pet needed it were that their veterinarian was only offering emergency services, they feared getting coronavirus from staff members, and financial cost barriers (**Figure 1**). **Table 1** presents the breakdown of the frequency of these reasons in non-vulnerable pet owners compared to vulnerable pet owners. While the top three reasons are in the same order between the two groups, a greater percent of vulnerable pet owners (41%, 33/80) selected financial cost compared to the 13% (5/38) of non-vulnerable pet owners, a difference that was statistically significant (Chi-square test; $p = 0.0045$). A veterinary clinic only offering emergency services was ranked consistently as the number one reason to not pursue veterinary care for both groups, however, a greater percent of non-vulnerable pet owners (74%, 28/38) selected this option compared to the 56% (45/80) of vulnerable pet owners, though this value was not statistically significant (Chi-square test; $p > 0.05$). Additionally, 26% (21/80) of vulnerable pet owners indicated that an inability to get to the veterinary clinic prevented them from pursuing veterinary care, compared to 2% (1/38) of non-vulnerable pet owners, a difference that was statistically significant (Chi-square test; $p = 0.0047$).

The majority of respondents either agreed or strongly agreed that concerns about their personal health risk (64%, 635/1,000) and the health risk to others (61%, 611/1,001) made it more challenging for them to take their pet to the veterinarian during the pandemic (**Figure 2**). A minority of respondents agreed or strongly agreed that the inability to utilize public transport, the lack of access to a car, and concerns about how others would perceive them if they left their home during restrictions made it more challenging to take their pet to the veterinarian during the pandemic. Concerns about the financial cost of veterinary care was more evenly split, with 47% (465/1,003) indicating disagreement or strong disagreement and 43% (434/1,003) indicating agreement or strong agreement.

Only 12% (121/1,003) of respondents considered surrendering their pet during the study period while 87% (877/1,003) did not and 1% (5/1,003) preferred not to say. Of the 12% of owners who considered it, 42% (51/121) did end up surrendering their pets. Of the owners who considered it, the most frequently reported reason was the cost of caring for the pet, followed by concerns/confusion over COVID-19 transmission possibilities, and inability to obtain veterinary care for the pet (**Figure 3**). Vulnerable pet owners were significantly more likely to consider surrendering their pets than non-vulnerable pet owners (Chi-square test; $p < 0.0001$).

Owner Perceptions

Respondents were asked their level of agreement with a series of statements about their pet during the study period. An overwhelming majority of owners either agreed (37%, 366/1,001) or strongly agreed (57%, 568/1,001) that their pet cheered them up during the pandemic, while fewer disagreed (1%, 14/1,001), strongly disagreed (1%, 5/1,001), or felt neutral (5%, 48/1,001). The majority also agreed (40%, 401/1,000) or strongly agreed (42%, 418/1,000) that their pet gave them purpose during the pandemic, while fewer disagreed (4%, 38/1,000), strongly disagreed (1%, 8/1,000), or felt neutral (14%, 135/1,000). Lastly, the majority of respondents agreed (41%, 406/1,002) or strongly agreed (42%, 425/1,002) that their pet kept them active during the pandemic, while fewer disagreed (6%, 57/1002), strongly disagreed (1%, 14/1,002), or felt neutral (10%, 100/1002).

When asked their level of agreement with statements about disease transmission, the majority of respondents either agreed (30%, 301/1,001) or strongly agreed (52%, 516/,1001) that they never worried about getting coronavirus from

TABLE 1 | Ranking of reasons why non-vulnerable and vulnerable respondents did not pursue veterinary care during the pandemic.

	Not vulnerable (n = 38)	Vulnerable (n = 80)
1	My veterinary clinic was only offering emergency services (74%)	My veterinary clinic was only offering emergency services (56%)
2	Fear of getting coronavirus from staff members at the veterinary clinic (47%)	Fear of getting coronavirus from staff members at the veterinary clinic (43%)
3	Financial Cost (13%)	Financial Cost (41%)
4	Too busy, not enough time (11%)	Inability to get to the veterinary clinic (26%)
5	Inability to get to the veterinary clinic (3%)	Too busy, not enough time (5%)
6	Myself or a family member became ill, and I couldn't bring my pet to the veterinarian (0%)	Myself or a family member became ill, and I couldn't bring my pet to the veterinarian (3%)

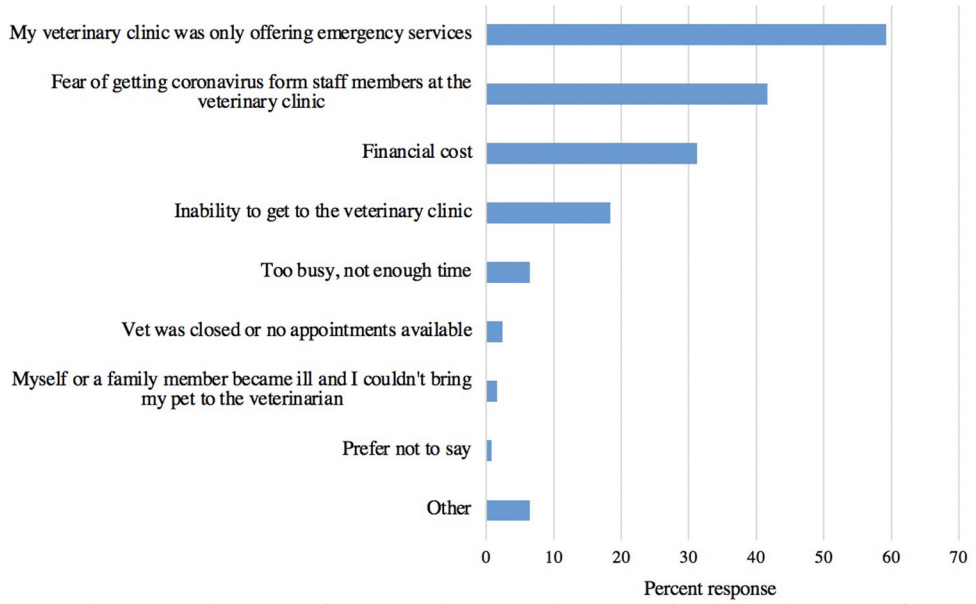

FIGURE 1 | The frequency of reasons responding pet owners selected for why they did not seek veterinary care during the pandemic when their pet needed it (n = 125).

their pet, while fewer disagreed (7%, 72/1,001), strongly disagreed (2%, 21/1,001) or felt neutral (9%, 91/1,001). The majority also agreed (41%, 414/1,001) or strongly agreed (47%, 474/1,001) that they trust their veterinarian to give them information on zoonotic diseases, while fewer disagreed (2%, 19/1,001), strongly disagreed (1%, 9/1,001) or felt neutral (8%, 85/1,001). Lastly, the majority of respondents either agreed (38%, 385/1,002) or strongly agreed (20%, 204/1,002) that they were comfortable with the idea of going to the vet during the pandemic, while fewer disagreed (18%, 177/1,002), strongly disagreed (4%, 42/1,002), or felt neutral (19%, 194/1,002).

Telemedicine

When asked if they had ever utilized telemedicine platforms for their veterinary care, most respondents (73%, 736/1,002) said they never had, 7% (67/1,002) said they had used telemedicine prior to the pandemic, 14% (143/1002) said they used it exclusively during the pandemic, and 4% (36/1,002) said they used it both before and during the pandemic. Only ∼1% (13/1,002) of respondents said they were not sure and ∼1% (7/1,002) preferred not to say. Vulnerable pet owners were statistically more likely to have used telemedicine compared to non-vulnerable pet owners (Chi-square test; $p < 0.0001$).

Owners who reported having used telemedicine during the study period were asked to select all reasons for which they did so. The most frequently indicated reasons were that their veterinarian recommended it (58%, 104/178), that telemedicine was easier than going into the veterinary clinic (55%, 98/178), and that respondents were worried about their risk of getting coronavirus by going to the veterinary clinic (47%, 83/178). Less commonly selected answers included that telemedicine was the only option because the veterinarian was only open for emergencies (29%, 52/178), and that they had used telemedicine prior to the pandemic (10%, 17/178). A majority (84%, 124/147) of respondents who used telemedicine during the pandemic said that they would have physically brought their pet to the veterinarian to receive care during the pandemic if telemedicine had not been an option, 15% (22/147) said that they would

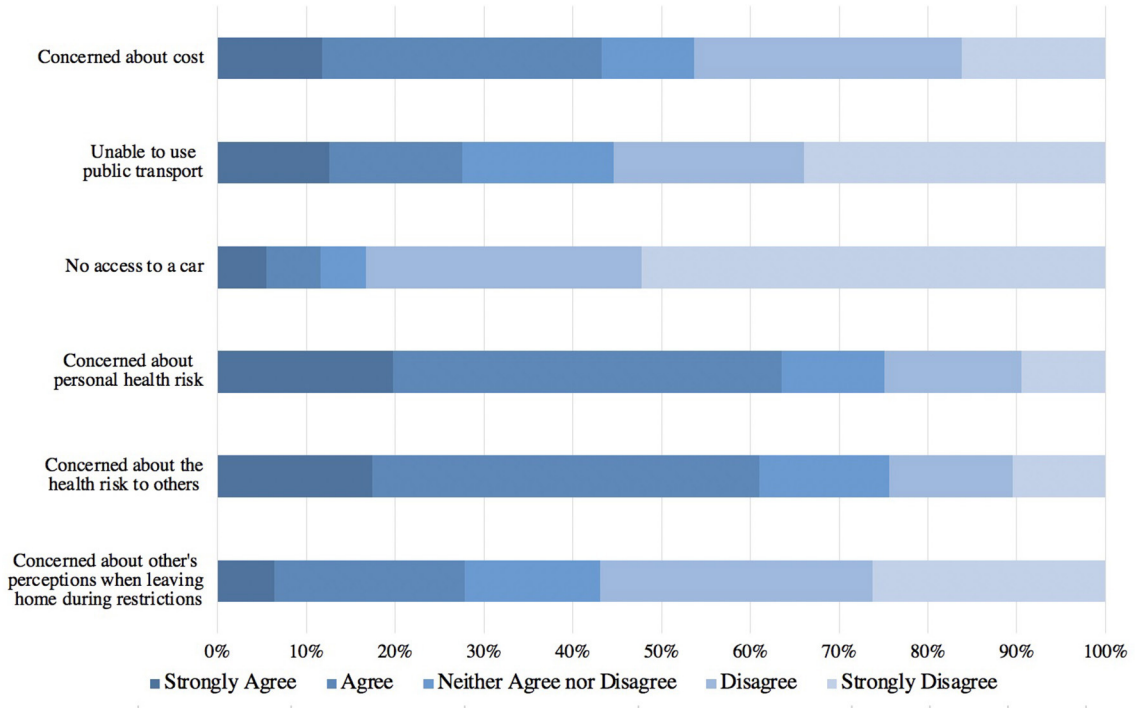

FIGURE 2 | The frequency of reasons responding pet owners gave when asked about what factors made it challenging for the surveyed pet owners to take their pet to the veterinarian during the pandemic (n = 998–1,003).

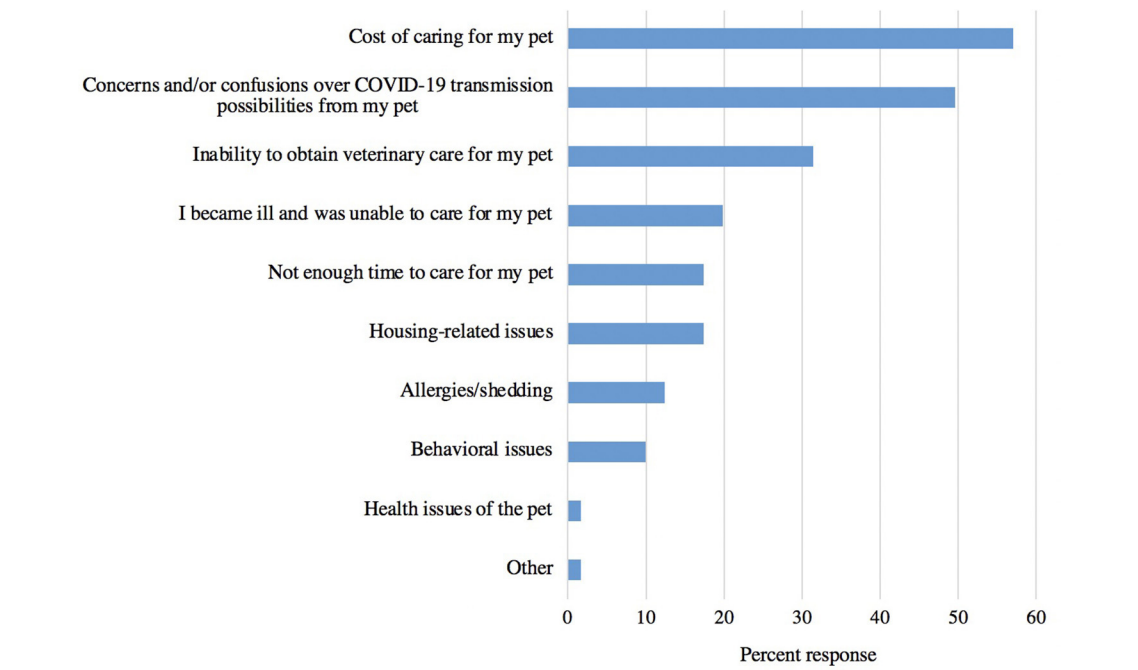

FIGURE 3 | The frequency of reasons responding pet owners considered surrendering their pet during the pandemic (n = 121).

not have, and 1% (1/147) preferred not to say. The majority of respondents either agreed (65%, 159/244) or strongly agreed (24%, 58/244) that they were satisfied with the care their pet received remotely through telemedicine. Fewer respondents disagreed (2%, 5/244), strongly disagreed (1%, 2/244), or felt neutral about the statement (8%, 20/244). In addition, the

majority of respondents either agreed (50%, 122/244) or strongly agreed (30%, 72/244) that they would be interested in using telemedicine in the future, while fewer indicated that they disagreed (6%, 15/244), strongly disagreed (1%, 2/244) or felt neutral about the statement (14%, 33/244).

Respondents reporting that they had never used telemedicine to receive veterinary care were asked to select all reasons for which they did not utilize it. The most commonly indicated reason was their veterinarian not offering it or making them aware of it (67%, 492/733). Second to this, owners said that the care their pet needed could not be done with telemedicine (44%, 324/733). Concerns about quality of care versus an in-person appointment was the third most frequently selected reason (27%, 201/733). Far fewer respondents indicated that they did not have the technology to access it (2%, 16/733) or that the technology seemed too difficult to use (2%, 11/733). Of the 1% (7/733) of respondents who wrote in an answer, 71% (5/7) of them said that they didn't use telemedicine because it was unnecessary, as their vet was doing all services in person. Finally, 67% (389/579) of respondents who had never used telemedicine before indicated that they would be interested in using telemedicine in the future, while 33% (190/579) said that they would not be interested.

Veterinary Clinic Survey

Demographics

A total of 516 veterinary clinic staff participated in the survey. The majority (63%, 327/516) of respondents were veterinarians (42%, 218/516 associate veterinarians, 16%, 85/516 owning veterinarians, and 5%, 24/516 classified as other). Veterinary technicians made up 24% (124/516) of respondents. The remainder worked in reception or client services (2%, 12/516), were office managers (3%, 18/516), or classified as "other" (7%, 35/516). Respondents primarily worked at privately owned (53%, 271/513) or corporate owned (35%, 179/513) practices, followed by academia/teaching hospitals (4%, 21/513), publicly owned clinics (3%, 15/513), non-profits (2%, 11/513), and shelters/rescues (1%, 4/513). The ownership status of their clinic was classified as "other" by 2% (12/513) of respondents.

Additional demographics included age; 32% (165/516) of respondents were 30–39 years old, 23% (119/516) were 40–49 years old, 20% (101/516) were less than 30 years old, 17% (85/516) were 50–59 years old, 7% (37/516) were 60–69 years old, and 2% (9/516) were greater than 70 years old. The majority of respondents identified as female (85%, 439/516), followed by male (13%, 68/516) and prefer not to say (2%, 9/516). Respondents were asked to identify the state they live in, and then the regional definitions put forward by the U.S. Census Bureau were used to group respondents into four regions: Northeast, South, Midwest, and West. The West had the most respondents (32%, 160/492), followed by the South (28%, 138/492), the Northeast (23%, 112/492), and the Midwest (17%, 82/492). The length of time respondents worked in veterinary medicine varied from >20 years (30%, 146/484), 5–10 years (25%, 120/484), <5 years (19%, 94/484), 11–15 years (16%, 76/484) and 16–20 years (10%, 48/484). Most respondents practiced in suburban areas (54%, 275/513), followed by urban areas (27%, 139/513), and rural areas (18%, 91/513), while 1% (4/513) of respondents practiced in areas they defined as a mix of the answer options, and 1% (4/513) listed "other." The vast majority of respondents practiced small animal predominant medicine (93%, 476/513). Less frequently selected were large animal predominant (3%, 14/513), unspecified academia practice (2%, 10/513), exotics or zoo (1%, 7/513), and other (1%, 6/513).

Impact of the Pandemic on Providing Care to Traditionally Vulnerable Populations

The frequency in which practices received various requests related to vulnerable populations is presented in **Figure 4**. Requests for reduced cost services increased the most (41%, 204/499), while the other requests increased by less than 20%. **Figure 5** shows the responses when asked about their practice's ability to respond to these requests. Of those that indicated their practice received an increase in the request for low-cost services, the majority responded that they were able to accommodate requests to support shelters and rescues (**Figure 5**), while at the same time the majority of respondents were unable to accommodate requests for reduced cost services that did not originate from shelters and rescues and they were unable to host mobile clinics. When asked if there was anything else respondents would like to share about requests received during the pandemic, 21% (20/97) of those who answered expressed that they did not receive any of the pandemic-related requests presented in the questionnaire.

Respondents were asked to select any resources that would best help them to increase their role in supporting vulnerable populations. The most frequently selected option was resources on how to create a sustainable system for their practice to support clients in financial need (53%, 258/490). This was followed by resources on how their veterinary practice can play an active role in companion animal care for vulnerable populations (33%, 164/490), resources on a veterinarian's role in public health for vulnerable populations (32%, 158/490), instruction in vet school on companion animal care for vulnerable populations (32%, 158/490), and resources on how to approach and interact with vulnerable populations (29%, 144/490). Other notable answers that were written in include resources on how to encourage a clinic-culture of non-judgement and decreased resentment, information on organizations who are looking for veterinarians to help vulnerable populations, and resources to improve community partnerships for care that cannot be provided by the practice.

Impact of the Pandemic on Providing Care to Newly Vulnerable Clients

Respondents were asked about changes they made in their practice in order to better support clients during the pandemic (**Figure 6**). Veterinary practices most frequently implemented modified drop off and pick up procedures, use of personal protective equipment (PPE), and sanitization of rooms and surfaces after every use. Most respondents for each option indicated that the practice was put in place for all clients rather than just for high-risk clients. The use of telemedicine had the highest number of respondents to indicate that it was only instituted for high-risk clients. The majority of respondents

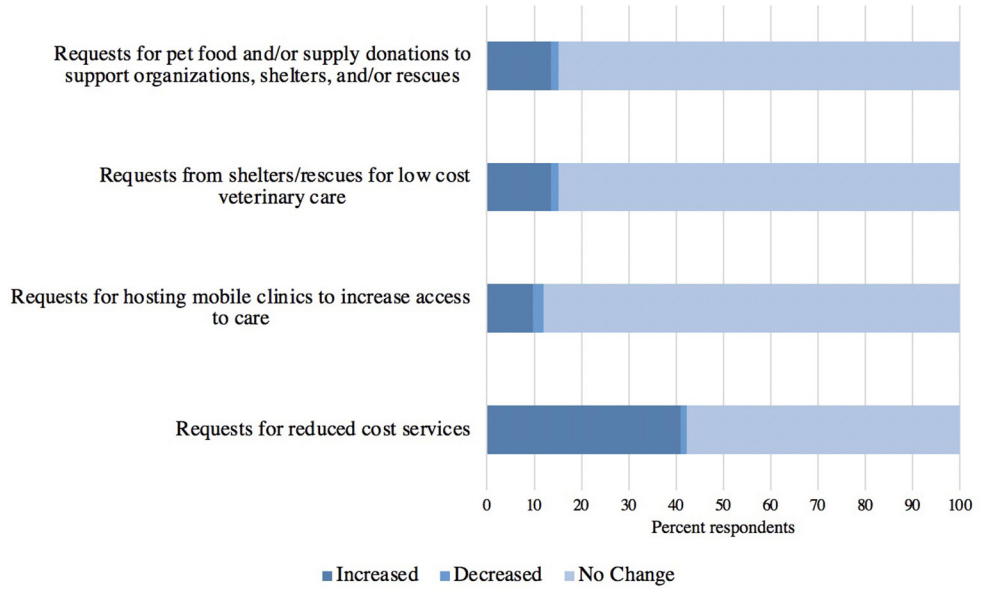

FIGURE 4 | The frequency in which responding veterinary practices received various requests from pet owners and outside organizations related to vulnerable populations during the pandemic (n = 481–499).

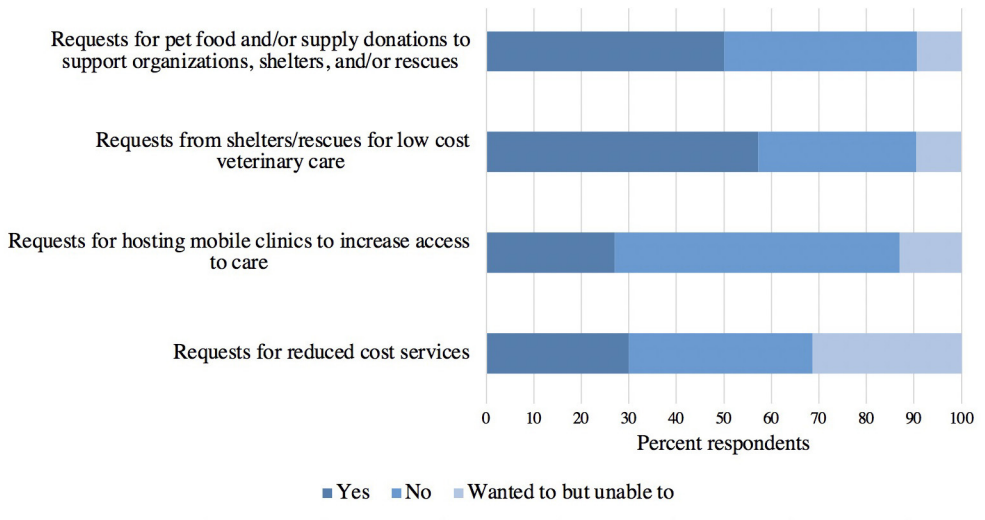

FIGURE 5 | Ability of responding veterinary clinics to accommodate received requests from pet owners and outside organizations for various low-cost services or products (n = 427–435).

(56%, 266/471) indicated that their practice plans to continue to implement the practices they had put in place during the pandemic (**Figure 7**).

When asked their level of agreement with statements regarding the pandemic's influence on their role as a veterinarian (**Figure 8**) the largest percent of respondents agreed or strongly agreed that the COVID-19 pandemic has changed their perceived role in public health. The majority of respondents agreed or strongly agreed with all other statements regarding vulnerability except that the COVID-19 pandemic has changed the way that they view companion animal care for vulnerable populations. Respondents were asked about any other perceptions that changed as a result of the pandemic, and of those who answered, the most common answer respondents remarked on was the extent that they believe the profession is undervalued or overlooked (10%, 7/72). Respondents were also asked to share anything else regarding access to care for vulnerable populations or high-risk clients, and the most common answer was the potential of telemedicine to increase access to care, which was discussed by 11% (4/37) of those who answered.

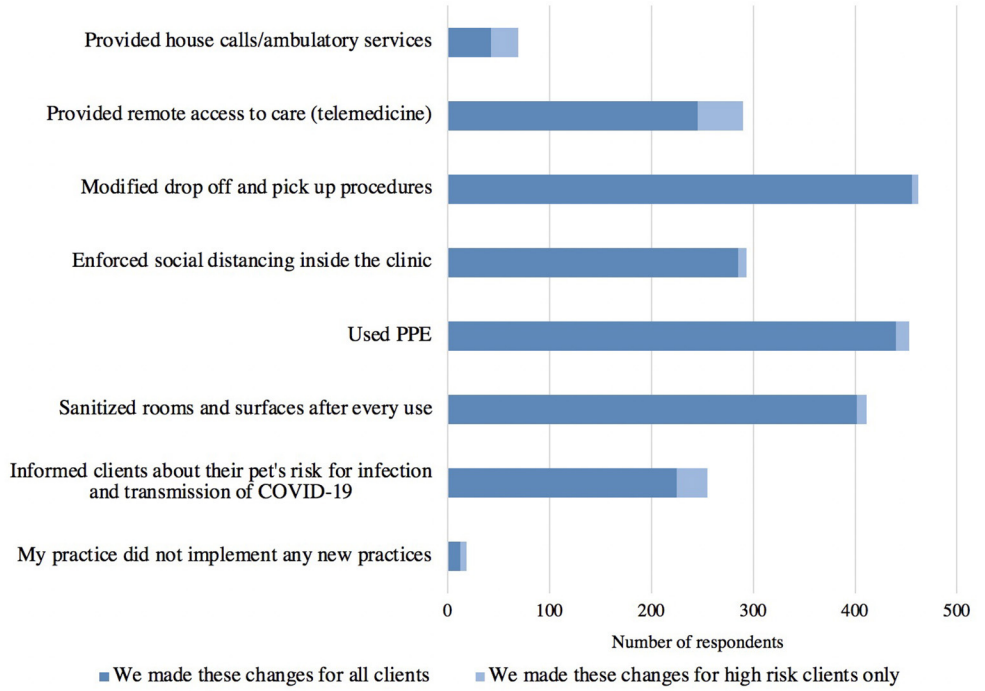

FIGURE 6 | Changes responding veterinary practices made to support all and high-risk clients during the pandemic ($n = 516$).

Telemedicine

Most respondents indicated that the pandemic either increased (50%, 230/464) or significantly increased (19%, 88/464) their interest in telemedicine, while fewer indicated their interest decreased (5%, 22/464), or significantly decreased (1%, 3/464), and 26% (121/464) of respondents said the pandemic did not change their opinion of telemedicine. Most respondents (63%, 288/456) used telemedicine during the pandemic, while 37% (168/456) did not. The types of telemedicine utilized prior to, during, and prior to and during the pandemic are shown in **Figure 9**. Teleconsultations were the most frequently utilized, followed by teletriage and E-prescriptions. The three most frequently selected reasons for implementing telemedicine were to protect the health of employees, to increase access to care for high-risk clients, and to abide by social distancing rules (**Figure 10**). Of the respondents who wrote in an answer for reasons they used telemedicine, 19% (5/27) indicated that it was because their clients requested it, and 15% (4/27) said that it was what they were doing prior to the pandemic.

Of the respondents whose clinic had utilized telemedicine, very few (5%, 11/205) indicated that they would not continue using telemedicine to provide veterinary care for their clients as pandemic recovery continues, while 70% (143/205) indicated that they would continue the use of telemedicine for all clients, and 25% (51/205) said they would continue it for clients at high risk for severe COVID-19 illness. Of the respondents who wrote-in additional thoughts on telemedicine, 16% (13/83) expressed concerns over standard of care, misdiagnosis, and the inability to perform a physical examination. Additionally, 12% (10/83) discussed their positive experiences in telemedicine and their belief in its use in the profession.

The majority of veterinarians and veterinary technicians said that they did not learn about telemedicine in their veterinary medicine curriculum (90%, 327/365), while 10% (38/365) indicated that they did. When asked if they thought veterinary medical school should make changes to curriculum content in response to the pandemic, 75% (276/370) of all respondents answered yes, while 25% (94/370) answered no. Those who answered yes were then asked the degree to which they agreed or disagreed with the implementation of several topics to the veterinary curriculum. Most respondents either agreed (54%, 149/274) or strongly agreed (41%, 111/274) that instruction on telemedicine use should be added to the curriculum, while fewer disagreed (0.4%, 1/274), or felt neutral (5%, 13/274). Most respondents also agreed (35%, 95/275) or strongly agreed (53%, 146/275) that there should be increased instruction on public health and zoonotic disease, while fewer disagreed (1%, 3/275), or felt neutral (11%, 31/275). Lastly, most respondents either agreed (50%, 136/274) or strongly agreed (41%, 112/274) that there should be instruction on vulnerabilities and access to care, while fewer disagreed (0.4%, 1/274), or felt neutral (9%, 25/274). No respondents strongly disagreed with the implementation of any of these topics to the veterinary curriculum.

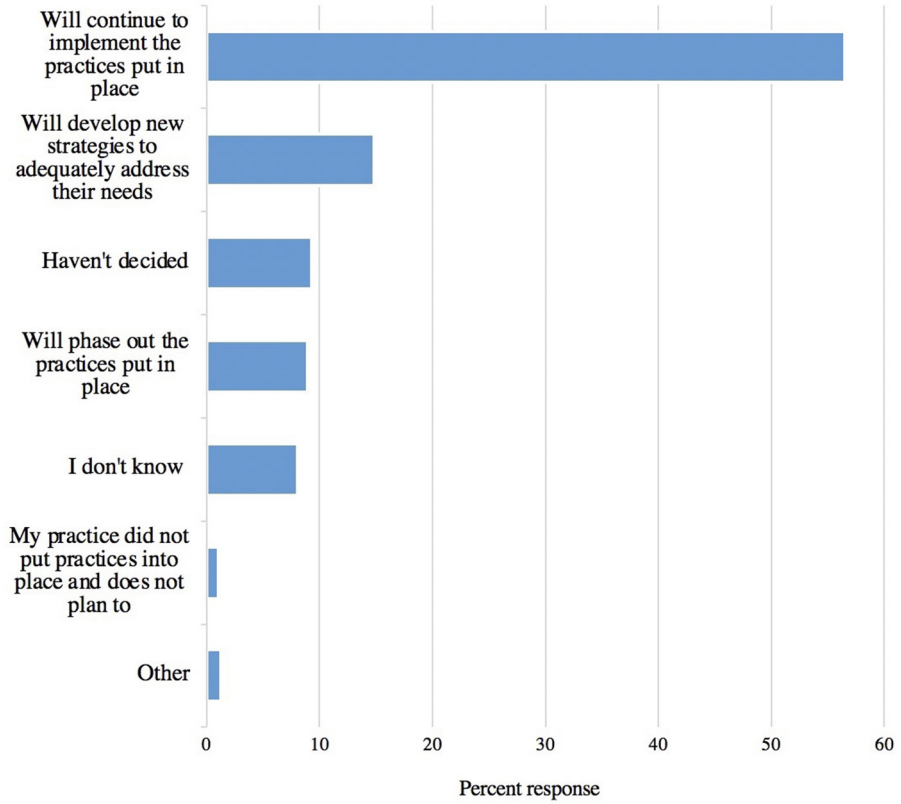

FIGURE 7 | Ways in which responding veterinary practices planned to move forward as pandemic recovery continues at the time of the survey ($n = 471$).

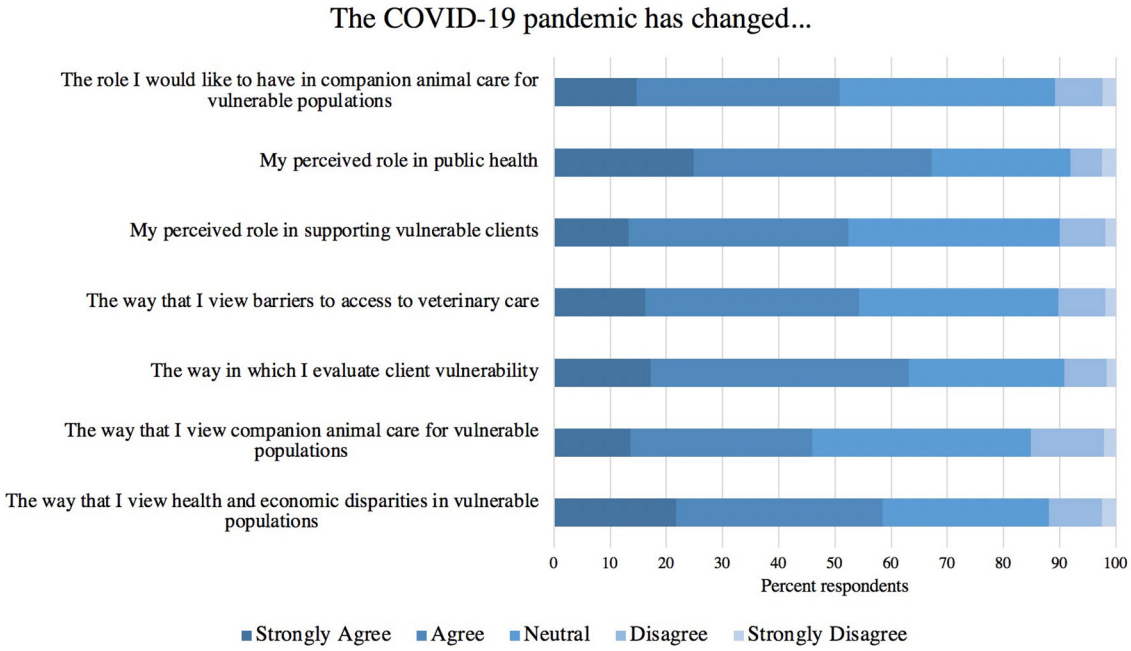

FIGURE 8 | Responding veterinarians' level of agreement with statements assessing the pandemic's influence on views and perceptions of aspects of veterinary medicine and vulnerable populations ($n = 466–470$).

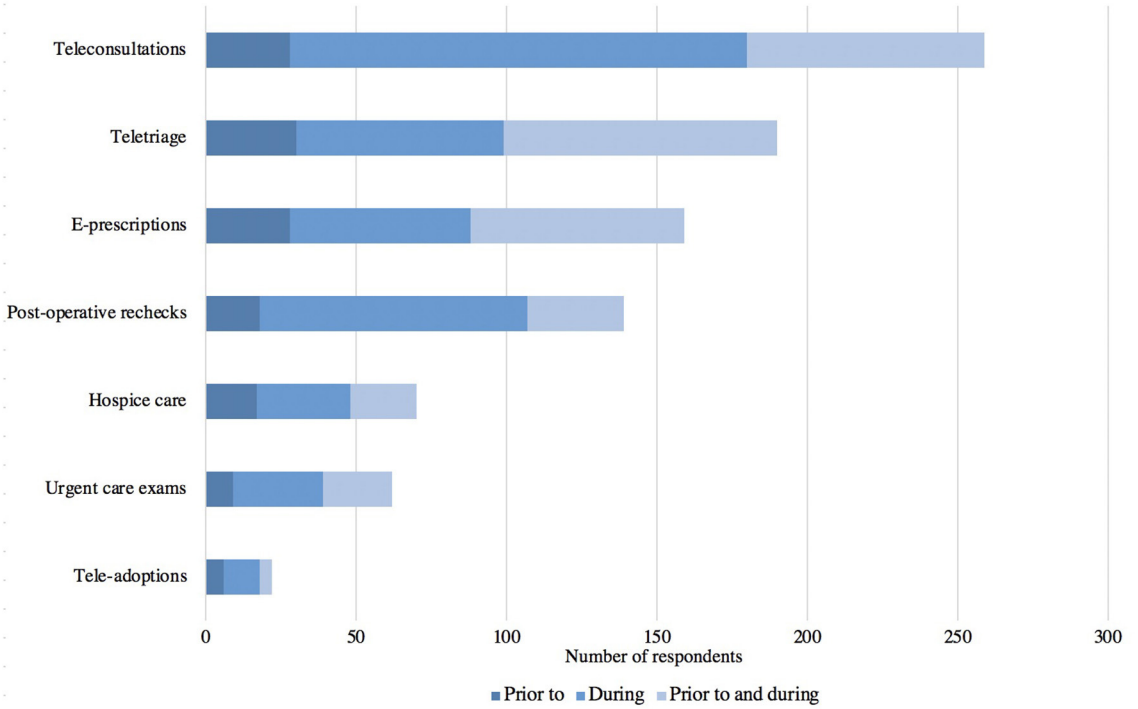

FIGURE 9 | Telehealth or telemedicine services offered by responding veterinary practices and if they used them, prior to, during or prior to and during the pandemic ($n = 288$).

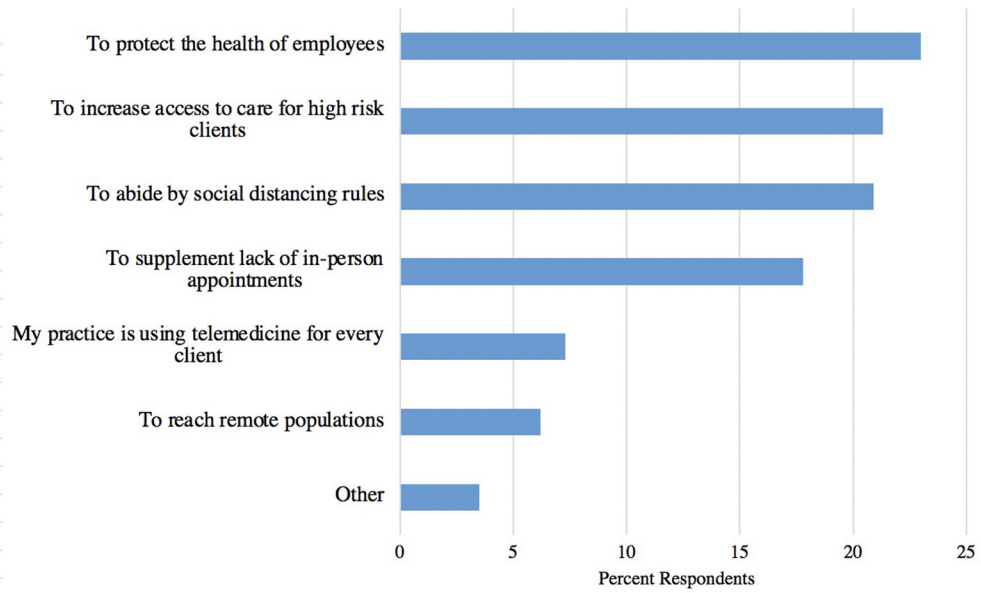

FIGURE 10 | Reasons for which responding veterinary practices implemented telemedicine during the pandemic ($n = 283$).

Interviews With Access to Care Organizations

Barriers to Care and Pandemic Services

Prior to the onset of the pandemic, most (80%, 16/20) of the access to care organizations represented in the interviews reported to provide preventative care and/or spay and neuters. Pre-pandemic 45% (9/20) of the interviewed organizations provided sick and emergency veterinary care, and 20% (4/20) provided non-veterinary animal-related services, including animal assisted therapy, grooming and provision of supplies.

Of the 20 access to care organizations represented, 80% (16/20) stopped all normal services at the onset of the pandemic. At the time of the interviews (July 24–September 27, 2020) 38% (6/16) of those organizations had not resumed any normal services, 31% (5/16) had resumed with limited services or fewer clinics and another 31% (5/16) had resumed with full services, 15% (3/20) of groups never fully stopped providing services, but did scale back at first and then resumed normal services. The most common reason for groups stopping or restricting services was due to government mandates, which was cited by 70% (14/20) of groups, followed by health and safety decisions of the organization or parent organization, cited by 60% (12/20) of groups, and 15% (3/20) of groups mentioned travel restrictions put in place by the communities being served. **Figure 11** presents ways in which organizations adapted operations to support communities during the pandemic. The three major themes included implementing COVID-19 safety protocols (45%, 9/20), implementing new ways or programs to support communities (40%, 8/20), and not allowing clients into buildings or not allowing clients to restrain/be next to their pet (40%, 8/20).

Interviewees were asked what barriers to access to veterinary care the communities they served experienced. The most reported barrier was financial (80%, 16/20) followed by transportation (55%, 11/20), geographic (40%, 8/20), and language (25%, 5/20). Judgement or distrust of veterinarians was noted by 20% (4/20) of groups, as well as lack of access to information, education, or communication. Accessibility to local veterinarians (due to local veterinarians being overwhelmed, or the lack of collars, leashes, carriers) was mentioned by 15% (3/20) of groups, and physical or mental inability to get to a veterinary clinic was mentioned by 10% (2/20).

Resources and Support

In the conversations, 35% (6/17) of the interviewees reported government guidelines as a resource used to guide decision making on conducting services during the pandemic. Other answers included collaboration with other organizations (29%, 5/17 of interviewees), information released by the American Veterinary Medical Association (AVMA) or shelter groups (24%, 4/17 of interviewees), communications with the communities they serve (18%, 3/17 of interviewees), CDC recommendations (18%, 3/17 of interviewees), social media or webinars (18%, 3/17 of interviewees) and guidance from the parent organization (12%, 2/17 of interviewees). When asked what support could have been used during the pandemic, 41% (7/17) of the interviewees indicated financial support. Mental health support for staff/volunteers, resources and information on best practices/what similar groups were doing, and PPE/supplies/facility support each were mentioned by 24% (4/17) of interviewees. Another 24% (4/17) of interviewees reported that there was no additional support they could have used.

Challenges Experienced and Concerns

Figure 12 shows major themes in terms of concerns about consequences in the community as a result of the disruption of services. The most commonly cited concern (71%, 12/17 of interviewees) was about uncontrolled population growth due to the lack of spay and neuter services and 47% (8/17) worried about the spread of infectious disease due to the lack of vaccines and preventatives.

Two major concerns were noted with respect to resuming services. Most (76%, 13/17) interviewees were concerned with COVID-19 transmission in terms of the health and safety of the communities and staff/volunteers, and 24% (4/17) were concerned about the potential of having to shut down and stop services if a team member were to test positive. Interviewees were asked about challenges to providing services during the pandemic. Major themes are presented in **Figure 13**, with the challenge of developing safe protocols, planning the logistics, and scheduling being the most commonly mentioned.

When asked about the hardest part of the pandemic, 47% (8/17) of interviewees said the hardest part was not being able to provide normal services. In expressing this sentiment, half of these interviewees elaborated on the mental health toll in knowing that animals and communities were suffering and yet not being able to help like they normally do. Additionally, 35% (6/17) of interviewees mentioned keeping up with the high demand or not being able to help everyone in need, 29% (5/17) said providing services with the new health and safety protocols, 29% (5/17) said missed opportunities for follow up care, collaboration, and spreading the word about the organization, and 18% (3/17) cited financial difficulties.

Successes and Opportunities for the Future

When asked about any positive moments during the pandemic, support and appreciation from the communities and the generosity of volunteers, funders, or donors were the most commonly reported themes (35%, 6/17 of interviewees each). Another 24% (4/17) mentioned comradery among organizations/veterinarians, 18% (3/17) of interviewees mentioned comradery within the communities, and 12% (2/17) mentioned comradery and/or adaptability within the team. Increased or new opportunity (18%, 3/17 of interviewees), student engagement (12%, 2/17 of interviewees), and connection with the communities (18%, 3/17 of interviewees) were other themes found. One of the major themes in terms of opportunities that arose as a result of the pandemic was that there became new opportunities to support the communities in unique ways (53%, 9/17 of interviewees). Additionally, 29% (5/17) of interviewees also noted opportunities to reflect on logistics and/or improve efficiency, 18% (3/17) mentioned new ways for community outreach and education, and 12% (2/17) said opportunities to support local partners and veterinarians.

When asked if there were any changes made during the pandemic that they would continue to implement moving forward, over half (59%, 10/17) of interviewees said that there were changes that ended up increasing efficiency and/or organization that would be continued. Of the interviewees, 24% (4/17) said that they would continue new services that were introduced during the pandemic, and 24% (4/17) said that the improved communication with the community would continue. Additionally, 12% (2/17) of interviewees said they would continue with the increased cleaning and disinfection.

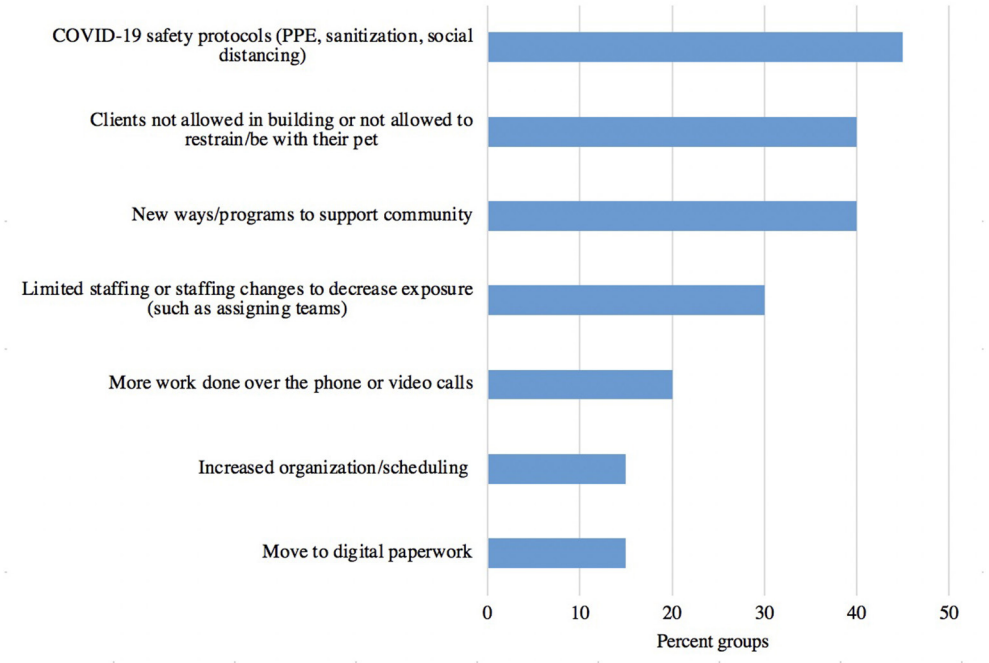

FIGURE 11 | Strategies and procedural changes responding access to care organizations used to adapt their operations to support vulnerable communities during the pandemic ($n = 20$).

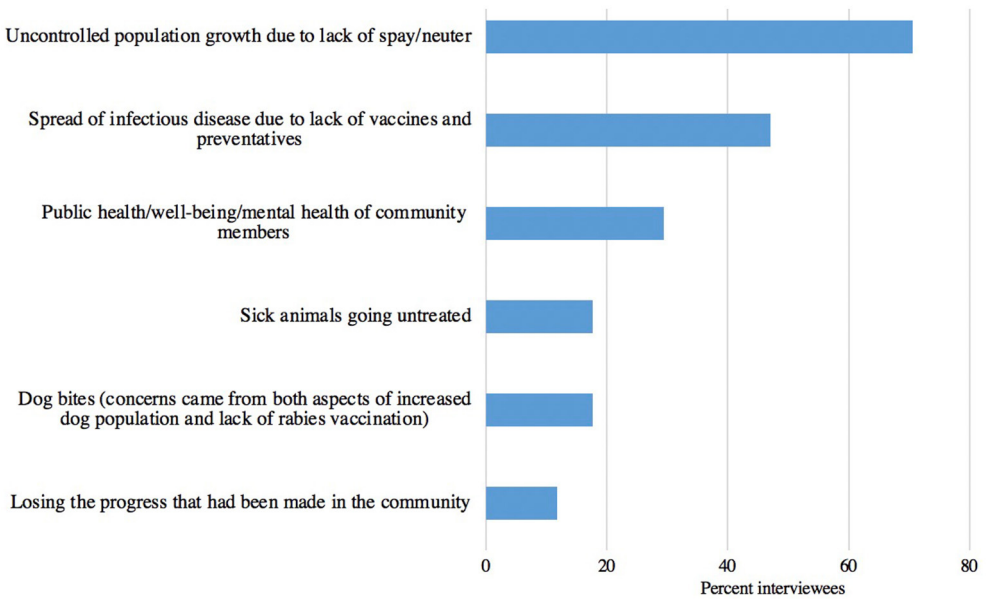

FIGURE 12 | Concerns expressed by access to care organizations about consequences to the community as a result of disruption of veterinary services ($n = 17$).

Interviewees were asked what they learned during the pandemic about vulnerable populations and/or the support those populations need (**Figure 14**). The most common themes that emerged was the extent of the barriers, disparities, and lack of resources that the populations face, especially in the face of the pandemic (41%, 7/17 of interviewees).

DISCUSSION

Collectively, this work highlights how the COVID-19 pandemic created new (ex. heightened infectious disease risk, reduced veterinary services), and exacerbated existing (ex. financial barriers), issues with accessing and providing veterinary care.

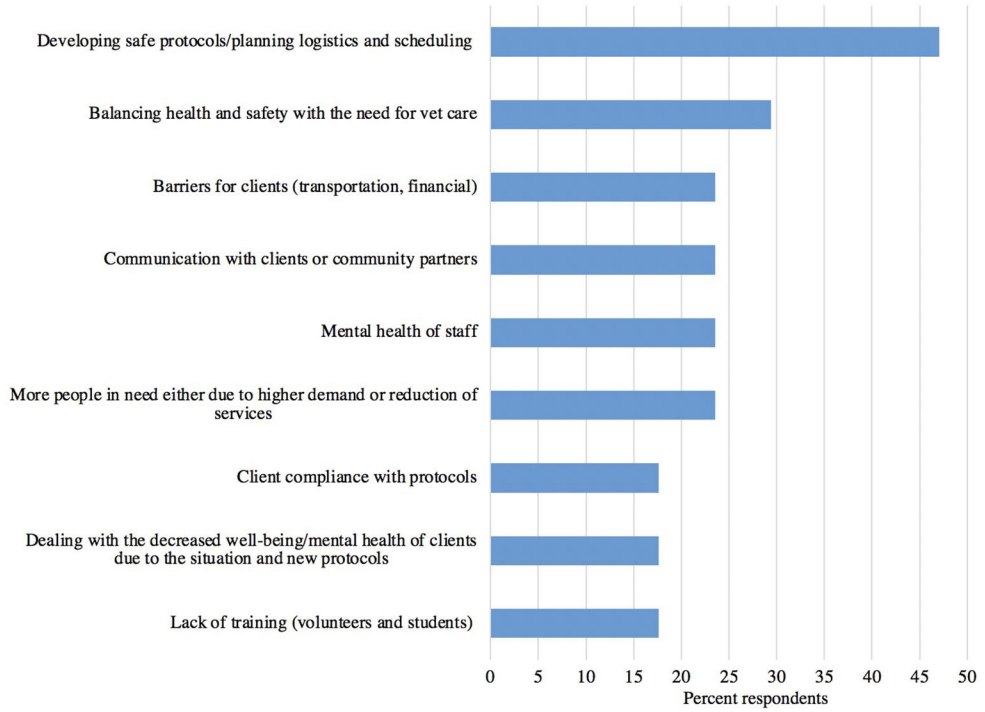

FIGURE 13 | Challenges to providing veterinary services during the pandemic experienced by access to care organizations ($n = 17$).

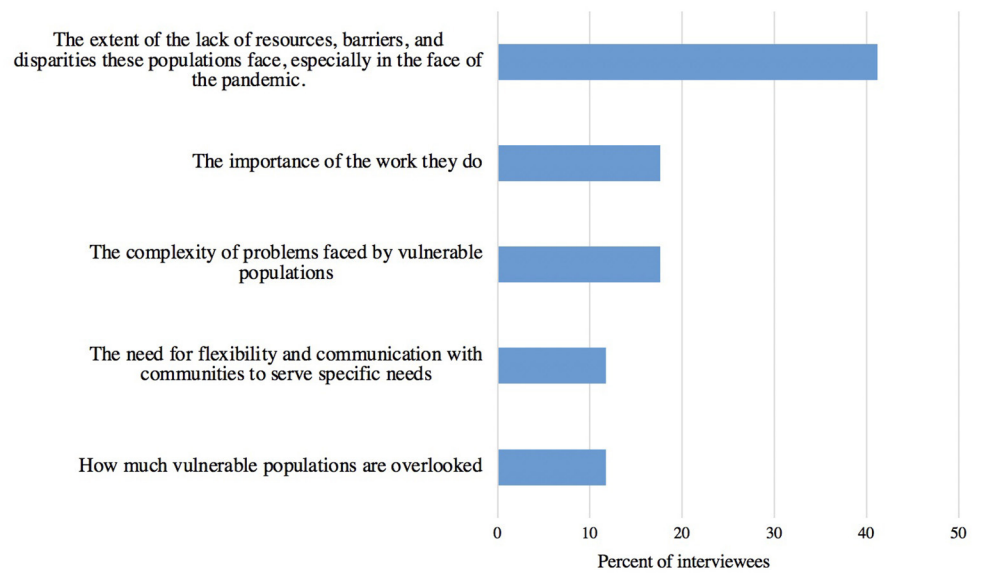

FIGURE 14 | Themes learned by access to care organization interviewees from the pandemic about vulnerable populations ($n = 17$).

The pandemic expanded the definition of vulnerability in the human population and the impacts further exacerbated the financial barrier in access to animal welfare and health, as demonstrated by the increased number of requests to veterinary clinics for reduced cost services, and by the disruption (financially and logistically) of low or no cost veterinary services provided by access to care organizations to traditionally vulnerable populations. Society and the veterinary profession have become more aware of the complexity of health and access to care, and the pandemic highlighted the veterinarian's perceived

role in public health. Additionally, this study identified areas on which the veterinary profession can focus in order to help increase access to veterinary care, including integration of critical instruction into the veterinary school curriculum and continuing education, and through strategic use of telemedicine.

While this research elucidated interesting information about the response by veterinary clinics, pet owners and access to care organizations during the initial phase of the COVID-19 pandemic, we focus here on broad themes that can help the veterinary profession and access to care organizations be the most prepared to respond when the next disaster or large response effort is needed. These are (1) opportunities for further learning for the veterinary profession; including curricula around telemedicine, financially resilient business models and understanding health disparities and vulnerable populations; (2) a need for a network of collaboration and communication across veterinary clinics and access to care organizations and (3) future preparedness for health, economic or other crises response.

Opportunities to Expand Education of Service Providers

In order to respond to the current stressors resulting from the pandemic, such as increased requests for reduced cost services, and prepare for future changes in the veterinary field, it is essential to provide veterinarians and students with the necessary background information to be successful. A goal of these educational materials is to prepare students for practice within and beyond traditional clinical practice and to provide a set of resources for creating systems that address barriers to care that can be implemented in practice settings and through access to care organizations and programs. The research presented here shows that the vast majority of veterinary professionals believe that veterinary schools should make changes to their curricula in response to the pandemic, including instruction on telemedicine and access to care. Other studies have shown support for the inclusion of additional topics, such as training on how to educate clients on pet insurance and future veterinary costs (22) as well as training on working with clients who have financial and emotional stress (23). There are several educational methods that should be developed and/or deployed to prepare veterinarians for success, including inclusion of materials in veterinary school curriculums and development of continuing education lectures and focused workshops for practicing veterinarians. The survey completed by veterinary clinics found that the primary topics that veterinarians and hospital staff requested information on were (1) telemedicine (2) sustainable business techniques for providing low-cost veterinary services and (3) how to play an active role in companion animal care and public health for vulnerable populations. With additional information on these topics, veterinarians can be more equipped to provide services to clients experiencing barriers to care for their pets.

Telemedicine

The pandemic highlighted the value of telemedicine in veterinary practice. Telemedicine was a critical tool for helping clients to access their veterinarian and veterinary advice from the safety of their own home. Our pet owner survey indicated that most clients who used telemedicine were satisfied with the care and interested in using this technology moving forward, though respondents who had never used telemedicine were more hesitant about using it in the future compared to those who had used it. The continued use of telemedicine could help to overcome the geographical and transportation barriers experienced by clients in remote areas, and those without transportation to travel to a clinic. A recent survey of veterinarians found that the biggest rate of telemedicine adoption in clinics during the pandemic occurred in regions of higher poverty levels, and only 20% of veterinarians reported having complications while utilizing telemedicine to perform exam visits (24). Continued use of teletriage as a resource could lessen the impact of these barriers and connect clients and patients to advice and care. However, issues with technology access and use were highlighted by the aforementioned survey as a challenge in implementing telemedicine use (24), a challenge which is likely to be greatest felt by vulnerable populations. These findings show that telemedicine should have a future in veterinary medicine and to help it become a safe and reliable method of care, education for both veterinarians and clients is essential so all parties involved can feel comfortable using these new modalities of care. Research by Widmer et al. may help motivate the veterinary community to advance these efforts, as they showed that pet owners were willing to pay over $30 more for telemedicine services with their primary veterinarian over services with an online veterinarian outside of their community (25).

Other recent research has found that clients in rural areas were highly interested in carrying out treatment for pets with chronic health conditions via telemedicine platforms, and these clients were highly motivated to utilize telemedicine due to the reduced amount of stress it would cause in their pets (26). This indicates that clients can transition to the new technology with support and confidence from their veterinary team. The veterinary team can develop this confidence through increased education on the legality and efficient uses of telemedicine leading to better and more frequent communication with clients and a subsequent increase in access to care. In fact, most respondents in the veterinary survey thought that telemedicine instruction should be added to the veterinary curriculum.

Veterinary concerns were raised in our study regarding the standard of care and misdiagnosis with the use of telemedicine, a finding consistent with other surveys (27, 28). This persistence in uncertainty and lack of knowledge on the use of telemedicine and its legalities is not in-line with the increase in use in veterinary medicine, and therefore there is a need for the veterinary profession to actively promote and encourage educational opportunities in both veterinary school curriculums as well as continuing education for veterinarians to feel both comfortable and empowered to use telemedicine appropriately and effectively in their practice. Additionally, the legalities of telemedicine use in veterinary medicine could be more clearly communicated to the veterinary community by the veterinary state boards and policy makers. Finally, strategic use of the "telemedicine platform," specifically for teleconsultations, teletriage and E-prescriptions, could help to assuage the primary concerns noted by clients and

veterinarians regarding standard of care, misdiagnosis, and the inability to perform a physical examination.

Support of Clients Experiencing Financial Strain

Helping clinics to establish sustainable financial systems will not only allow for increased outreach to vulnerable groups during normal times but will also help them be better equipped to handle moments in time when increased client vulnerability results in a higher strain, such as during this pandemic. The third most reported reason for not seeking veterinary care was financial cost, and although this cannot be directly tied to the pandemic, a greater percent of vulnerable pet owners reported this issue than non-vulnerable pet owners. Although financial constraints were not the top reason for not seeking veterinary care, the cost of caring for their pet overall was the most frequently reported reason for considering surrender of their animal during the pandemic. A recent survey of pet owners additionally found that pet owners had concerns over the ability to afford veterinary care now (41.9%) and in the future (45%) (29). Another recent (2021) study more specifically interviewed low-income pet owners and found cost to be a significant barrier to accessing veterinary care during the pandemic (23). On the veterinary professional side, almost half of respondents indicated that their practice received increased requests for reduced cost services during the pandemic and the majority were unable to fulfill these requests. Furthermore, during this time of marked increase in financial strain, access to care organizations providing low- to no-cost veterinary services reported a marked reduction, or complete cessation, in available services during the study period. This gap in coverage could be addressed through teaching veterinarians to provide financially accessibly services through continuing education or veterinary curriculum courses. An example curriculum is The Ohio State University Preparing for Excellence in General Veterinary Medicine Program, which is designed to provide students with opportunities and build confidence in providing a "spectrum of care" in order to be prepared with these requests and financial realities upon graduation (30). Additionally, veterinary students at Lincoln Memorial University's College of Veterinary Medicine demonstrated more confidence in offering incremental care treatment options to their clients after participating in an online module focused heavily on access to care (31). Access to courses that describe the development of incremental care business models or methods to provide low costs services to clients would help clinics provide care to all pet owners in a manner that is more financially attainable. Community-medicine clinics have already been shown to increase access to veterinary care, as suggested by a recent survey study revealing that around half of pet owners visiting community-based veterinary medicine clinics had never received veterinary care for their pet before (32).

Understanding Issues Facing Vulnerable Populations

Education on health disparities and access to care issues faced by certain communities would help veterinarians provide service in this area. There is an opportunity here for integration and collaboration with access to veterinary care groups, who would have valuable insight into providing low-cost veterinary care. As one interviewee noted, "Many of the challenges that our communities are facing during the pandemic are basically exacerbations of challenges that already existed." Education is needed to work with vulnerable populations and those experiencing access to care issues. When interviewees from access to care organizations were asked what they learned during the pandemic about vulnerable populations and/or the support they need, there was a resounding sentiment of a new appreciation of the extent of the barriers, disparities, and lack of resources that these populations face. This sentiment was echoed by the veterinary professionals surveyed, as over half said that the pandemic changed the way that they viewed health and economic disparities in vulnerable populations. A developed curriculum for these topics could help veterinarians connect these communities with animal health resources. Critical curricular themes in addition to the inclusive business models mentioned above include public health and veterinary care for vulnerable populations, strategies for inclusive engagement with vulnerable populations, improving in-clinic perceptions of vulnerable populations, ways to crowd-source organizational aid for veterinarians, and ways to improve community partnerships with clinics to help aid vulnerable populations. Additionally, other researchers have proposed incorporation of a trauma-informed model (33) designed to combat unconscious bias while working with low-income populations (23). While organizations and groups are focusing on access to care, incremental care and support of owners experiencing these challenges, information is not equally available to general practitioners in veterinary practice, and an effort to share knowledge and approaches to these methods of client support is necessary to help bolster the traditionally and newly vulnerable pet owners as the impacts of the pandemic continue. As illustrated by Fingland et al. (30), research and support exist for spectrum of care to improve access to care across financial barriers. The next steps are to help our practicing profession build confidence and feel supported in carrying out this approach to care in a successful clinical model. Integrating this research and methodology into veterinary curricula and CE events are important steps to achieving these goals.

Community of Care

Better networking and connections would improve communication, adaptation and support across organizations, regions, and clinics. Less than a quarter of interviewees from access to care organizations cited the use of information from the AVMA or animal shelter organizations as a resource to guide decision making during the pandemic. Further, when these interviewees were asked about support, they could have used during the pandemic, they expressed the need for resources on best practices for access to care groups during the pandemic, or information on what similar groups were doing. This highlights a need for increased collaboration and continuity within the access to veterinary care community, as well as a need for better dissemination of resources that currently exist. The networking and dissemination should be accessible beyond the veterinary profession, to include technicians and other

volunteers and Access to Veterinary Care program coordinators that to not have a DVM degree, as these groups contain interested participants from varied professional backgrounds. Though distinct vulnerable populations experience different barriers and differ from each other in many ways, our research shows that access to care groups, regardless of what type of population they support, faced similar experiences during the pandemic (i.e., mental health challenges and logistical planning obstacles). There needs to exist a better infrastructure for these groups to connect with each other, allowing for efficient and valuable communication. The benefits of such a support network expand beyond the pandemic, as it could expand the network of access to care and allow for idea exchange and innovation. If such a system exists, the research here shows that it is not well-known or well-utilized, as interviewees expressed the need for information on best practices or how other access to care groups were handling the pandemic. There is therefore room for creation or expansion and improvement of a robust communication infrastructure for these organizations. Since the pandemic has started there has been an increased effort to address this issue. The American Society for the Prevention of Cruelty of Animals and the University of Minnesota brought together veterinary professionals and organizations focused on this important theme at the "Engaging the Future: Access to Veterinary Care Roundtable" hosted virtually in December 2021. Additionally, Human Animal Support Services (HASS) has been hosting twice weekly virtual meetings to bring together professionals involved in access to care organizations for support and idea exchange (34). Prior to the pandemic, the creation of the Access to Care Coalition in 2016 and the subsequent Access to Veterinary Care report released in 2018 (20) was of invaluable benefit to the field and indicative of a movement to increase discussion and education on the topic. The increased spotlight that the pandemic has shed on vulnerable populations can serve as a catalyst that builds upon this effort to increase continuity and communication within the field of access to veterinary care.

In addition to the facilitation of collaboration among professionals already in the access to care field, this could also help to increase participation of other veterinary professionals who do not yet partake in access to care work but are interested. The responses from the veterinary survey showed that the pandemic has changed perceptions on vulnerability and the role that veterinary professionals would like to have in animal care for vulnerable populations. Therefore, there could be increased interest in contributing to access to care work. Organizational infrastructure and increased communication among organizations and professionals would help facilitate the participation of more veterinary professionals and help increase involvement of veterinary clinics in access to care work.

Lastly, improved communication between veterinary hospitals and access to care organizations could help to facilitate referrals for treatable disease processes or injuries that otherwise would result in euthanasia due to cost of treatment. One study has shown that 97% of surveyed high quality, high volume spay-neuter clinics were willing to accept referrals for pyometra (35). This is a critical example of communication between organizations about the availability of low-cost services in the face of an emergency could help owners seek affordable care and avoid making a cost-based euthanasia decision.

Future Preparedness

Looking at the future, it is critical that the veterinary and animal health professions integrate not only the educational and collaborative pieces mentioned previously but also remain aware of pre-existing issues that have been exacerbated by the pandemic. With cessation of critical services by access to care organizations, interviewees worried about unchecked animal population growth and the spread of infectious disease in areas where services focused on spay/neuter and preventive medicine services were halted. There was also concern about the public health, well-being, or mental health of community members, a notable concern considering the discussion of the disproportionate burden vulnerable populations are bearing in the face of COVID-19. Veterinarians play a crucial role in public health and the prevention of zoonoses, and in a time when disease transmission from animals has become a center of discussion among top public health officials, the veterinarian's role is now more important than ever. The pandemic has also brought to the forefront of discussion the vast disparities and inequalities in access to resources that result in vulnerable populations being disproportionately incapable of coping with and adapting to hardships (8–10). Studies have demonstrated that the prevalence of zoonotic disease is higher in underserved areas such as low-income urban areas, disadvantaged, rural populations, and areas of low socioeconomic status (36–38). The issue of zoonoses and inequalities in resources converge with each other in the very places where the vulnerable populations supported by the groups represented in these interviews exist. The pandemic could serve to spur a greater focus on zoonoses and underserved populations, while needing to address that the halt in veterinary services could cause an increase in unwanted populations and disease spread. Future responses by governments to permit these essential animal health activities will support population maintenance and disease control and lead to improved health in both human and animal populations.

Given the extensively documented and widely acknowledged issue of mental health and high suicide rates in the veterinary profession (39–41), the topic of the mental health impact of the pandemic on those who work in access to care organizations warrants proper discussion. Interviewees from access to care organizations noted that they could have used mental health support for their staff because of the toll that the pandemic was taking on the organization, and many worried about the possibility of COVID-19 transmission to the communities they served when services resume. These findings bring our attention for mental health support for the veterinarians associated with these groups to all those who work in this segment of animal care, including technicians, volunteers and all team members involved. For people who have dedicated their career to helping to support vulnerable populations, it is not surprising that the idea that delivering their support services could ultimately harm the community (as a result of transmission of disease) is a heavy weight to bear. Almost half of the interviewees said that not being able to provide normal services to the communities was

the hardest part of the pandemic, and 50% of them went on to elaborate upon the mental health toll of knowing that there was animal and community suffering because they were not there. Interviewees also discussed the strain of keeping up with the high demand for services or not being able to help everyone in need. As one interviewee observed, "I think that it's important to take into account what toll this is taking on our profession … I think this is likely to have a long-term impact on our already troubled suicide rate." In preparation for future global health disruptions and responses, it will be critical to develop and implement methods and approaches to providing support not only to the clients and communities impacted but to the health care professionals providing services. This could be accomplished through networks, collaboration, education on mental health and self-care, and by organizations creating systems of response and self-care for future instances.

Limitations

Surveys and interviews for this project were all conducted in the first few months after the start of the COVID-19 pandemic, and associated restrictions, began in the United States. To better understand the issues that arose or persisted later in the pandemic, follow up surveys and interviews with participants would be helpful. Amazon's MTurk was used to disseminate the survey to pet owners used in this study. MTurk respondents have been shown to be more representative of the US population than those found using convenience-sampling (42). Studies have shown that respondents on MTurk tend to be younger and live in more urban areas, which is a potential limitation to representing the general population of pet owners, this also limits the potential for representation of the new and traditionally vulnerable population we sought to understand, such as older individuals and those without internet access (43). Of the respondents to the pet owner survey 27.1% reported being at high risk to COVID-19 and therefore fit into the newly vulnerable category. When added to those vulnerable based on demographic characteristics, a total of 71% of the survey respondents were categorized as vulnerable. Nonetheless, it is critical to be aware that the voices of certain vulnerable populations were not captured in the results of this study, specifically pet owners without access to the internet (for example, unsheltered and geographically isolated pet owners). To address sampling and response bias from the pet owner survey, we conducted interviews of access to care organizations who work with a range of pet owners and communities in an attempt to understand the challenges experienced by the vulnerable populations they serve. Findings were broadly consistent with survey data, however future studies should work to distribute and collect surveys, both electronically and physically, with the clientele of access to care organizations. The researchers acknowledge the limited number of access to care organizations represented. Future studies could involve interviewing additional organizations to broaden the scope of experiences shared to those from an expanded list of geographical regions, barriers encountered and professional viewpoints (beyond veterinary).

Given the opportunistic dissemination of the veterinary survey and interviews with care providers, the potential for response bias exists. Similarly, even though the veterinary clinic survey was anonymous, it is possible that participant responses were influenced by what they perceived to be a socially desirable manner. Finally, this preliminary work focuses largely on perceptions which may not accurately reflect an individual's willingness to operationalize these activities. Additional research into access to veterinary care should include exploring perceptions in animal care professionals who may not self-select to participate in this work and more participatory exercises focused on implementation. A critical step to fill these gaps in knowledge and information availability would be for access to care organizations to build upon the progress made by the 2018 Access to Veterinary Care report (20) and gather to continue to discuss relevant and emerging topics, determine common terminology and themes and develop materials and information to share.

Summary

While the COVID pandemic has, and continues to, put significant strain on the ability of the veterinary profession to provide access to animal care, it has also helped to identify areas of improvements and ways to prepare for future crises. Education of veterinary students and professionals on the implementation and legality of telemedicine, business models to support financial resilience and client support, and understanding of improved approaches to incremental and community veterinary medicine can help improve access to care for communities experiencing barriers. Networks, collaboration and communication between veterinarians and access to care organizations can also improve responses and narrow the gaps in access to care. Finally, as a profession, it is important to advocate for the essential nature of preventive medicine should services be halted in future responses by governmental agencies, and to be aware and prepared for the dramatic impact on mental health and act to support the individuals and teams of professionals in enduring the prolonged response.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Integrity and Compliance Review Office, Institutional Review Board of Colorado State University. The participants provided their written or verbal informed consent for all studies.

AUTHOR CONTRIBUTIONS

DF and CD obtained grant funding for the research project and oversaw the research team. SS and ZG participated in the entire research process including study design, execution, data analysis, and preparation of initial drafts. DF and CD contributed to final drafts and DF finalized and submitted the

manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fvets.2022.804794/full#supplementary-material

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Spatial-Temporal Accessibility and Inequality of Veterinary Service in Hong Kong: A Geographic Information System-Based Study

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Veterinary services are vital to the welfare of pets and their owners. Previous studies examined multiple factors affecting pet owners' decision to consult veterinarians, yet few studied the spatial accessibility of veterinary services. This study is one of the pioneering studies on the spatial-temporal accessibility of veterinary service and how it is associated with social and spatial inequality in Hong Kong. We measured the spatial availability and accessibility of both general and 24/7 veterinary clinics (i.e., veterinary clinics offering service for 24 hours, seven days a week or providing emergency services outside of business hours) using Geographic Information System and principal component analysis. We found that the spatial distribution pattern of general and 24/7 veterinary clinics can be explained by the average district-to-district distances and the area of a district. In addition, social and spatial inequality of access to veterinary services were observed. The spatial accessibility of general veterinary clinics within walking distance is negatively correlated with household size and the number of public-housing and subsidized-housing households, but positively correlated with the number of private-housing households. The spatial availability and accessibility of 24/7 veterinary service are positively correlated with the number of private housing households and households with the highest monthly household income, and the latter also positively correlates with a population with a post-secondary degree, further shedding light on the social and spatial inequality issue that communities with wealthier households and highly educated populations have more accessibility to 24/7 veterinary services. Last, we argue that the need-based veterinary support tends to target remote rural areas while overlooking the new growth areas close to the traditional urban core but poor in accessibility to veterinary care. Therefore, a comprehensive investigation into the pet ownership landscape and their needs over space and time will be beneficial to construct a more robust animal welfare system in Hong Kong.

Keywords: veterinary care, spatial accessibility, Geographic Information System (GIS), Hong Kong, affordable care, companion animals, animal welfare

INTRODUCTION

Companion animals or pets have long been in a close relationship with human beings and the positive effect of their companionship on humans' well-being is well documented (1, 2). The presence of pets is beneficial to peoples' mental well-being. For instance, the influence of good human-pet compatibility was found to be positive on one's mental health by relieving anxiety and distress (3). Other than mental well-being, the positive effect of pet ownership on physical health is also well documented. The presence of pets can render peoples' perception of the surrounding environment as more friendly and less threatening, which ultimately may contribute to several positive physical health outcomes such as lowered blood pressure and heart rates (4–6). Dog walking is also negatively correlated with the body mass index, activities of daily living limitations, doctor visits and positively correlated with the vigorous exercise of the elderly (7). Moreover, pet ownership is a protective factor against allergy by increasing house dust bacterial diversity, reducing fungal species in the living environment, and strengthening the immune system (8, 9).

Since pets sometimes get sick like humans, the veterinary healthcare system is critical for pets' welfare. Previous studies have documented various barriers to seeking veterinary services, such as cost, operation hours, geographic location, transportation, educational attainment of pet owners, culture, language, and veterinarian-owner communication (10–13). The difference in native languages between veterinarians and owners may prohibit effective communication for trust-building between owners and veterinarians, which can affect a pet owner's willingness to consult a veterinarian (12). Among all barriers, care cost has been identified as the dominant factor determining owners' decision on seeking veterinary services (10, 11, 13–15). Financial constraints of pet owners may negatively impact their decisions of seeking a veterinarian and potentially impair their pets' welfare (10). A previous study in the United States (U.S.) indicates that the 2007–2009 economic recession was the primary factor that drove the growing concern of the cost of veterinary services because of potential job or income loss (14). The study also found that unemployed or low-income pet owners were less likely to consult a veterinarian than full-time employed or higher-income counterparts (14). The decision to seek a veterinarian is made with reference to various factors, including but not limited to, clinical symptoms (e.g., trauma, ingested poisonous substances, and end-of-life care), a pet owner's income level, cost barriers, and transportation barriers for seeking veterinary services as well (11). An animal welfare study conducted in Soweto, Gauteng, South Africa, found that $<$1% of the respondents used private vehicles while more than 60 and 30.5% relied on taxis and mobile services provided by the Society for the Prevention of Cruelty to Animals (SPCA) to seek veterinary services in the low-income urban community (16). Though this study did not further investigate how cost and transportation interact to affect animal welfare, this study's finding provides an important implication that cost plus the availability of affordable transport options may affect how the pet is delivered.

Spatial accessibility, concerning the interaction between supply, demand, and mobility, defines the ease of travel and the spatial variation of availability (17–20). The concept of spatial accessibility to everyday services or facilities, such as supermarkets, public bikes, health, and medical services, has been extensively studied for human health, and social and spatial inequality of such services, in many cases, has been widely identified (21–25). For instance, a Geographic Information System (GIS) study on the accessibility of supermarkets in London, Ontario, Canada, found that neighborhoods in an inner-city with low socioeconomic status have the poorest access to supermarkets. Such social and spatial inequality has been exacerbated over time, raising the concern of access to healthy and affordable food for the underprivileged (24). While it is not uncommon to use GIS in veterinary studies, few studies, to our understanding, apply it to assess the spatial or spatial-temporal accessibility of everyday veterinary services (26). Several studies on the accessibility of veterinary clinics identified transportation as one of the major hurdles to accessible veterinary services (11, 13, 27), but they mainly employed questionnaires from a user's subjective perspective without objective quantitative analysis on spatial accessibility of veterinary services. Spatial accessibility is critical because veterinary services beyond acceptable walking distance potentially limit available veterinary services. In addition, companion animals are often prohibited in public transport in many countries, causing transportation costs to escalate when people resort to private transport or taxis as they are the only travel option (12, 27). Therefore, a study on spatial variation of veterinary services is essential to identify underserved groups, which may provide a reference for future planning of veterinary services.

Since major public transport systems, such as Mass Transit Railway (MTR) and buses, prohibit animals in Hong Kong, the most feasible travel modes are private cars or taxis. When the distance to veterinary service is beyond walking distance, Hong Kongers without cars would have to rely on taxis and private cars, thus incurring an increased transportation cost. Furthermore, the uncertainty of the traffic condition such as gridlock and "change shifts" of the taxi drivers may also lead to a delay in proper veterinary treatment. From 2005 to 2016, the number of registered veterinary surgeons and pet dogs and cats increased from around 400 and 297,000 to around 800 and 511,000, respectively (28). In 2010, the availability of veterinarians defined by the veterinarian-to-pet ratio in Hong Kong was 1:735, far higher than Singapore (1:2,543), the U.S. (1:3,072), and the United Kingdom (1:2,374) (28). However, an increase in the overall supply of veterinary services does not guarantee an increase in the spatial accessibility of the services for every area and pet owner. The underserved area will likely remain unserved if additional veterinary clinics cluster only at a specific geographic locale. The literature on pet welfare or veterinary services is sparse in Hong Kong and is mainly confined to users' perceptions and practices, such as satisfaction with the veterinary services, the intention of relinquishment, and vaccination, without considering the travel impedance or spatial accessibility (28, 29). Therefore, there is a

need to investigate the spatial accessibility of veterinary services in Hong Kong.

This paper aims to examine the spatial accessibility of veterinary services and their implications to social and spatial inequality in Hong Kong by using GIS. This paper will be one of the first studies that incorporate spatial data and geospatial technology into companion animals' welfare and social and spatial inequality, providing a framework of how companion animals' welfare can be safeguarded and investigated through interdisciplinary approaches.

MATERIALS AND METHODS

The present study applies GIS and R programming to analyze the spatial accessibility of veterinary services at the district level in Hong Kong. This study sets the following questions: (i) How are general and 24/7 veterinary clinics in Hong Kong spatially distributed across its territory? (ii) What are the supply and demand ratios for general and 24/7 veterinary clinics for each district in Hong Kong? (iii) What may contribute to the spatial availability of general and 24/7 veterinary clinics? (iv) Can general and 24/7 veterinary clinics be reachable within walking distance in Hong Kong? (v) Is there a social and spatial inequality of accessibility of veterinary services?

Study Area

Hong Kong, a Special Administrative Region of China, is a metropolitan city in the eastern Pearl River Delta in Southeast China. As of mid-2020, a population of 7.48 million resides in Hong Kong, formulating 2.6 million households with a median monthly household income of 28,200 Hong Kong dollars (HKD) as of the first quarter of 2020 (3,617USD equivalent) (30). Hong Kong occupies a 1,114 km^2 land area, of which 25.1% is densely urbanized while 70.3 and 4.6% are natural landscape and agricultural land, respectively (31). The population density of Hong Kong is 6,715 people per square kilometer for its whole territory and 26,751 people per square kilometer for its urbanized land area (279.6 km^2). There are 18 District Council Districts (hereinafter districts) in Hong Kong, and we performed our analysis at the district level in this study. The district is an important small area unit for administration and council election and is a most commonly used boundary for public communication in Hong Kong.

The Kowloon Peninsula and the north of Hong Kong Island are the traditional urban core where urbanization first took

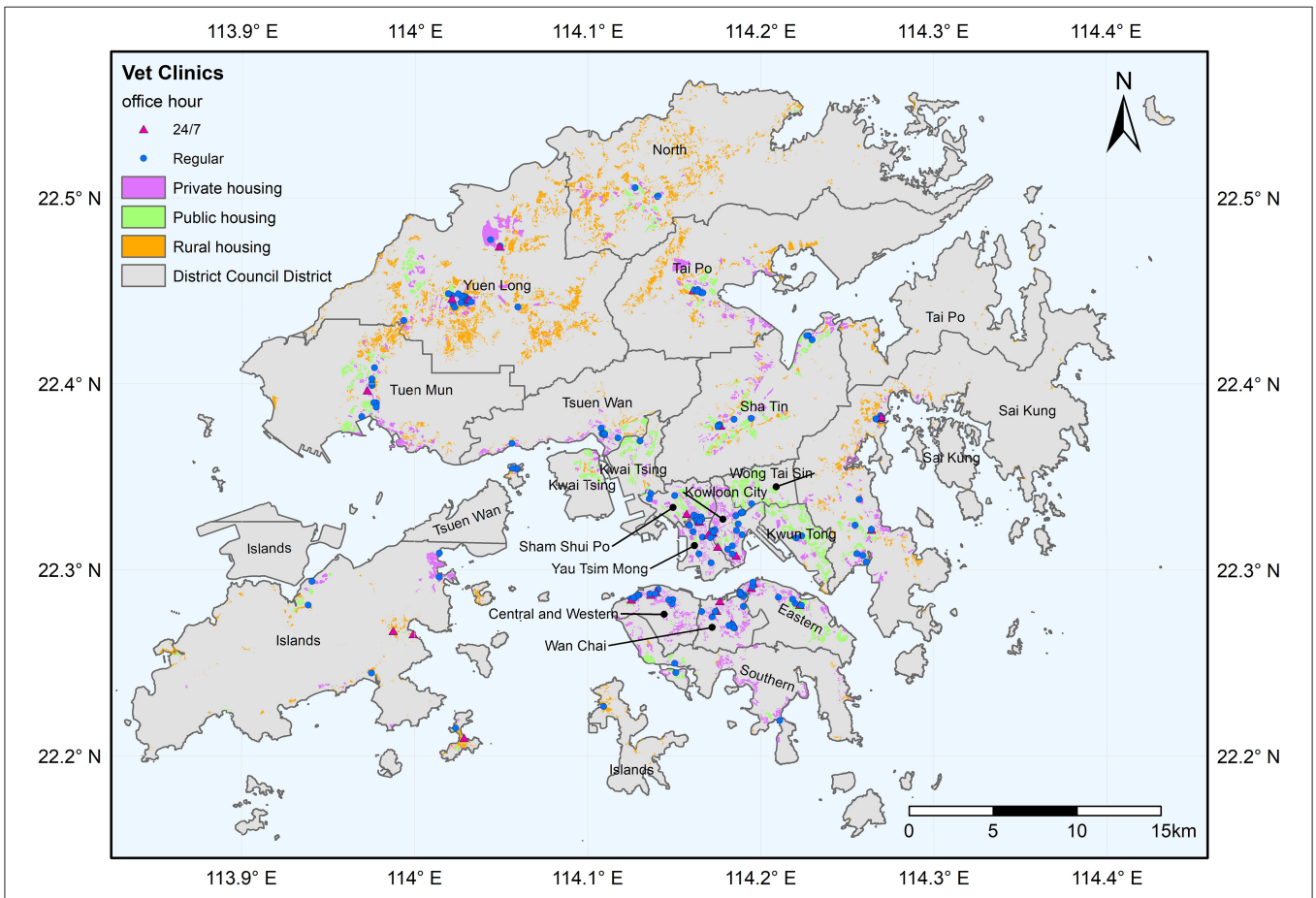

FIGURE 1 | Spatial distribution of general and 24/7 vet clinics and the residential types in Hong Kong.

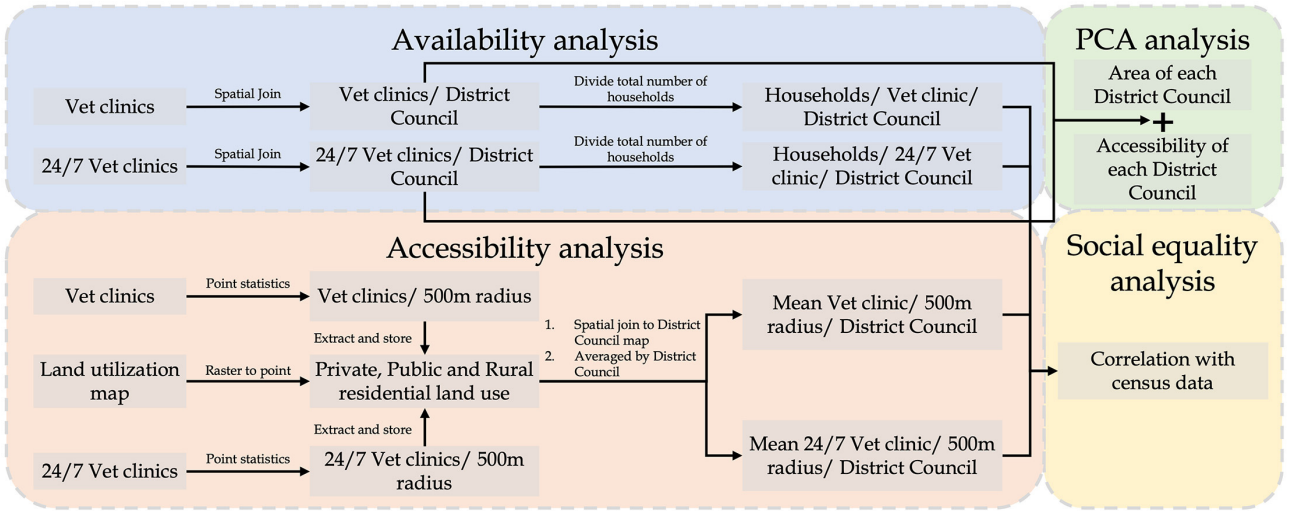

FIGURE 2 | Flow chart of the data processing and analysis of this study.

place. In response to population growth, the population was redistributed away from the core to the new growth area, such as Sha Tin, northern Island, Tuen Mun, and Sai Kung Districts (32). The new growth area is comprised mostly of government-led new towns and many private developments (32). Therefore, as shown in **Figure 1**, housing in the traditional urban core, such as Wan Chai, Yau Tsim Mong, and Eastern Districts are mostly private housing, while the new growth area is composed of much public housing and private housing. Northernmost Hong Kong, such as Yuen Long and North Districts and some outlying islands, such as Island District, are less dense and less developed, featuring extensive rural housing land use built with village houses (**Figure 1**). Public housing (as defined in the land use map in **Figure 1**) can be divided into public rental housing and subsidized home ownership housing. Public rental housing provides accommodation with affordable rental for low-income families who cannot afford the rental of private housing (33). Subsidized home ownership Scheme sells flats for low- to middle-income families at prices cheaper than the property market (33). As of the first quarter of 2020, 30.8, 14.6, and 53.9% of all domestic households in Hong Kong live in public rental housing, subsidized homeownership housing, and private permanent housing, and earn a median household income of 18,000, 28,000 and 40,000HKD, respectively (30).

Data

Data used in this study encompass the addresses and office hours of the veterinary clinics, land utilization map, census data, the Hong Kong coastline, and district map. We first obtained the latest list of veterinary clinics (last updated on July 23, 2020) from the Hong Kong Agriculture, Fisheries, and Conservation Department website. Duplicated records and clinics with no address were removed. Then, we obtained the office hours of each clinic from each clinic's website. Roof-top geocoding was performed by using Google Earth Pro. There are 185 veterinary clinics, of which 30 provide 24/7 services (**Figure 1**).

The 2020 land utilization map, on 10 x 10 m grids, produced by compiling satellite images, governmental surveys, and records, was obtained from the website of the Hong Kong Planning Department (31).

The latest census data (2016 version) were obtained from the Hong Kong government's GeoData Store website. This dataset is in a GIS shapefile comprising 18 districts and bounded by administrative boundary. The Hong Kong coastline was obtained by clipping the global land area by the Hong Kong administrative boundary. The global land area on the Open Streetmap (OSM) was downloaded from https://osmdata.openstreetmap.de/info/license.html. The Hong Kong administrative boundary was obtained from the plugin "Quick OSM" in QGIS. The final product of the census data is a polygon shapefile bounded by the coastline (**Figure 1**). The number of households in the census data was used to proxy the demand for veterinary services.

Data Processing and Analysis

Figure 2 presents four components of this study's analysis and the data processing workflow. Spatial accessibility *per se* considers the number of options available in a given space, while service availability is also affected by the demand that may lead to competition and the shortage when demand outweighs supply. Therefore, the availability analysis will first investigate the supply of and potential demand for veterinary services per district to identify the potential service gap. Hereinafter, *general vet clinics* refer to all veterinary clinics, and the *24/7 vet clinics* are those veterinary clinics providing 24-h services every day or providing emergency services after office hours. *Second*, a Principal Component Analysis (PCA) was conducted to investigate the potential factors leading to the distribution pattern of vet clinics. PCA is a powerful dimensionality-reduction

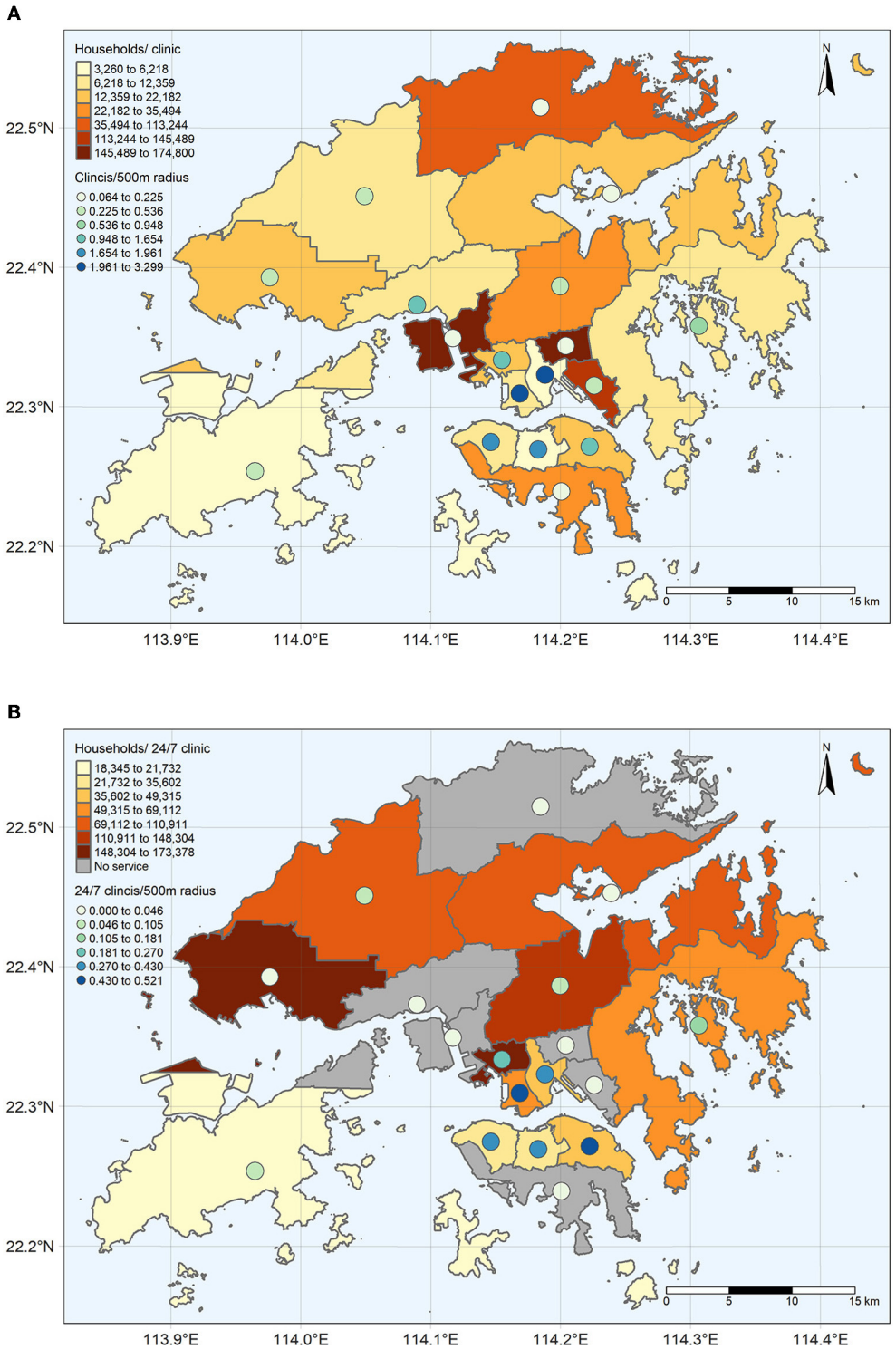

FIGURE 3 | The average number of **(A)** general and the **(B)** 24/7 vet clinics per 500 m radius in residential area per district (point) superimposed on the number of households per **(A)** general and **(B)** 24/7 vet clinic for each district in Hong Kong (polygon). The Natural Breaks classification method is used to determine the interval breaks.

technique widely used for unsupervised machine learning to reduce the data's dimensionality while minimizing information loss and providing valuable data classification information (34). *Third*, the accessibility analysis investigates the number of general and 24/7 vet clinics available within walking distance (500 m). Since the level of urbanization varies by district, averaging the general and 24/7 vet clinics available within walking distance for each district could be biased by its share of land use and the area. Therefore, this study confined the computation of accessibility into the residential area to avoid bias to land use and area. Only private, public, and rural residential land uses were retained in the land utilization map (**Figure 1**). Finally, the relationship between the pattern of socio-demographic characteristics and spatial availability/accessibility was explored. We used R for statistical analysis and ArcGIS for the geospatial analysis of this study.

RESULTS

Potential Service Gap and Accessibility of Veterinary Services

Supply and demand for veterinary services determine the availability of services spatially and temporally. **Figure 3** shows the number of households per vet clinic for each district. Kwai Tsing, Wong Tai Sin, and Kwun Tong Districts experience the most supply-demand deficit, where each vet clinic may serve over 113,244 households (**Figure 3A**). In contrast, districts such as Wan Chai, Islands, and Kowloon City serve the least number of households (6,218 or less) (**Figure 3A**).

Besides, the supply-demand gap widens when considering services out of regular working hours, suggesting spatial and temporal inequalities (**Figure 3B**). There are no 24/7 veterinary services available in North, Tsuen Wan, Kwai Tsing, Wong Tai Sin, Kwun Tong, and Southern Districts. The number of households served by 24/7 vet clinics in the Islands, Central and Western, and the Wan Chai Districts is the least (35,602 households or less), while Tuen Mun and Kwai Tsing serve the most (148,304 households or more). A greater number of households served by the 24/7 vet clinics than general vet clinics is expected as fewer clinics provide 24/7 services, which may be due to higher operating costs and fewer emergency cases than regular cases. However, 24/7 veterinary services are not available in every district, which makes cross-district travel unavoidable for people living in districts without a 24/7 vet clinic to consult the veterinarian under an emergency condition beyond office hours.

Regarding the spatial accessibility of the services, the numbers of general vet clinics within walking distance are the highest in the northern Hong Kong Island, Kowloon City, and the Yau Tsim Mong Districts (**Figure 3A**). On average, people living in these districts may gain access to one or more general vet clinics within walking distance. In contrast, Southern, Kwai Tsing, Wong Tai Sin, North, and Tai Po Districts have fewer general vet clinics within 500 m walking distance (0.064–0.225 vet clinics per 500 m radius), implying that most residents in these communities may require a vehicle ride or long walking journey to its nearest clinic.

The pattern of access to 24/7 vet clinics within 500 m walking distance (**Figure 3B**) generally resembles the pattern of general vet clinics (**Figure 3A**) that the highest average number of 24/7 clinics within a 500 m radius is found in northern Hong Kong Island, Kowloon City and the Yau Tsim Mong Districts. However, the number of available 24/7 vet clinics within walking distance is much fewer than the general vet clinic. For instance, the highest number for general vet clinics is 3.299, while it drops to 0.521 for 24/7 vet clinics. It suggests that, generally, vet clinics may not be reachable within walking distance in most of the residential areas after regular office hours.

Relationship Between Area, Average District-to-District Distances, and the Distribution of Veterinary Services

While we have identified a clustering pattern of vet clinics and unequal access to veterinary services, it is unsure what underlying factors may be related to this spatial distribution of vet clinics. According to the *central place theory* in geography, the location choice of a store rests on two essential concepts—i.e., the inner and the outer ranges (35, 36). The outer range defines the maximum distance the customers are willing to patronize, while the inner range defines the radius of the area from the store that contains the necessary demand to support the store. A store can only be economically viable when the outer range is greater than the inner range because the more-than-necessary demand can be secured in the catchment area (35). Therefore, its attractiveness highly depends on the ease of travel and the store's catchment area. We created a distance matrix of the average district-to-district distances from a district to all the other districts to proxy the accessibility of each district, which is calculated by averaging the Euclidian distance from the centroid point of each district to the centroid points of all the other districts. However, the average district-to-district distances are not significantly correlated with the number of general vet clinics ($P>0.05$) and 24/7 vet clinics ($P>0.05$) for each district. This indicates that the distribution of the vet clinics may not be only related to the overall accessibility of the districts linearly. Furthermore, the average district-to-district distances do not take the regional variation and size of the district into account. Therefore, this paper, as illustrated in **Figure 4**, employed the PCA to explore the relationship between average district-to-district distances (presented as *dist*), area (presented as *area*), and the number of general vet clinics (presented as *vet*) and 24/7 vet clinics (presented as *vet247*).

The four input variables produced four principal components (PCs), known as the data dimensions. The first two PCs explained 92.46% of the total variance, so the first two PCs contained the most useful information. Four clusters can be identified from the biplot of the PC1 and PC2 (**Figure 4**), and they were used to produce a nominal map (**Figure 5**). As shown in **Figure 5**, Yuen Long, Sha Tin, Sham Shui Po, Kowloon City, Yau Tsim Mong, Island Districts, and the districts in the northern Hong Kong Island are higher in the availability of vet clinics. However, Tuen Mun, North, Southern, Wong Tai Sin, Kwun Tong, Tsuen Wan, Tai Po, Kwai Tsing Districts are lower in the availability of vet clinics. From the pattern shown in **Figure 5**, we can observe that

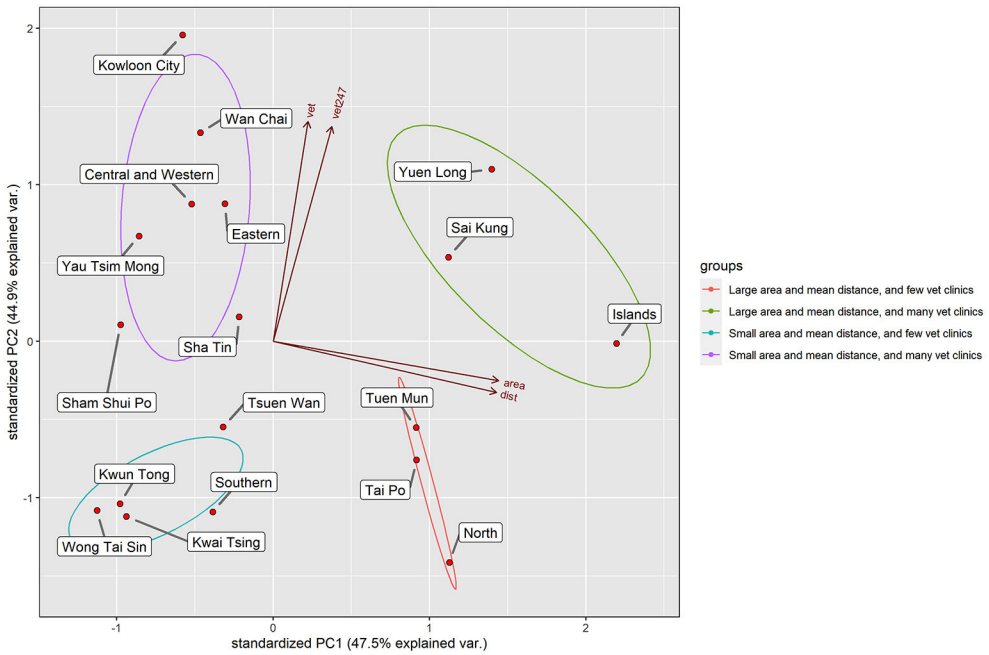

FIGURE 4 | The biplot of the reprojected values on PC1 and PC2. The arrows are the eigenvalues and eigenvectors of each variable.

districts with few vet clinics (districts in green and in purple) are immediately adjacent to the district with many vet clinics (districts in red and in yellow). Therefore, the arrows (**Figure 5**) show the direction of customer flow if vet service is not sufficient (or a 24/7 vet clinic is not available). Overall, one cross-district movement is required for districts with few vet clinics to reach the districts with many vet clinics. The lower average district-to-district distances for a district suggests that travel cost is lower than other districts and indicates that the district is more accessible among the entire territory. Caution should be taken that the average district-to-district distances capture the spatial centrality of the districts, and it provides information on the level of spatial accessibility at the district level. Owing to the shorter average district-to-district distances, vet clinics tend to concentrate in Yau Tsim Mong, Sham Shui Po, Kowloon City and Sha Tin Districts, and the Northern Hong Kong Island. The ease of travel both within and across districts may provide convenience to staff and customers, increasing its attractiveness to recruit staff and attract customers. Since Island and Sai Kung Districts have a large area and are located at the outermost of the Hong Kong territories, their travel time within/between the districts is relatively longer. Therefore, these districts may have an isolated market for many vet clinics, more targeting local patients within the districts. The northernmost part of Hong Kong has a relatively low average district-to-district distance but with a larger area such as Yuen Long, Tuen Mun, and North Districts. As Yuen Long District is large in area and is located between Tuen Mun and North Districts, more vet clinics may serve here for a relatively large within-district market. As a result, the distribution of vet clinics may be related to the accessibility, area, and market.

Social and Spatial Inequality of Accessibility to Veterinary Services

The distribution of vet clinics and 24/7 vet clinics and the space-time supply-demand gap have been investigated above. This section investigates the implication of the spatial-temporal availability of veterinary services to social equality.

Figure 6 shows the correlations of spatial accessibility and availability of general and 24/7 vet clinics with demographic characteristics. When considering the availability of general (*vet*) and 24/7 (*vet247*) vet clinics per district, they significantly correlate with the number of domestic households living in private housing (*dh_pri*). This suggests that districts with more private-housing households have more general and 24/7 vet clinics. Furthermore, the availability of 24/7 vet clinics also positively correlates with the median monthly domestic household income (*ma_hh*), population with a post-secondary degree (*edu_deg*), and households with monthly domestic households income ≥60,000HKD (*dhi_7*; the highest income category in the census record). This implies that vet clinics offering 24/7 services may tend to locate in the district with a larger population with higher educational attainment, the wealthiest households, more private-housing households, and higher median monthly domestic household income.

The spatial accessibility of general (*vetbuf500*) and 24/7 (*v247buf500*) vet clinics positively correlates with the number of households living in private housing, which is statistically significant at 0.05 level. It is consistent that availability at the district level and within walking distance positively correlates with private housing households (statistically significant at 0.05 level). The accessibility of general vet clinics also negatively

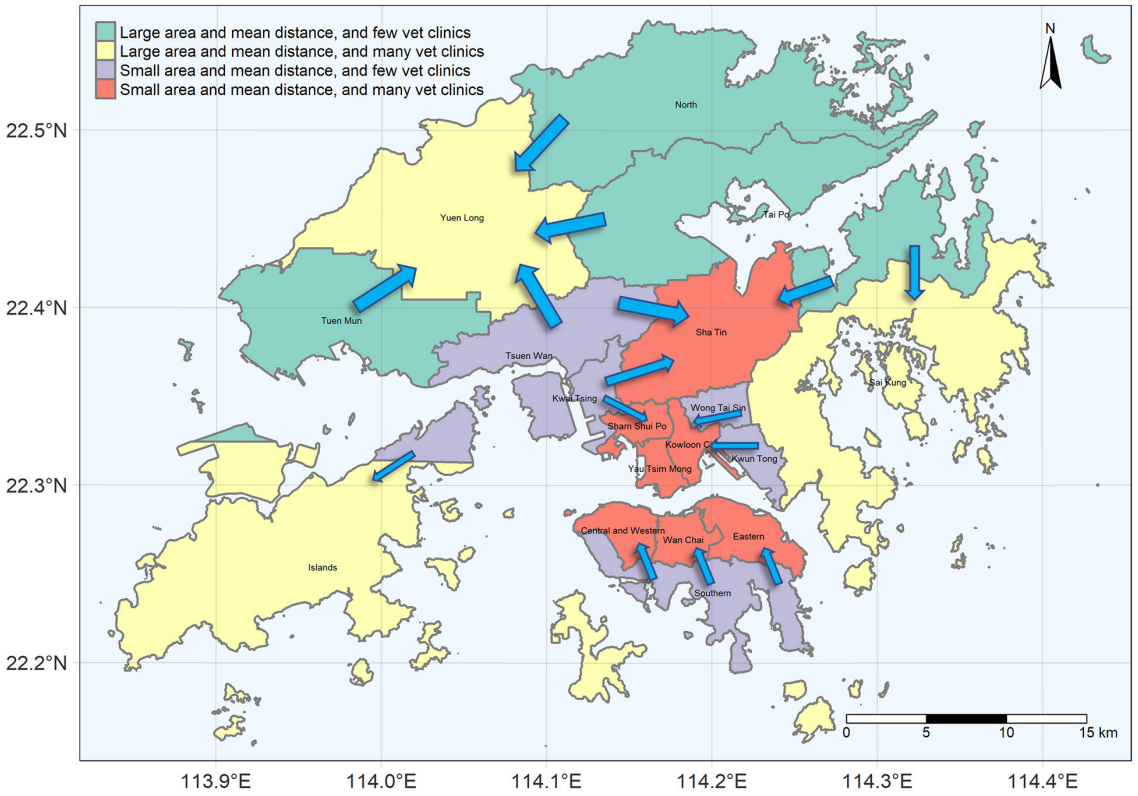

FIGURE 5 | Classification map derived from the PCA in **Figure 4**. Arrows indicate the movement of customers.

correlates with the average domestic household size (*adhz*), and the number of public housing households (*dh_pub*) and subsidized homeownership households (*dh_s*) (all are statistically significant at 0.05 level). Overall, districts with higher availability of general vet clinics per 500 m radius in residential areas may have a smaller average domestic household size and less public and subsidized housing households while having more private housing households. Conversely, the accessibility of 24/7 vet clinics also significantly correlates with the number of households with monthly households income ≥60,000HKD. Therefore, it may suggest that a community with more wealthiest households may be more accessible to the 24/7 vet clinics within walking distance. Other than ≥60,000HKD income category, none of the other income categories (≤6,000; 6,000–9,999; 10,000–19,999; 20,000–29,999; 30,000–39,999; 40,000–59,999) significantly correlated with accessibility and availability of general or 24/7 vet clinics.

Spatial accessibility of veterinary services was also examined with residential types. We averaged the number of general and 24/7 vet clinics per 500 m radius per grid in the residential area by housing type (**Figure 7**). On average, people living in private housing can reach 1.07 vet clinics, which is the greatest among all housing types (Public: 0.42; Rural: 0.17) (**Figure 7A**). This difference is statistically significant at 0.01 level according to the ANOVA test. As expected, the difference in the number of 24/7 vet clinics accessible among residential types is identical to the general vet clinic, while the reachable number of clinics drops substantially (Private: 0.160; Public: 0.08; Rural: 0.03; $P < 0.01$ according to ANOVA test) (**Figure 7B**). Age and marital status were also incorporated into the correlation analysis, but no significant relationship was found.

DISCUSSION

This study provides an exploratory analysis of how the provision of veterinary services varies across space and time and its implication to social equality by using advanced geospatial data techniques.

Employing PCA, we found that the area and the average district-to-district distances may be related to the locational decision of vet clinics. Stores tend to locate in areas where a sufficient population can visit within acceptable travel distance and be economically viable (37). In addition, as the minimum differentiation theory and the principle of cumulative attraction suggest, stores with similar features may be economically viable when they are arranged in a clustered geographic order than in a dispersed manner (37). A cluster of stores with a similar nature can provide wider choices within a restricted area and hence, it may reduce the uncertainty and search cost for the customers, increasing the market's overall attractiveness (36, 37). This may address why the vet clinics cluster spatially (**Figure 1**).

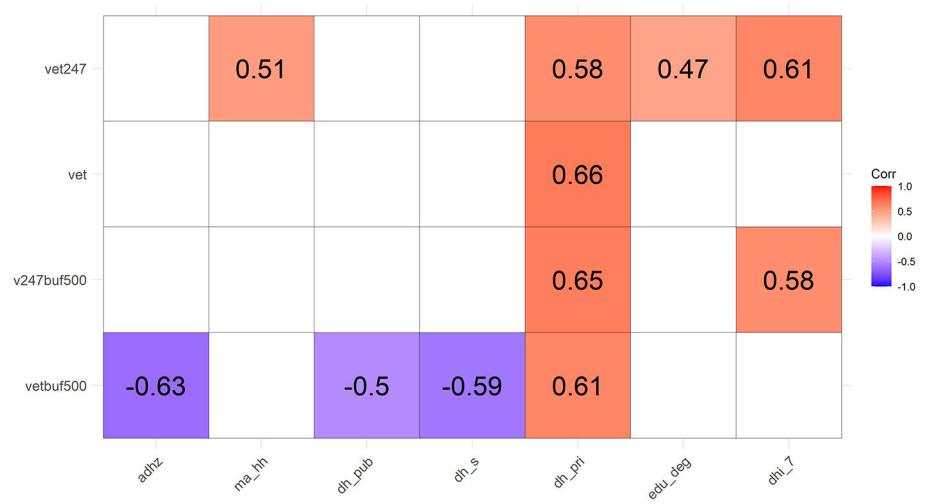

FIGURE 6 | Correlation matrix of accessibility and availability of general and 24/7 vet clinics with demographic characteristics. Correlation with a *P*-value >0.05 is left blank.

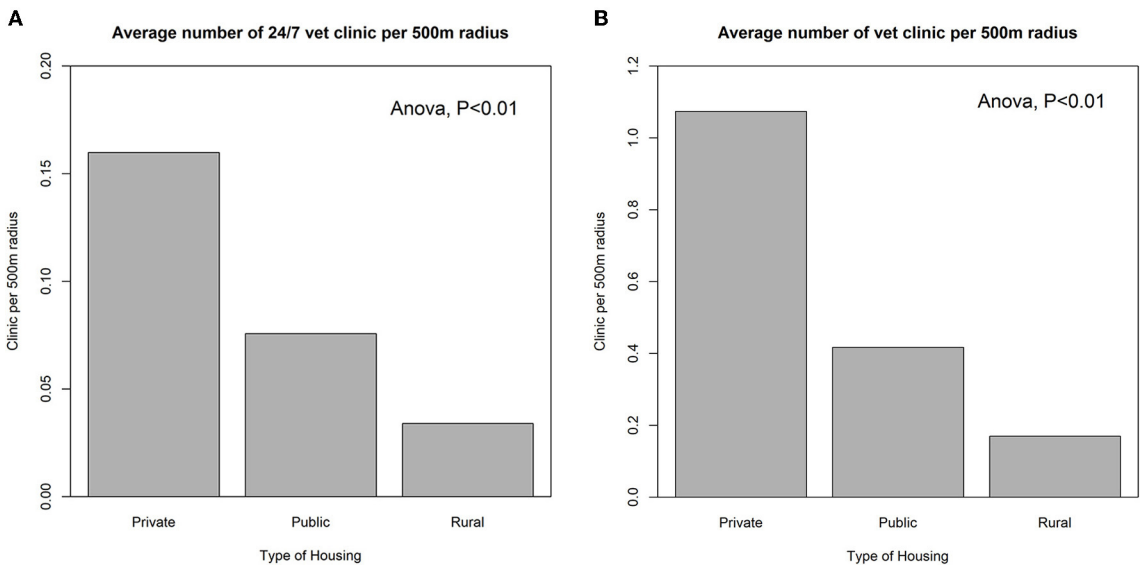

FIGURE 7 | The average number of **(A)** general and **(B)** 24/7 vet clinics by housing type per 500 m radius per 10 m x 10 m grid in the residential areas.

Apart from the physical environment as revealed in the PCA analysis, the demographic characteristics may also alter the spatial-temporal provision of veterinary services, further revealing the underlying business consideration and social inequality. This study discovered that general and 24/7 vet clinics are the most available and accessible to private housing than public and rural housing. Besides, household income, as well as educational attainment, is also positively related to the accessibility and availability of 24/7 vet clinics in a district. A previous study has indicated that private-housing households dominate the number of pet ownership in Hong Kong: 85 and 63.8% of households that owned cats and dogs are living in private housing, respectively; and 14.9 and 36.2% of households that owned cats and dogs are living in a public rental or subsidized homeownership housing, respectively (29). This suggests that private housing households may constitute the major market share of veterinary services. People with higher income are more likely to have a pet (29) and have fewer financial constraints to veterinary care (38). Moreover, the positive influence of educational attainment on visiting vet clinics rests on a better awareness of their pets' medical needs (13) and more promising employability (38). Besides, accessibility to general vet clinics is negatively associated with household size (**Figure 6**). A previous study found that over 40% of

households keeping dogs/cats in Hong Kong have only one to two household members (29). Further study is required to investigate the relationship between pet ownership and household size, while the negative association between the household size and accessibility to general vet clinic may relate to the covariation with pet ownership. Moving to the perspective of clinic operation, veterinarians with the heavy education debt load, productivity-based remuneration system of a clinic, together with logistical, operational, and financial challenges, may discourage the setup of vet clinics in remote or rural areas (38). Therefore, vet clinics may target a more affluent and educated population to cover the most active group of customers. However, this market-oriented practice may consequently facilitate unequal access to veterinary services (13).

In Hong Kong, the public transport system is mature, facilitating low car dependency (39, 40) and achieving around 90% of the passenger trips using public transport (41). Railways and franchised buses are the most popular transit mode (75.1%) (**Table 1**), but they explicitly prohibit animals (42). Riding with animals on Public Light Buses are at the drivers' discretion, but they are low in capacity (16 passengers per vehicle). Furthermore, Public Light Buses serve as the supplementary transport mode providing services for the area where the market is too small to support franchised buses service or for the area with low accessibility (44). Therefore, Public Light Buses cannot provide universal service, and its low capacity may also make it uncertain whether the owner can reach vet clinics on time. Pets are also allowed by some ferry operators. For instance, each pet is charged 9.5 to 20.5HKD for routes operated by Sun Ferry Services Company Ltd (43). However, some of the additional costs are comparable to the base charge of taxis (from 19 to 24HKD). Ferry is a less popular travel mode in Hong Kong (**Table 1**), where the railway is centered as the backbone of the public transport system (44). Under the circumstance that the transit system is very convenient and cheap, people in Hong Kong mainly rely on public transit for their daily travel. Taking a taxi is the most viable option for seeking veterinary services, especially in an urgent situation, as it provides point-to-point and high flexibility services and minimizes the required walking journey. Therefore, the transport option is limited, and the distance to veterinary services may lead to additional expenditure other than veterinary consultation costs.

Those living in the public rental or subsidized homeownership housing feature lower income and low private car ownership (32). Therefore, they can be sensitive to transportation costs and consultation costs. Though this research found that households living in rural housing (combined with the private housing household by the government in the census data) have the lowest accessibility, they have higher income and also higher car ownership (32). Therefore, those living in public housing could be more sensitive to transportation and cost. These suggest that those who are wealthier (and more sophisticated) have greater accessibility to general (and 24/7) veterinary services than those who are less financially viable. Therefore, less affluent people may take more time and cost for accessing veterinary services. Future studies should conduct a micro-scale study on the barriers and difficulties of taking a taxi to seek a veterinarian to justify this hypothesis further. The cost barriers plus financial constraints may reduce the pet owners' willingness to seek veterinary services, increasing the risk of their pets developing serious diseases due to delay in seeking treatment (14, 27). Furthermore, the financial burden on raising pets may also increase the risk of pet relinquishment (45, 46). A previous survey conducted in Hong Kong found that 52.6% of respondents who had considered relinquishment attribute the reason to financial problems (29). Hence, the cost of raising pets, such as transportation, veterinary cost, and daily necessity, is one of the factors to be emphasized in animal welfare issues.

TABLE 1 | Public Transport Patronage in 2019 and animal-friendly policy by Mode.

Transport mode	Thousand patronages (%)	Allow animal (except guide dog)	Additional charge
Railways	1,917,359 (42.2)	No	/
Franchised buses	1,494,283 (32.9)	No	/
Public light buses	642,796 (14.2)	On driver'/ operators' decision	No
Taxis	311,945 (6.9)	On driver's decision	Yes
Residents' services	77,989 (1.7)	No data	/
Ferries	44,593 (1)	Varies among operators	Vary
MTR buses	51,484 (1.1)	No	/

Source: (40, 42, 43).

To relieve the financial burden, both from consultation costs and transportation, low-cost and/or mobile services can be provided for the underserved community. Many low-cost or free veterinary services have been established in many countries such as Canada (47), the U.S. (27, 48), and the United Kingdom (49). In Hong Kong, SPCA and Non-Profit making Veterinary Services Society (NPV) have provided reduced-cost, mobile services for the outlying areas (50, 51). These services may alleviate the financial burden for the underserved population and promote the equity of medical support. For instance, the SPCA mobile clinic serves around 3,000 companion animals annually (50). However, the SPCA suspended the mobile clinic since 2020 owing to operational reasons, while the NPV mobile clinic only provides service 2 days a week (50, 51). This may incur a threat to animal welfare as the service may become more competitive and those who cannot afford the regular price may delay seeking medical services until their pet deteriorates to a serious condition.

The implication for future veterinary services from this paper's findings is twofold. First, focusing areas in the spotlight may overlook areas otherwise in need. For instance, the mobile clinics, operated by both SPCA and NPV, provide services in remote areas, such as Tuen Mun, Island, and the North Districts (50, 51). However, some new growth areas, such as Wong Tai Sin, Southern, and Kwai Tsing Districts, are close to the traditional urban core but are also poor in accessibility to veterinary services

(**Figures 3A,B**). Therefore, the need-based veterinary services should also consider areas not geographically remote but are indeed the service desert. Second, need-based services should also extend beyond regular office hours. To our understanding, low-cost veterinary service is rare and only NPV provides both low-cost and 24/7 services (51, 52). However, the NPV is situated in Eastern and Yau Tsim Mong Districts, while only the latter provides 24/7 service (51, 52). The limited spatial-temporal coverage of low-cost services, plus the focus on the remote area, may create a service gap in new growth areas close to the traditional urban core.

Due to this paper's findings, the authors call for a comprehensive situational analysis of Hong Kong's animal welfare through qualitative and quantitative approaches. This paper found that geographically accessible new growth areas may be overlooked in the need-based service system and we cannot accurately estimate the number of the needy. To sustain and optimize the need-based services, future study should estimate the number of the needy and provide a clearer picture of the service gap and lay down a direction for service planning. For instance, a public health study on adult obesity in the U.S. used survey data to simulate the prevalence of obesity at the county level by using spatial microsimulation techniques (53). Future studies may consider this technique to estimate the actual demand for veterinary services. In addition, we also need to investigate how other factors, such as transportation, consultation cost, and language barriers, may affect owners' decision on seeking veterinarians, which is important to identify how to improve the overall service system to safeguard the companion animal's welfare.

This study provides an empirical framework for carrying out cross-disciplinary analysis on animal welfare and an essential account of the strategic planning of veterinary services. Yet, there are some limitations of this research. This paper used household numbers rather than the actual pet counts to investigate the supply-demand gap due to data unavailability. This method may yield potential errors as it does not account for some contextual factors related to pet ownership, such as the prohibition of raising pets in the property and limited room for raising pets. Furthermore, this study does not account for the clinic's capacity, such as the number of veterinarians on duty, reputation, services provided, and open hours. Therefore, it may pose some potential errors in estimating the supply-demand gap. However, this may not affect our conclusion on the spatial accessibility of veterinary services because we focus on the distance and travel impedance over space and time rather than whether the demand can be totally met.

CONCLUSION

Using GIS, this study examined the spatial-temporal accessibility of veterinary services and their implication to social and spatial inequality in Hong Kong. Our study implies that there may exist spatial-temporal inequalities in accessibility of veterinary services, potentially worsening animal welfare in Hong Kong. We also argue that the need-based veterinary support tends to target remote rural areas while overlooking the new growth areas close to the traditional urban core but poor in the accessibility of veterinary care. Therefore, a comprehensive investigation into the pet ownership landscape and their needs over space and time will be beneficial to construct a more robust protection net for animal welfare in Hong Kong.

DATA AVAILABILITY STATEMENT

Data used in this paper are publicly available and the source is disclosed in this paper. The processed data supporting the analysis of this article can be made available by the authors on request.

AUTHOR CONTRIBUTIONS

KN: conceptualization, methodology, software, formal analysis, investigation, data curation, writing—original draft, writing—review and editing, and visualization. CH: conceptualization, writing—original draft, and writing—review and editing. KK: conceptualization, methodology, writing—original draft, writing—review and editing, supervision, project administration, and funding acquisition. All authors contributed to the article and approved the submitted version.

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A Pilot Study Examining the Experience of Veterinary Telehealth in an Underserved Population Through a University Program Integrating Veterinary Students

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Cost and transportation are two commonly cited barriers to accessing health care in both human and veterinary medicine within underserved communities. While human medicine has utilized telehealth as a means of breaking down this barrier, limited research exists to describe its use in veterinary medicine. The Pets for Life (PFL) program has partnered with the Penn Vet Shelter Medicine Program to provide veterinary appointments to clients, at no cost to the client, in underserved zip codes through virtual telehealth visits. These visits incorporated veterinary students as part of their clinical rotations through a service learning based model. Between January and August 2021, 31 PFL clients and nine veterinary students completed surveys to describe the role of telehealth in addressing barriers to accessing veterinary care, their perceptions of telehealth appointments, the human-animal bond, and changes in veterinary student empathy. PFL clients completed the survey immediately following their telehealth appointment, and veterinary students completed surveys prior to and following their participation in the PFL appointments during the rotation. Nearly 25% of clients reported that they would not have been able to secure transportation and 58% reported they would not have been able to afford an appointment at an in-person veterinary clinic. The population of clients who responded that cost was a significant barrier to accessing care did not entirely overlap with those who responded that transportation was a significant barrier to accessing care, indicating support for the use of telehealth in providing an alternative modality to address transportation challenges as a barrier to accessing veterinary care. Additional data suggests that both client and student experience was overwhelmingly positive, providing support for further service learning initiatives in veterinary student education. Further research is warranted to continue to assess the emerging role of telehealth in improving veterinary care for underserved communities.

Keywords: access to care, telehealth, barriers to veterinary care, veterinary student, veterinary education, human-animal bond

INTRODUCTION

Social and economic factors, including access to food and transportation, housing status, and educational attainment, contribute to up to 40% of human health outcomes (1). Individuals who lack security in these social and economic factors subsequently experience poorer health outcomes that can ultimately negatively affect both length and quality of life. Similar barriers can also prevent underserved pet owners from accessing veterinary care. Although there is overall a lack of literature regarding veterinary care in underserved communities, the most commonly identified barriers to care include cost, accessibility of care, lack of veterinarian-client communication, culture/language, and lack of client education (2).

One initiative that has tried to address these barriers to human health care in underserved communities includes the use of telemedicine and telehealth. Telemedicine is defined by the World Health Organization as

> The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities [(3), p. 9].

Telemedicine is further differentiated from telehealth as being, "restricted to service delivery by physicians only, and the latter signifying services provided by health professionals in general, including nurses, pharmacists, and others" [(3), p. 9]. The broader definition of telehealth is utilized for the remainder of this paper. A review of the literature regarding telehealth in developing countries shows that telehealth can improve access to quality healthcare and can even allow patients to seek earlier treatment with better continuity of care, especially for those with chronic conditions (3). Additionally, recent studies that examine the use of telehealth specifically during the SARS-CoV-2 pandemic show that the use of televisits are an important resource for increasing access to care, specifically for non-surgical specialties (4). Research on the use of telehealth in veterinary medicine specifically is limited, however published data supports similar advantages to pet owners in terms of increased access to care and overall positive experiences (5).

Telehealth has also been described as a means for providing educational opportunities for medical students. A mixed-methods review of literature regarding telehealth training in medical education indicates that it has been integrated into lessons, ethics case studies, clinical rotations, and teleassessments, to provide a valuable experience for students (6). However, its use in human medical education remains relatively limited and further incorporation of this emerging platform is indicated (7).

Current methods for providing client communication education for veterinary students include staged interactions, small group communication teaching, peer assisted learning, and evaluation of recorded authentic client interactions (8–11). A unique approach to client communication education includes the use of service learning. Service learning focuses on reflecting upon service based community experiences in a reciprocal nature in order to benefit all participants (12). A recent study in the veterinary field has shown that students who have participated in a low cost clinic that promotes service learning have positive experiences that provide valuable learning opportunities while improving access to care for pet owners (13). There is currently very little research on the impact of telehealth in veterinary education, and no known studies on its use within the context of underserved communities. The purpose of this study was to evaluate the experience of veterinary telehealth for underserved pet owners and the ability of telehealth to eliminate barriers to veterinary care within underserved communities. A secondary aim was to describe veterinary students' perceptions of telehealth and changes in student empathy following participation in a service learning veterinary telehealth rotation.

MATERIALS AND METHODS

Pets for Life Program

The purpose of the Pets for Life (PFL) programming of the Humane Society of the United States is to provide pet resources to members of underserved communities through positive and long-term relationships in the context of door-to-door community outreach (14). PFL outlines distinct initiatives that allow their organization to address potential barriers to pet ownership. One of these initiatives is direct care, which utilizes relationships built through an established community liaison to schedule at-home veterinary visits to clients and their animals in specific neighborhoods of Philadelphia, at no cost to the client (14).

The Penn Vet Shelter Medicine Program has partnered with PFL to offer medical and surgical services for over 8 years. Faculty, interns, and supervised students through that time period have offered varied programs including vaccine clinics, spay-neuter surgery, and at-home visits for patients. The Penn Vet Shelter Medicine Program and PFL has had a continued interest in developing a telehealth component to public outreach programs to help alleviate some challenges in accessible care as indicated in human literature (3). The SARS-CoV-2 pandemic accelerated this development process as the team recognized that at-home visits were a high risk for disease transmission but wanted to continue to provide services to the community. The Penn Vet Shelter Medicine Program hosts an internship program for veterinary graduates, which is offered through the Veterinary Internship and Residency Matching Program (VIRMP) (15). This internship program requires completion of a community-directed project, and in 2020, the project focused on the development of a new telehealth service for PFL clients. These appointments are seen by interns, faculty, and veterinary students during the shelter medicine clinical rotation. As part of the program's development, assessment of the program's impact for clients and their pets was integrated. Since this service was being utilized in the shelter medicine rotation during the SARS-CoV-2 pandemic for student experiences, the pilot evaluation

also included evaluating the perceptions of telehealth and clients for student education.

PFL Appointment Structure

The PFL program independently scheduled individuals for appointments appropriate for telehealth as designated by the Penn Vet Shelter Medicine team. A community liaison, an employee of PFL, was in charge of communicating with clients in Spanish, troubleshooting technology, and scheduling appointments. The liaison participated in appointments individually through the virtual platform. At least one PFL community liaison was in attendance during at least a portion of each appointment. All appointments were conducted via a virtual video chat platform (16), and each appointment was scheduled for a 1 h time slot. Approximately three appointments were scheduled per day. The Penn Vet Shelter Medicine Program faculty and staff hosted appointments once per week. Students were present for these appointments twice a month. The remainder of the appointments were hosted by the program faculty and/or intern only.

These appointments ranged from general health consultations to non-life threatening sick appointments. For each scheduled appointment, the veterinary team and veterinary students would sign on to the virtual platform along with the client and community liaison. Each person would join the appointment individually through their personal device. The veterinary team consisted of one program intern, and one to two faculty veterinarians. There were generally between three and four veterinary students present on the call, however only one student was assigned as the lead on each appointment. This student would take primary responsibility during the appointment under the supervision of the program veterinarian. This included history taking, devising appropriate treatment plans, client communication, and post appointment medical record keeping. Telehealth regulations in effect during the study period allowed for establishment of a veterinary patient client relationship in order to provide a diagnosis and subsequent treatment for patients through the virtual platform. All medical records and discharges were reviewed by a program veterinarian prior to finalization. The PFL team scheduled any needed follow up appointments as directed by the Penn Vet Shelter Medicine team.

The PFL appointment interactions closely followed the service learning model within the context of higher education. Student contributions to appointments were monitored by the Penn Vet intern and faculty veterinarians in order to ensure that the experience closely matched each client's individual goals for their animals. Students were also asked to discuss their experience immediately following the end of the appointment day in order to reflect on the interaction and gain insight into its impact on the community. Penn Vet faculty instructors present during the appointment were experienced in debriefing such learning models.

Surveys were administered to clients and veterinary students through Qualtrics between January 2021 and August 2021. The survey distributed to clients was utilized to collect information on access to veterinary care, appointment outcome, and veterinary student-client communication. The survey that was distributed to fourth year veterinary students was used to comparatively evaluate client communication, appointment outcome, and the impact of these appointments on veterinary student attitudes and perspectives toward working with and providing care for the underserved. After initial review from the University of Pennsylvania's Institutional Review Board, this study was deemed minimal risk and was exempt from full review (IRB protocol number 843503).

Client Survey

All individuals who were scheduled for a telehealth appointment with the Penn Vet Shelter Medicine Program by PFL for the first time were eligible for the study. After the conclusion of the appointment, students and faculty exited the virtual meeting space, leaving the PFL community liaison and the client on the call. The community liaison would then ask if the client would like to participate in an optional study. If the client agreed, an online survey was administered verbally. Responses to the survey were recorded anonymously by the community liaison through the Qualtrics software. The liaison was able to administer a pre-translated survey in Spanish, should the client have requested this.

The client survey included demographic data, as well as a five question survey designed to look at the effectiveness of veterinary student communication throughout the appointment from the perspective of the client. Each question was designed as a five point Likert scale from 1-5 (strongly disagree to strongly agree). There was an additional section for optional open text feedback. The client survey was administered in the same manner regardless of whether or not students were present during the appointment. Please see **Table 1** for a full copy of the client survey.

Veterinary Student Survey

All veterinary students participating in their clinical year elective shelter medicine rotation during the study period were eligible for participation in this study. Rotations lasted 2 weeks in duration, with students participating in one PFL appointment day per week. Participation in clinical rotation activities, including telehealth appointment days, was required for a passing grade for the rotation, however completing the survey was optional and did not have any impact on grading.

The veterinary student survey portion of this study was administered to veterinary students in the form of two separate online surveys, one prior to participation in the first PFL appointments scheduled and one following participation in the final PFL scheduled appointments. At the beginning of the Shelter Medicine elective rotation, the instructors verbally described the survey, including that it would remain anonymous and their participation had no impact on their grade. Veterinary students were sent an initial pre-appointment Qualtrics survey link by the shelter medicine rotation course organizer, which included a unique ID code for each student that was used for both pre- and post-appointment surveys so that data could be paired for each individual, but anonymized. Students were able to complete this survey until their participation in the first PFL appointment during the rotation. If they did not

TABLE 1 | Client post appointment survey.

Demographics
What would best describe you?
What is your gender?
What is your age?
What is your education level?
How many people live in your home including yourself (if you do not wish to answer this question, please write N/A)?
How many animals live in your home for the majority of the day?
Access to care
If the Pets for Life program had not provided this telehealth appointment, would you and your pet have been able to secure transportation in order to attend an appointment at an in person veterinary clinic?
If the Pets for Life program had not provided this telehealth appointment, would you have been able to afford an appointment at an in person veterinary clinic?
Comparative survey
Please respond to the following statements on a scale of 1–5 (strongly disagree to strongly agree):
My expectations for the appointment were met today.
I feel a strong bond with my pet
I understood what the vet team discussed with me today.
I am satisfied with the outcome of today's appointment.
I felt that the student involvement in the appointment was a positive experience.
Please provide any additional feedback regarding your experience with Pets For Life today.

TABLE 2 | Veterinary student pre appointment survey.

Demographics
What would best describe you?
What is your gender?
What is your age?
Have you completed your Pets for Life appointment day as part of your Shelter Medicine rotation?
Jefferson scale of empathy rated on a scale from 1 to 7 (strongly disagree to strongly agree).
Three items out of 20 are listed for illustrative purposes
2. Patients feel better when their physicians understand their feelings.
7. Attention to patients' emotions is not important in history taking.
14. I believe that emotion has no place in the treatment of medical illness.

complete the pre appointment survey prior to getting oriented to the appointments immediately preceding their participating in the first appointment, they were ineligible for the study. Approximately 48 h following the second PFL appointment day, veterinary students were sent the post appointment survey. Students were required to enter the same unique ID code that was given to them with the initial pre appointment survey. Students were sent an additional reminder email to complete the post appointment survey within the month following the conclusion of their rotation.

The pre-appointment survey included demographic information, as well as administration of the Jefferson Scale of Empathy, Medical Student Version (17). This is a 20 question validated scale that was utilized to evaluate any changes in empathy toward patients after participating in the PFL appointments. A total empathy score was calculated according to the established scoring system (17). Please see **Table 2** for a full copy of the pre appointment veterinary student survey, including three items from the Jefferson Scale of Empathy for illustrative purposes.

The post-appointment survey included the same Likert scale questions that were administered to the client about veterinary-student client communication. In addition, the veterinary student survey included the post appointment administration of the Jefferson Scale of Empathy.

Please see **Table 3** for the full veterinary student post appointment survey.

Statistical Analysis

Data were analyzed using SPSS Statistics (IBM SPSS Statistics for Windows, Version 27). Descriptive statistics were calculated regarding the demographic characteristics of the sample, client-student perceptions of the telehealth appointment and barriers to veterinary care. Mann Whitney U tests were used to compare client perceptions of the veterinary appointment relative to the presence of students. A Wilcoxon Signed Rank Test was used to compare pre- and post-veterinary student empathy scores. A Mann-Whitney U Test was also used to compare pre-veterinary student empathy scores between students who completed the post-survey and those who did not. Statistical significance was set at $p < 0.05$.

RESULTS

Participant Demographics

A total of 31 clients and nine veterinary students were included in the final dataset. Twenty two students completed the pre appointment survey, 11 students completed the post appointment survey, and nine students had valid pre and post appointment survey responses. Of the 31 clients, 18 client responses were collected when students were present on the rotation. The remaining 13 responses were collected when only the veterinary staff was present. All 31 clients who participated in the PFL appointment days chose to participate in the study.

Clients identified as Black or African American ($n = 9$, 29%), White/Caucasian ($n = 11$, 36%), Hispanic or Latino ($n = 9$, 29%) or other ($n = 2$, 7%). Most client respondents were female ($n = 23$, 74%). The average education level possessed by clients was a high school degree or equivalent ($n = 17$, 55%). Demographic data for clients is represented in **Table 4**. Of the nine student participants, all of them identified as White/Caucasian female students between the ages of 25 and 34.

Client Survey Results

Client Perceptions

All clients agreed or strongly agreed that their expectations for the appointment were met ($n = 5$, 16% and $n = 26$, 84%, respectively). Similarly, the majority of clients agreed or strongly agreed that they understood what the veterinary team discussed

TABLE 3 | Veterinary student post appointment survey.

Demographics
What would best describe you?
What is your gender?
What is your age?
Have you completed your Pets for Life appointment day as part of your Shelter Medicine rotation?
Comparative survey
Please respond to the following statements on a scale of 1–5 (strongly disagree to strongly agree):
I felt my client's expectations for the appointment were met today.
I felt that the client had a strong bond with their animal
I felt that the client understood what the vet team discussed with them today.
I am satisfied with the outcome of today's appointment.
I felt that my involvement in the appointment was a positive experience for the client.
Please provide any additional feedback regarding your experience with Pets For Life today.
Jefferson scale of empathy rated on a scale from 1 to 7 (strongly disagree to strongly agree).
Three items out of 20 are listed for illustrative purposes.
2. Patients feel better when their physicians understand their feelings.
7. Attention to patients' emotions is not important in history taking.
14. I believe that emotion has no place in the treatment of medical illness.

TABLE 4 | Client demographic data.

Characteristics	N	%
Race/ethnicity		
Black or African American	9	29.0
White/Caucasian	11	35.5
Hispanic or Latino	9	29.0
Other	2	6.5
Gender		
Male	8	25.8
Female	23	74.2
Age		
18–24	3	9.7
25–34	6	19.4
35–44	6	19.4
45–54	5	16.1
Over 55	11	35.5
Education level		
Less than a high school diploma	2	6.5
High school degree or equivalent	17	54.8
Bachelor's degree	9	29.0
Master's degree	1	3.2
Other	2	6.5

with them ($n = 1$, 3% and $n = 30$, 97%, respectively). Clients also agreed or strongly agreed that they were satisfied with the outcome of their appointment ($n = 4$, 13% and $n = 27$, 87%, respectively).

Mann-Whitney U tests were utilized to compare client perception responses to each individual survey question between those who had students present and those who did not. There was no significant difference found between the responses.

Barriers to Veterinary Care

The majority of clients responded that they would not have been able to afford an appointment at an in person veterinary clinic had the PFL program not provided the telehealth appointment ($n = 18$, 58%). The remaining clients responded that they either would have been able to afford the appointment (16%, $n = 5$), or were not sure if they would have been able to afford the appointment (26%, $n = 8$).

The majority of clients responded that they would have been able to secure transportation to attend an in person veterinary clinic had the PFL program not provided the telehealth appointment (68%, $n = 21$). The remaining clients responded that they would not have been able to secure transportation (23%, $n = 7$) or were not sure if they would have been able to secure transportation (10%, $n = 3$). Please see **Table 5** below for further representation of barriers to veterinary care data.

Human-Animal Bond

The majority of clients either agreed or strongly agreed that they felt a strong bond with their pet ($n = 2$, 7% and $n = 28$, 90%, respectively). The remainder of the clients were undecided ($n = 1$, 3%).

Student Involvement

For those appointments that included veterinary students ($n = 18$), clients agreed or strongly agreed that the student involvement in the appointment was a positive experience ($n = 2$, 11% and $n = 16$, 89%, respectively).

Veterinary Student Survey Results

Veterinary Student Perceptions

Twenty-six students participated in the rotation during the study period and were eligible to complete the survey. Out of the 26 students, 22 completed the pre-rotation survey, 11 completed the post-rotation survey and nine students had both pre and post-test data. All students agreed or strongly agreed that they felt their clients expectations for the appointment were met ($n = 7$, 64% and $n = n = 4$, 36%, respectively). Students also agreed or strongly agreed that they felt the client understood what the veterinary team discussed with them ($n = 7$, 64% and $n = 4$, 36%, respectively). Similarly, the majority of students agreed or strongly agreed that they were satisfied with the outcome of the appointment ($n = 7$, 64% and $n = 4$, 36%, respectively).

Human-Animal Bond

All veterinary students agreed or strongly agreed that they felt their client had a strong bond with their animal ($n = 2$, 18% and $n = 9$, 82%, respectively).

TABLE 5 | Cross-tabulation showing overlap between transportation and cost barriers to veterinary care.

Cost	Transport			
	Yes *n* (%)	No *n* (%)	Not sure *n* (%)	Total *n* (%)
Yes *n* (%)	5 (16)	12 (39)	1 (3)	18 (58)
No *n* (%)	1 (3)	4 (13)	0 (0)	5 (16)
Not sure *n* (%)	1 (3)	5 (16)	2 (7)	8 (26)
Total *n* (%)	7 (23)	21 (68)	3 (10)	31 (100)

Student Involvement

The majority of students agreed or strongly agreed that they felt their involvement in the appointment was a positive experience for the client ($n = 6$, 55% and $n = 4$, 36%, respectively). The remainder of the students were undecided ($n = 1$, 9%).

Veterinary Student Empathy

A total of nine students completed valid pre and post-test surveys. There was no significant difference in student empathy following telehealth appointments ($Z = 1.55$, $p = 0.12$). Veterinary students had a median total empathy score of 121 (IQR 118–133) prior to the PFL rotation and 120 (IQR 114–132) following the rotation. However, there was a significant difference in student empathy between students who completed the pre survey only and students who completed both the pre and post surveys ($U = 93.50$, $Z = 2.34$, $p = 0.02$). Students with baseline data only had a significantly lower median JSE score of 113.00 (IQR 103.50–121.50) prior to the rotation. There was no significant difference between students with post-rotation data only compared with students with valid data for both time-points ($U = 58.00$, $Z = 0.95$, $p = 0.44$).

DISCUSSION

There is limited research regarding the use of telehealth in veterinary medicine or veterinary student learning, and currently no research exists to evaluate its use specifically in underserved populations. This pilot study is the first of its kind to identify the role of telehealth in addressing barriers to veterinary care within an underserved population. Additionally, this is the first known study to evaluate the use of telehealth in veterinary student communication education within the context of underserved communities.

Access to Veterinary Care

Although the majority of clients responded that they would have been able to obtain transportation to a veterinary appointment without PFL, nearly 25% of clients indicated that transportation to a veterinary appointment was a significant barrier to accessing veterinary care. This did not entirely overlap with those who could not afford care, which represents how additional modalities of care could help fill gaps in accessibility beyond just financial limitations. In a review of barriers to veterinary care among underserved populations, one of the biggest concerns for clients in terms of transportation was owners in large cities utilizing public transportation with their pets. An additional concern was veterinarians who were unwilling to open clinics in underserved areas (2). This study provides evidence in support of utilizing appropriate telehealth measures in order to identify individuals who do not have secure transportation and effectively eliminate this barrier to ultimately increase access to veterinary care.

Although this study was conducted within an urban environment, transportation barriers also exist in rural areas where access to veterinary care is geographically limited (18). Additional research looking into telehealth's ability to break down barriers such as mobility, transportation, time, and complex work schedules within different types of communities might also be effective. Although the sample size for this pilot study was limited, all of the new clients that engaged in appointments and were eligible to participate in the study opted to complete the survey. Future studies with larger sample sizes that dive deeper into the outcomes and long-term client experience could be beneficial.

The majority of clients also reported that they would not have been able to afford their appointment without the PFL program. Although this in itself does not necessarily support the use of telehealth over conventional in person veterinary appointments in increasing access to veterinary care, it seems that the initiative itself was effective at eliminating at least one barrier to care. The cost of veterinary care has historically been one of the most commonly cited reasons that owners do not seek veterinary care for their animals (2).

Veterinary Team/Client Perceptions

Overall, survey responses from both clients and veterinary students were overwhelmingly positive. Client responses indicate that this initiative was successful in terms of client satisfaction, veterinary team communication, and student involvement. Veterinary students perceived these interactions similarly, with equally positive responses in each respective category. These responses provide support for telehealth as beneficial to both the client and the student. This also indicates that veterinary student and client perspectives were aligned on the appointment experience. Other studies evaluating veterinary student involvement in the context of service learning initiatives have found similarly positive results (13), lending similar support for such initiatives in student learning.

While the overwhelming positivity of responses provides support for such initiatives, it is also considered a limitation. Those who felt strongly about the interaction were probably more likely to provide feedback in survey form. Those who had different experiences, including more neutral or possibly even negative responses, might not have felt compelled to complete a survey regarding their experience. Therefore, it is possible that the nature of the responses could be skewed and valuable feedback from those who did not have such a positive experience was lost. However, PFL reported that all clients

that were eligible to take the survey elected to and therefore negative feedback should have been captured. For the students, a much lower response rate makes this type of error more likely. Additionally, surveys were administered to clients verbally by the PFL liaison in an attempt to reduce language or technological barriers. However, the use of client interviews may have increased the risk of social desirability bias, whereby clients may have provided answers that they believed would be viewed more favorably by the liaison. Some clients may have provided more accurate information if they had the ability to self-administer the survey.

Data regarding the human-animal bond showed that both clients and veterinary students perceived a strong bond between the client and their animal. The human-animal bond has been extensively studied, with data describing a potential positive impact of pet ownership for humans on both mental (19, 20) and physical wellbeing (21), however these studies do not exclusively focus on underserved communities. Additional research suggests a complicated role of pet ownership in populations facing various forms of adversity (22). While not a major focus of this study, data from this study suggests that this bond was largely present in clients evaluated within this underserved community and was well perceived by veterinary students. Current research regarding veterinary student perception of the human-animal bond has not been extensively studied in underserved populations. One qualitative study evaluated veterinary student perception of animal welfare in the specific context of a community clinic providing care for underserved individuals. This study revealed that students had pre-existing perceptions of poor animal welfare among pets belonging to these clients, however after participating in the clinic they felt very strongly that clients did in fact share a strong bond with their pet (23). More in depth research on the perception of the human-animal bond in underserved communities by veterinary students is warranted.

The lack of significant difference in client responses between appointments with veterinary students as the primary communicator vs. appointments with program clinicians as the primary communicator suggest that appointments integrated with students in telehealth can be supervised properly to allow a positive client experience. Although having multiple individuals on a telehealth call had the potential to be confusing or distressing to clients, this did not seem to change their perceptions of the appointment experience. More exploration on how to create properly supervised experiences that protect the target community's experience and quality of care and that can assist with student learning is critical as these new modalities and community interventions are developed. In the clinical setting, whether in telehealth or more traditional in-person clinical settings, properly developing programming with students including careful assessment is critical to ethical community engagement. Training future practitioners in how to perform telemedicine and telehealth appointments will also likely be important skills to prepare them for the future of the veterinary field.

Veterinary Student Empathy

The Jefferson Scale of Empathy utilized in this study did not show any significant difference in empathy after students completed their PFL appointment days, which could be due to several reasons. To the author's knowledge, there has only been one other study that utilizes the Jefferson Scale of Empathy within the context of veterinary medicine (24). As this scale was originally developed to evaluate medical students specifically within the context of human medicine, it is possible that some of the questions did not adequately translate well into the veterinary setting. The largest limitation, both in regards to the scale and throughout the study, was sample size. The small number of responses represented only one demographic (White females between the ages of 25 and 34) and might not accurately reflect the views of the majority of veterinary students. However, it is interesting to note that White females currently comprise the majority of the present day veterinary student population, so this data might actually be representative of the field to some degree (25). Out of 26 students who participated in the rotation during that time period, 22 elected to fill out the pre-test, however, only 11 completed the post-test survey. Students who completed the pre-test only had significantly lower empathy scores prior to the rotation than students who had valid data at both time points, which may have contributed to the null findings pertaining to student empathy relative to the rotation. For example, it is possible that a ceiling effect occurred, whereby students with both pre and post data already had high levels of empathy and thus, did not report a measurable increase in empathy following the rotation. Future research with more veterinary students, including students who do not report high levels of empathy initially, could help elucidate more nuanced changes in student learning.

Overall, median scores on the Jefferson Scale of Empathy for veterinary students were similar to previously published estimates in females (26), with no significant difference in pre and post appointment scores. It is possible that students had previous opportunities to engage with underserved communities either within or outside of the context of veterinary medicine. The rotation itself is elective, which might self-select for those students who are more informed about community work. Due to its strong emphasis on the community and other curricular electives offered by the shelter medicine program integrating these concepts, students might already have been exposed.

Lastly, the PFL appointments comprised a total of only several hours over 2 weeks. The limited interaction time paired with a short period between pre and post scale administration could be contributing to the lack of significant difference. Students who participate in longer term initiatives with more client interaction might be more likely to be impacted by their experiences and reveal a significant increase in empathy toward clients. However, a previously unpublished study on journaling on this rotation found that these PFL appointments were highly valued and represented strong development of understanding of the community (Jafarian et al., manuscript in preparation). It is possible that the Jefferson Scale of Empathy was unable to capture the nuances more evident in qualitative analysis, such as in the previously described study. It is also possible that this scale might not have been entirely applicable to veterinary medical students, as it was originally designed for use in human medicine. Further investigation into experiences that

shape veterinary student empathy including mapping student experiences and perceptions before and after interventions is warranted.

CONCLUSIONS

This study provides a preliminary report on the impact of targeted initiatives for underserved communities involving veterinary students within the context of a telehealth appointment. The feedback from both clients and veterinary students implies that these interactions were overall positive. Veterinary students were able to integrate into appointments while maintaining clear communication and accomplishing client goals. Further investigation is needed to fully evaluate the scope of technical and interpersonal skills gained by veterinary students within this context. Barriers to veterinary care were identified and addressed through this study and provide support for identification of additional initiatives that can continue to increase access to care. The use of telehealth specifically proves to be an emerging but promising means of providing basic care to underserved communities. Additional research is needed to assess its role within a larger population across a wider variety of applications.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because data governance arrangements limit sharing the full dataset. Requests to access the datasets should be directed to brittawa@vet.upenn.edu.

ETHICS STATEMENT

This study went through an initial review from the University of Pennsylvania Institutional Review Board and was deemed a minimal risk study. It was therefore exempt from full review. Veterinary student participants provided informed consent electronically. Clients were verbally asked by the PFL community liaison if they consented to participation in an optional survey. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LL, BW, and CR contributed to conception and design of the study. EH oversaw data collection. LP performed the statistical analysis and data visualization. LL wrote the first draft of the manuscript. BW, CR, and LP provided feedback and contributed to editing the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Impacts of COVID-19 on Owner's Veterinary Healthcare Seeking Behavior for Dogs With Chronic Conditions: An Exploratory Mixed-Methods Study With a Convenience Sample

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This mixed-method study explored the impacts of the COVID-19 pandemic on owners' veterinary healthcare seeking, with particular focus on dogs with chronic conditions. A convenience sample of 719 UK dog owners completed an online survey (December 2020-January 2021). Differences in treatment provision and respondents' decisions to seek care across acute, preventative, chronic conditions and for end-of-life care were explored. Multivariable logistic regression models were used to identify factors associated with seeking care for any health issue compared to deciding against it, and urgency to seek care given symptom that could indicate chronic conditions. Open-ended questions were analyzed by thematic analysis. Significant (p-value$<$0.05) differences in care seeking decisions were identified regarding access to veterinary care and the way treatment was provided across all health issues. The top reasons for not seeking care across all health issues were a lack of access to a veterinarian (30%, $n = 56/187$) and a reluctance for a dog to go to the clinic unaccompanied (20%, $n = 38/187$). Variables related to stronger dog-owner relationship, higher confidence in seeking care, perception of: benefits of veterinary care, dog's high susceptibility to illness and high severity of dog's condition, increased the odds of seeking, and urgency to seek, care. A dog's chronic illness diagnosis reduced the odds of seeking care during the pandemic, reportedly due to difficulties in accessing care for non-urgent issues. Qualitative analysis showed that limited access to routine consultations, delays in test results and restricted access to complementary treatments, led some owners of dogs with chronic conditions to believe that their dog's welfare had deteriorated during the pandemic. Pandemic control measures necessitated changes to how consultations were run. These changes were often viewed favorably, but dog-client separation during consultations were considered problematic, sometimes delaying veterinary advice-seeking, including for euthanasia. Separating owners from their dogs during veterinary consultations should be avoided wherever possible due to impacts on dogs, owners and healthcare seeking. Interventions

to improve veterinary healthcare seeking could target attitudes toward benefits of seeking care, improve owners' self-efficacy and capitalize on the dog-owner bond. Such interventions should be implemented alongside interventions aimed at removing structural barriers to accessing healthcare.

Keywords: dogs, chronic disease, COVID-19, delivery of veterinary healthcare, health literacy (HL), terminal care

INTRODUCTION

Efforts to slow down the transmission of COVID-19 virus in the UK led to restrictions of individuals' movements, social interactions and work, including work of veterinary practices (1–5). During the first strict UK national lockdown introduced on the 23rd March 2020, veterinary practices were only permitted to carry out emergency services (1, 6), consultations were run in a socially-distanced manner and wearing of personal protective equipment was common (7). The strict national restrictions were lifted on 13th May 2020, however further national and regional lockdowns were in place throughout 2020–2021 and changes to veterinary practice protocols largely continued. The provision of veterinary healthcare was additionally disrupted as only veterinary professionals involved in food supply or provision of essential veterinary care were initially considered as critical workers and thus eligible to access in-person childcare or schools, enabling those with child-care responsibility to continue to work (8). In January 2021, the provision of essential veterinary care in England was no longer considered as a criterion for the crucial worker status (9), further disrupting the provision of veterinary care. Many dog owners acquired dogs during the pandemic, therefore further disruptions occurred at a time when the UK's dog population, and plausibly the demand for veterinary care, also increased (10, 11).

Veterinary clinics in the UK and globally adapted standard operating protocols to accommodate socially-distanced consultations (12). Although many dog owners worried about access to veterinary care for emergency and non-emergency health issues (12), nearly 97% (n = 1,794/1,843) of those who booked an emergency appointment and 100% (n = 40/40) who arrived at a veterinary clinic for an emergency without an appointment were able to access help (13). However, owners often struggled to book appointments, in particular for issues that were not life threatening and reported significant delays in accessing preventative healthcare [specifically vaccinations and neutering, (13)]. Additionally, changes to how consultations were run affected, and often tested or challenged, the veterinary-client relationship (12). Some dog owners welcomed the flexibility that came with using telemedicine and were content with their dog being examined without them being present (13), but most found this prospect deeply distressing (12). This, combined with a need to rely on remote consultations, led some owners to perceive the quality of care to be lower than pre-pandemic, which in turn led to delays in seeking care (13). Studies based in the USA showed that dog owners with disabilities and from underprivileged communities additionally struggled accessing veterinary healthcare due to difficulties in arranging transport and accessing relevant financing options (14, 15). Together, these challenges made work in the veterinary sector more stressful (16–18) and led to concerns regarding long-term public engagement with veterinary healthcare (6).

COVID-19-related measures also impacted on daily routines of many dog owners. Although specific guidelines regarding dog walking for England, Scotland, Wales and Northern Ireland differed, generally, during the lockdown period, members of the public were only permitted to leave the house for exercise purposes once a day, including for dog walking purposes (2–5). Owners walked their dogs for longer, but less frequently, they walked more locally and kept away from other dog walkers when out (19, 20). Most dog owners spent more time with their dog than before the pandemic and some also substituted walks and exercise outside of the house with exercise at home (19, 21). Many dog owners reported that the company of their dog during the pandemic was important to their mental health, overall resilience and helped them to feel less lonely (19–25).

Many dogs suffer from chronic health issues i.e. health conditions that prevail over a course of one year (26, 27). These animals often depend on regular access to veterinary healthcare and other healthcare services [e.g. physiotherapy, massage therapy; (28)], which were not available or restricted during the pandemic. For many musculoskeletal chronic conditions, such as arthritis, frequent short walks are also advisable (29), meaning that the pandemic may have also affected the routine management of such dogs.

The Health Belief Model is often used in human health research to understand how individual demographic and psychological characteristics, knowledge and beliefs about illness and treatment, previous health-seeking experiences and the design of the healthcare system shape health-seeking behavior (30, 31). Some of these factors have been identified in relation to dog owners' veterinary healthcare seeking. For example, owners' compliance with routine check-ups and adherence to a vaccination schedule is influenced by their education, normative beliefs (social norms shared with family/friends), bond with a dog and knowledge about the disease and vaccination (32, 33). Seeing dog vaccinations or routine check-ups as expensive or unnatural (33) and having difficulties with accessing veterinary services (34) has been identified as a barrier to seeking vaccinations. In addition, research suggests that dog owners do not prioritize treatment for chronic health issues, such as obesity and dental conditions, in the same way as veterinarians, potentially because they are not aware of signs of these conditions (35) and their negative long-term impact (26, 36, 37). It is plausible that dog owners may struggle to recognize signs of chronic pain in dogs [common with some chronic diseases, (38)], thus potentially

TABLE 1 | Summary of themes of questions used in the survey.

Questionnaire section	Subject of questions
About your dog	Sex, age, neuter status, source and date of acquisition, breed, and size. Monash Dog-Owner Relationship Scale [MDORS, (41)], Inclusion of Other in the Self (42, 43).
About you	Age, gender, education, household, living arrangements (living alone or with others), current number of dogs and number of dogs owned as an adult.
About your vet	Reasons for selecting the current vet, duration of attendance at the current veterinary practice, number of visits before and since the pandemic (and number of visits specifically for a chronic issue), duration of a visit (including travel time)
About COVID-19 in your area	Respondent's and household members COVID-19 symptoms, self-declared vulnerability to COVID-19 and worries regarding income caused by COVID-19.
Veterinary care during the COVID-19 pandemic: acute care/ standard preventative care/end-of-life-care/ chronic health conditions	In each section, the respondents were asked about reasons for potentially seeking treatment, whether they decided to seek treatment and if so, when and if they manage to access it, how care was received (e.g., a "dog was handed over to the vet/ vet nurse" or "owner was able to enter the practice with a dog"). Respondents who stated that they chose not to seek care/ were unable to access it were asked why this was the case. An open-ended question was included asking all respondents about factors taken into consideration when seeking care on this occasion.
Caring for dog's chronic illness*	Respondents who confirmed that their dog has a chronic condition were asked when the dog was diagnosed (before or since the pandemic), whether the treatment was covered by insurance, how the treatment/ medications prescribed by the veterinarian affect dog's behavior, if additional treatments (not prescribed by the veterinarian) were tried, and if so, how did they affect dog's behavior. These respondents were also asked to described how, if at all, caring for their dog was affected by COVID-19.
Knowledge and General attitudes to veterinary healthcare	Attitudes toward healthcare, e.g. "I care about my vet's views about how I manage my dog's health", "My vet thinks that providing my dog with regular check-ups or treatment is important": answers were presented on a 5-point Likert scale with strongly agree/ strongly disagree used as anchors.
	"The treatment provided by my veterinarian is necessary to manage my dog's health" and "Interrupting the treatment would be very risky"*
Urgency to seek care	Questions presented symptoms that could indicate chronic health conditions and asked respondents how quickly they would seek veterinary care, (e.g., Please indicate how long you would wait to contact your veterinarian in the following circumstances: If your dog became lame without having any visible injury or accident or If you noticed your dog bumping into objects). Answers were presented on a 5-point Likert-scale with options: Immediately seek an emergency appointment; On the same day to seek an appointment as soon as possible; Within a week, if the condition didn't improve; Within a month, if the condition didn't improve; I would not contact the vet for this.
Managing your dog's health in the future	Open-ended free-text question about owners' future plans for management of dog's health

**Asked only if the respondent confirmed that a dog has a chronic health issue.*

delaying access to treatment for conditions like osteoarthritis (39). Understanding of associations between owner-, dog-, and veterinary-healthcare-design factors, and seeking veterinary care for chronic and other health issues in dogs, is still poorly understood and to date research into veterinary healthcare seeking has tended to focus primarily on routine check-ups and vaccinations.

Therefore, this study aimed to explore impacts of the COVID-19 pandemic on dog owners seeking veterinary healthcare in the UK, with particular attention paid toward owners caring for dogs with chronic health conditions. We hypothesized that changes in provision of veterinary healthcare during the pandemic were likely to have a more profound impact on dogs suffering with chronic health issues than those without such diagnoses. Specifically, our objectives were to:

1) Compare dog owners' experiences of seeking and accessing veterinary healthcare for chronic, emergency conditions and preventative healthcare during the pandemic;
2) Explore reasons for not seeking care during the pandemic;
3) Explore dog owners' experiences of caring for a range of chronic health problems before and during the pandemic and their future care-plans; and
4) Identify associations between owner-, dog-, and veterinary-healthcare-design factors and seeking veterinary care for chronic health conditions in dogs within the Health Belief Model framework.

METHODS

This study implemented a mixed- methods qualitative and statistical analyses approach to improve understanding and interpretation of findings by applying analytical triangulation (40).

Participants

An anonymous online survey, promoted through social media, was open between 15th December 2020 and 25th January 2021. The study inclusion criteria were age over 18 years old; living in the UK and owning a dog at some point during the COVID-19 pandemic, defined here between 23rd March 2020 (the first day of the first national lockdown in England) and 25th January 2021 (when the survey closed).

Materials

The questionnaire was comprised of nine sections summarized in **Table 1** (see **Appendix A** for details). Both open- and closed-ended questions were used. Owners of multiple dogs were asked to answer the questionnaire thinking about the

dog whose name starts with a letter that appears earlier in alphabet.

Data Handling

Data were de-duplicated by removing ($n = 15$) the same occasions of seeking care described multiple times (e.g., as an answer to questions regarding seeking care for acute health issues, chronic health issues and preventative care). Data cleaning included re-coding responses described in the free-text boxes as "other" into pre-existing categories where possible. Variables with multiple response options (e.g., household income, education) were pooled into 2–3 options ahead of multivariable logistic regression analysis (see **Appendix A**). A binary variable "Covid-19 experience" (yes/ no) was created by combining responses to questions "Have you experienced suspected COVID-19 disease symptoms" and "Has anyone else in your household experienced suspected COVID-19 symptoms" so that a positive response to either of these questions was recorded as a Yes. A binary variable "Sought help for any health issues" (yes/no) was created by pooling responses to questions "Did you seek veterinary advice, care or treatment since the beginning of the restrictions imposed due to the COVID-19 pandemic" asked about acute/ chronic conditions/ preventative healthcare/ end-of-life treatments. Response "Yes, I sought to access veterinary advice, care or treatment" to any of the health conditions was coded as "yes" and otherwise a response of "Yes, I considered it, but at that time I decided against accessing veterinary advice, care or treatment" or "No, I did not consider seeking veterinary advice care or treatment at the time" was coded as "no". Surveys ($n = 9$) where respondents stated that they did not potentially need to seek help for any conditions were removed from the analysis. A binary variable ("urgent"/ "not urgent") was created by dividing the combined score on questions about urgency to seek care as below or above the mean.

As the Monash Dog Owner Relationship Scale (MDORS) questionnaire consists of three sub-scales: Dog-Owner Interaction (9 questions, hereafter MDORS interactions sub-scale), Emotional Closeness (10 questions, hereafter MDORS closeness sub-scale) and Perceived Cost (9 questions, hereafter MDORS cost sub-scale), a total score as well as score for each sub-scale was calculated in accordance with published instructions (41). For questions that were a part of MDORS questionnaire or aimed to assess the urgency to seek care, single missing responses were replaced with a median for that sub-scale (MDORS) or across all responses (urgency to seek care). Where more than one response was missing, data were excluded from the analysis.

Following the approach taken by Beyene et al. (34), questions assessing knowledge and general attitudes to veterinary healthcare (summarized later in **Figure 1**) were mapped onto constructs of the Health Belief Model (HBM). Constructs considered here included:

- Perceived susceptibility, i.e., belief about developing or contracting a condition;
- Perceived severity, i.e., belief regarding how serious the condition is or the perceived risk associated with a condition being untreated;
- Perceived benefits, i.e., beliefs regarding benefits of actions likely to reduce the threat of illness or contracting it, including benefits nor directly related to health (e.g., complying with social norms, financial gains, being perceived as responsible;
- Perceived barriers, i.e., negative aspects of taking health-related actions; and
- Self-efficacy, i.e., confidence that one's actions will lead to the desired outcome (44).

The sixth potential facet, "cues to action," was not included as cues are often unconscious and therefore difficult to study via a survey (45).

Quantitative Data Analyses

The demographic variables were summarized with descriptive statistics. Data distribution was checked visually and with Shapiro-Wilk tests to decide on suitability of parametric or non-parametric tests. Chi-square tests with Bonferroni corrections for multiple comparisons were used to compare the mode of treatment delivery (e.g., delivered as normal compared to dog examined without the owner) and respondents' ability to access healthcare for different health issues (acute/ preventative/ chronic/ end-of-life treatment). The mean monthly number of vet visits before and during the pandemic for dogs with/without chronic conditions was compared with paired Wilcoxon signed ranked tests.

Internal reliability of MDORS sub-scales, questions used to assess urgency to seek care and HMB construct was explored with Cronbach alpha (see **Appendix B** for how questions were mapped on the HBM constructs and for the detailed results of the reliability analysis).

Questions "It's important to vaccinate dogs" and "I think that providing my dog with regular veterinary check-ups or treatment is important" made the Perceived susceptibility HBM construct; questions "The treatment provided by my veterinarian is necessary to manage my dog's health" "Interrupting the treatment would be very risky" made the Perceived severity construct; "The treatment and advice provided by veterinarian is necessary," "I trust my veterinarian," "My veterinarian is knowledgeable," "I care about my vet's views about how I manage my dog's health," "My vet thinks that providing my dog with regular check-ups or treatment is important," "My friends and family think that providing my dog with regular check-ups is important" made the Perceived benefits construct. Finally, "Managing my dog's health is easy," "I feel well informed and knowledgeable about my dog's health," "I know where to seek information about my dog's health," "I am confident in recognizing when my dog is not feeling well," "I am aware of different treatment options for my dog's condition," "If I needed to, I would be able to access veterinary care for my dog" made the Self-efficacy construct. Other questions were fitted within logistic regression models individually (see **Appendix B** for reliability analysis).

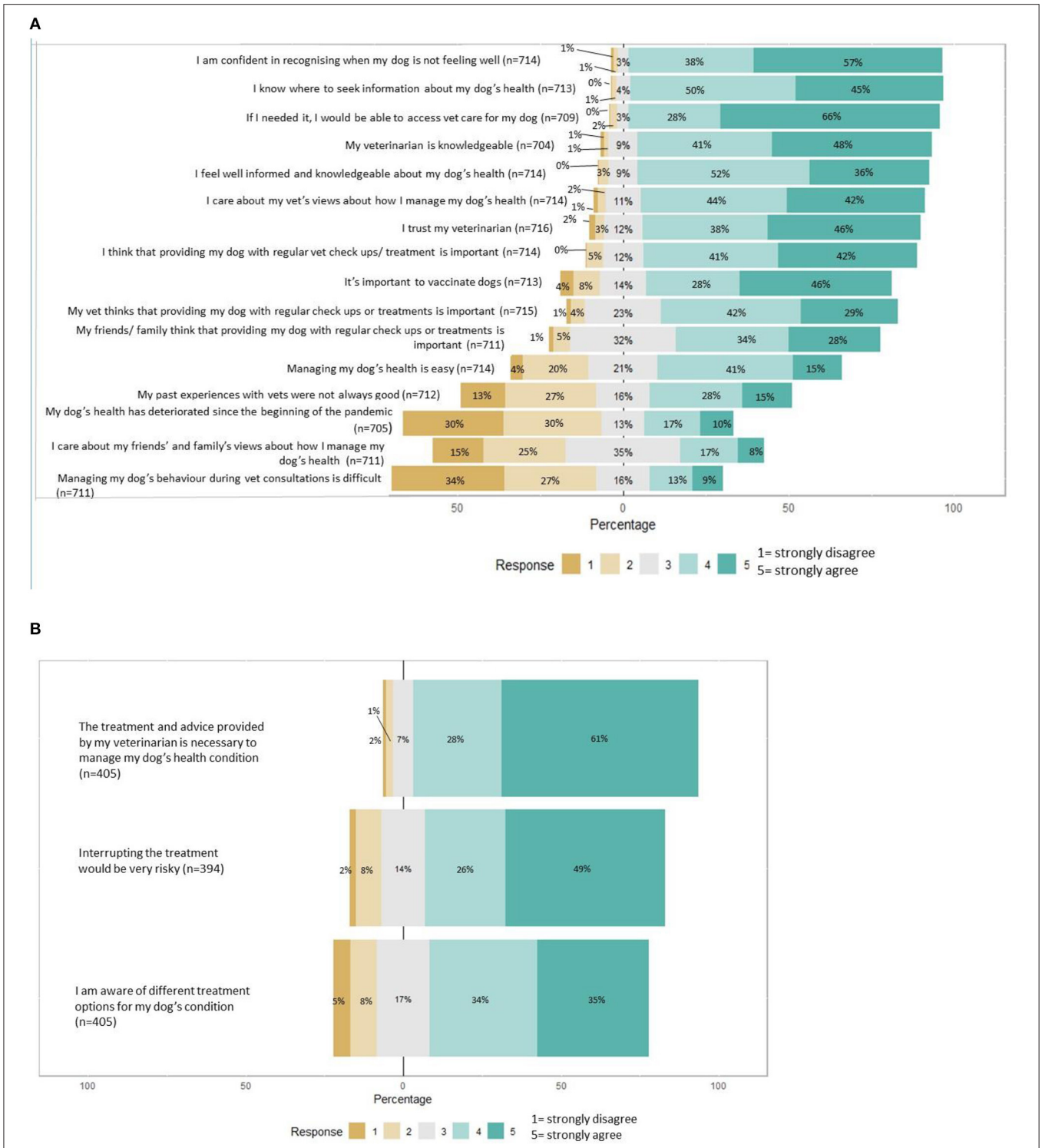

FIGURE 1 | Summary of attitudes to seeking dog healthcare. **(A)** Summary of dog health-related attitudes among the whole population. **(B)** Summary of further dog health-related attitudes for owners of dogs with chronic helath issues.

Three logistic regression models were constructed, with the following outcome variables: (1) seeking care for any health issues; (2) urgency to seek care (analysis of the entire dataset), and (3) urgency to seek care (analysis of the subset of dogs with a chronic condition, as respondents who confirmed a chronic condition diagnosis were asked additional questions that could

be included in modeling). Predictive variables included in all three models were: dog and owner demographic variables, dog-owner relationship (MDORS), household income and concerns about loss of income due to the pandemic, mean monthly number of vet visits before and since the pandemic, length of attendance at the veterinary practice, owners'/ household experiencing COVID-19 symptoms and owner's vulnerability to COVID-19. Depending on reliability level, Knowledge and General attitudes to veterinary healthcare questions (total score per construct/ statement) were included within all the logistic regression models as HBM constructs ($\alpha > 0.7$) or as individual statements ($\alpha < 0.6$). Constructs that yielded an $\alpha = 0.6$–07 were tried within the models as individual statements and as constructs and the version that led to a better model prediction (see below) was selected. Therefore, HBM constructs (Perceived susceptibility, benefits, and self-efficacy) and individual statements corresponding to the barriers construct were included in all three models. Reasons for seeking care (acute/ preventative/chronic/ end-of-life care) were included in model 1 or 2. The first model also included a total score on urgency to seek care questions. Perceived severity construct and information about dog's insurance were included in the third model for the subset of dogs with chronic health condition diagnosis (questions about severity/ insurance were only asked if the respondent confirmed that a dog has been diagnosed with a chronic condition).

Correlation matrices of predictive variables were constructed first to avoid using correlated items (i.e., $r > 0.7$). All models were built as generalized linear models (GLMs) by backward elimination, starting with all predictive variables. General Additive Models were used to determine if polynomial functions for continuous variables provided a better fit. Comparisons between models with a linear, quadratic or cubic function were carried out using ANOVA Likelihood Ratio Test. Interactions between predictive variables were assessed with *post-hoc* pairwise comparisons with Tukey *p*-value corrections for multiple comparisons. The final variables left in the models were determined by significant *p*-values (<0.05) and using ANOVA Chi-Square analysis to identify if all remaining variables were significantly reducing the residual deviance. Models' predictive power was assessed with McFadden's pseudo R^2 and Receiver Operating Characteristic (ROC) curves measured with c-statistic. Goodness of fit was assessed with Hosmer-Lemenshow (H-L) statistic. All analyses were conducted in R (46).

Qualitative Data Analysis

Semantic inductive thematic analysis on open-ended questions was carried out. Inductive coding means that codes were assigned to summarize the data rather than to reflect an existing theory or pre-defined categories (47). Semantic coding (i.e., coding driven by the explicit content of the data) was deemed most suitable due to the often brief nature of free-text responses. The analysis followed the process outlined by Braun and Clarke (48). Briefly, after familiarization with the text, responses were coded line-by-line by two co-authors (SCOG and IL). Codes, aimed to summarize and condense the meaning expressed within each line (49), were assigned iteratively and updated as coding progressed, so that the coding scheme was continuously revised. The revised coding scheme was applied to the whole dataset and coding discrepancies were removed following a discussion between the co-authors. Codes were compared and similar codes were grouped to develop domain summaries, i.e., groupings of related codes (50). The final themes were created by comparing the relationships between codes within each domain summary and between the domains (48, 49). Direct quotes are used to illustrate themes. All coding was carried out in NVivo [v.2, QSR, (51)].

RESULTS

The survey was started by 1034 respondents, of whom 726 (70%) submitted a finished survey. Six respondents were excluded due to not meeting inclusion criteria, therefore 720 responses were used in the analysis. Below we describe the demographic data, COVID-19 variables, owner-vet relationship, health attitudes and pattern of responses to urgency to seek care questions. We then summarize owner's care routine for dogs with chronic health issues before the pandemic, before presenting analysis of owner's interactions with veterinary healthcare during the pandemic, reasons for not seeking care, predictors of seeking care and urgency to seek care and future plans regarding engagement with healthcare.

Dog and Owner Characteristics

Based on the Inclusion of Self in others scale (42, 43), the majority ($n = 481$, 67%) of respondents had a strong relationship with their dog; 27% ($n = 105$) had a moderate relationship and 6% ($n = 39$) had a weak relationship. The mean total score on the MDORS scale was 117.1 (median =118) and the mean and median for the MDORS closeness, cost, and interactions sub-scales was 44.0 (median = 44), 38.2 (median = 39) and 35.6 (median = 36), respectively. The closeness and cost sub-scales had an excellent internal reliability ($\alpha > 0.8$) and the interactions sub-scale had a reliability of $\alpha = 0.48$ (95% CI 0.4–0.52). However, as the questionnaire has been previously validated (41), all sub-scales were included in the analysis in their entirety. The Cronbach alpha for Inclusion of Self in Others scale was poor ($\alpha = 0.23$, 95% CI 0.18–0.25), therefore this variable was dropped from the analysis. Further dog and owner characteristics are summarized in **Table 2**.

COVID-19 Related Variables

At the time of survey completion (15th December 2020- 25th January 2021), most (84%, $n = 598$) respondents had not experienced any COVID-19 symptoms, though 17% ($n = 118$) had. Among those who lived with others, most reported that no one else in their household had experienced COVID-19 symptoms (76%, $n = 542$), whereas 12% ($n = 89$) reported that other household members had experienced COVID-19 symptoms. Most respondents ($n = 86\%$, $n = 616$) were not officially classified as vulnerable to COVID-19 (i.e. they have not received an official government notification letter). The remaining 6% ($n = 46$) were formally notified that they were

TABLE 2 | Dog and owner characteristics.

Dog characteristics (*n*, %)	
Sex	Male (*n* = 359, 50) Female (*n* = 350, 50) Missing information (*n* = 2, 0.1)
Age	Mean age: 82.0 months (6.8 years); SD = 52.2 months Median 72 months (6 years); IQR = 84 months
Neuter status	Neutered (*n* = 550, 77) Unneutered (*n* = 168, 23) Unknown (*n* = 1, 0.1)
Most common breeds	Cross-breed/ mongrel (*n* = 93, 13) Labrador Retriever (*n* = 66, 9) Border Collie (*n* = 45, 6) Miniature Schnauzer (*n* = 33, 5) Cocker Spaniel (*n* = 30, 4)
Size	Toy (*n* = 29, 11) Small (*n* = 171, 24) Medium (*n* = 282, 39) Large (*n* = 227, 32) Giant (*n* = 11, 2)
Timing of acquisition	Acquired before the pandemic (n=646, 90) Acquired during the pandemic (n=72, 10)
Source of acquisition	Commercial or hobby breeder (*n* = 403; 56) Dog shelter/ rescue (*n* = 213; 30) Other source** (*n* = 104; 14)
Number of dogs in the household	One (*n* = 380, 53) Two (*n* = 182, 25) Three or more (*n* = 120, 17) Dog passed away during the pandemic (*n* = 34, 5)
Owner characteristics (*n*, %)	
Gender	Woman (*n* = 665, 93); Man (*n* = 43, 6) Prefer not to say (*n* = 7, 1) Non-binary (*n* = 2, 0.3)
Age	<50 years of age (*n* = 418, 58) >50 years of age (*n* = 292; 41) Prefer not to say (*n* = 6, 1)
Education	Educated to a degree level or above (*n* = 407, 57) Educate below a degree level (*n* = 303, 43)
Living arrangements	Living with others (*n* = 582, 82) Living alone (*n* =129, 18)
Dog-ownership experience	First time owning a dog as an adult (*n* = 277, 39) Owned previous dogs during adulthood (*n* = 436; 61)
Household income	Within or above UK's median (*n* = 473, 66) Below UK's median (*n* = 92, 13) Prefer not to say (*n* = 145, 20)
Concerns regarding the impact of the pandemic on financial security	Unconcerned (*n* = 314, 44) Neither concerned nor unconcerned (*n* = 80, 11) Concerned (*n* = 275, 38) Prefer not to say (*n* = 50, 7)

**The UK median in 2021 was £29,900 annually (52).*
***Other sources included: guide dog organizations, farms, friends/ family.*

particularly vulnerable and should be shielding, and 8% ($n = 55$) considered themselves vulnerable, although they did not receive the formal letter.

Owner's Attitudes to and Relationship With the Vet and Urgency to Seek Care

Most respondents had been clients at their current veterinary practice for over 7 years ($n = 253$, 35%), 15% ($n = 108$) for <1 year; 11% ($n = 80$) for 3–5 years; 10% ($n = 74$) for 5–7 years and 0.3% ($n = 2$) could not remember. Most respondents (34%; $n = 240$) chose their vet practice because someone recommended it to them. Other reasons included: nearby location ($n = 190$; 27%), affordable prices ($n = 68$; 10%), friends or family attending the same practice ($n = 64$; 9%), vets taking time to explain things clearly ($n = 61$; 9%), access to specialist services (n=28; 4%), practice or services offered by it being covered by the insurance ($n = 17$; 2%) and other reasons ($n = 47$, 7%).

Questions that summarize owner's attitudes to healthcare are shown in **Figure 1**. Overall, owners in this sample were confident about seeking care and recognizing signs of poor health in their dog; responses to these questions were homogenous. Owners also agreed with the importance of preventative healthcare. There was a much greater diversity of responses, indicative of differences in experience, to questions about ease of managing dog's health, past experiences with veterinary healthcare, dog's health deteriorating during the pandemic and management of dog behavior during veterinary consultations.

Internal reliability of questions about urgency to seek care was excellent ($\alpha = 0.8$, 95 CI% = 0.78–082). Therefore, the total score for these questions was treated as a single construct of urgency to seek care. Of all conditions listed in the hypothetical scenarios, owners reported the least urgency to seek veterinary healthcare if their dog was over-weight or aggressive (**Figure 2**). The greatest urgency to seek care was reported for dog becoming lame or bumping into objects.

Management of Dog's Health Pre-pandemic (Dogs With Chronic Health Issues)

Owners who reported that their dog had chronic health problems were asked about their normal (i.e., pre-pandemic) health care management routine. Qualitative analysis identified three themes that summarize healthcare management: "Monitoring dog's health," "Adapting care routines and owner's lifestyle" and "Financial commitment." The first two themes were brought up by the majority of respondents. Although the third theme was not frequently discussed, it is important to consider it and document this experience, as financial commitment may be proportionally greater among dog owners who are not as affluent as those taking part in this study.

Monitoring Dog's Health

In addition to seeking preventative healthcare, annual wellness checks or treatment for acute health issues, owners of dogs with chronic health conditions also commonly sought veterinary care to monitor the dog's health and deliver specialist treatment or therapy:

> *"He has to have blood/ urine tests every 6 months due to the medication he is on (…) Weekly hydrotherapy sessions planned - not only good for his conditions, but as regular therapist they can spot issues that I may have missed."* (Respondent 11)

Adapting Care Routines and Owner's Lifestyle

Lifestyle adaptations that some dog owners made to manage their dog's health were common and sometimes substantial:

> *"Every 2 hrs day and night I was taking him out and he'd sleep on my bed with me as he was having seizures and I didn't want him on his own. I didn't leave him alone for the last few months of his life*

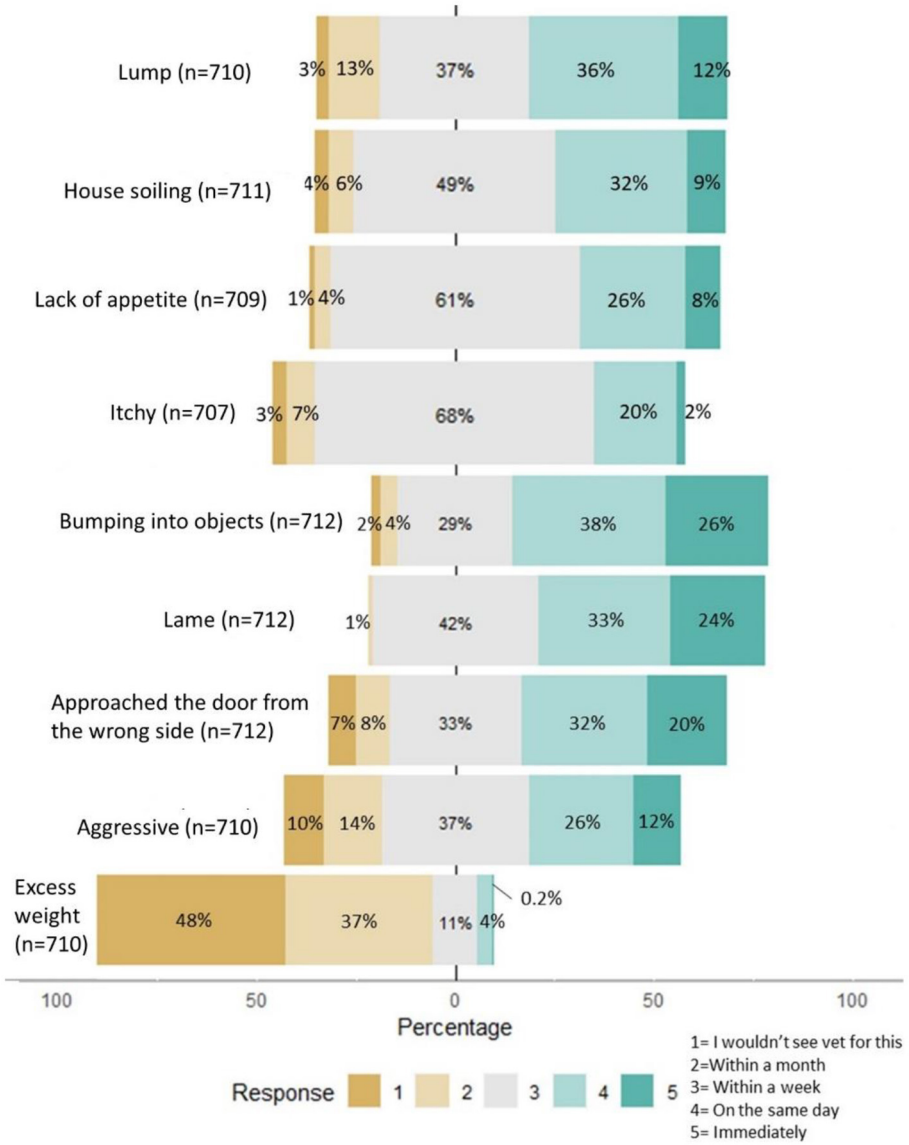

FIGURE 2 | Summary of responses to questions about urgency to seek care given dog showing symptoms that could indicate common chronic health conditions.

as I know it was coming and didn't want him to pass away on his own". (Respondent 571)

Other reported adaptations and care given are summarized in **Table 3**.

Financial Commitment

Some owners described substantial financial commitment linked with caring for a dog with chronic issues:

> *"When we had [our dog] euthanised and I went to pay her final bill I asked how much we had spent at that practice it came to £56,000 this did not include a couple of stays at an emergency vet hospital and cataract surgery at an optical vet, or ongoing supplies sourced online. I would guess that would increase the total to nearer 75k in total. Wouldn't change it for the world though and would have spent double that to keep her going, unfortunately money couldn't buy that."* (Respondent 249)

Interactions With Veterinary Healthcare Services During the Pandemic

Quantitative Findings

The five most common acute health issues that respondents potentially needed treatment for were: gastroenteritis ($n = 72$, 13%), joint/ligaments problems ($n = 61$, 11%), skin infection or other skin issues ($n = 47$, 8%), ear infection ($n = 44$, 8%) and seizures ($n = 32$, 6%). The five most common preventative issues were: vaccination (primary or booster, $n = 284$, 58%), deworming

TABLE 3 | Management tools/ methods for managing health of dogs with chronic health conditions.

Method	*n* (%)
No other ways	118 (13)
Weight management	86 (9)
Home adaptations, e.g., Installing ramps, non-slip carpets	143 (15)
Modified exercise regime, e.g.,frequent but short walks, regular exercise	141 (15)
Nutrition, e.g., raw feeding; specific dietary formula, exclusion diet, soaking food to aide chewing, supplements believed to aid arthritis, prescribed medications	169 (18.)
Homeopathy	48 (5)
Herbal, e.g., over the counter and home-made herbal remedies	43 (5)
Acupuncture	20 (2)
Magnetic field therapy	10 (1)
Laser therapy	37 (4)
Hydrotherapy	70 (7)
Physiotherapy, e.g., with a trained practitioner; guided physiotherapy at home (e.g., over Zoom)	58 (6)
Massage	4 (0.4)
Other*	35 (4)

**Other approaches included: behavior modification (n = 2, 0.2%), shampoo and other skin care products (n = 2, 0.1%); chiropractic therapy, wearing a coat, Galen myotherapy, using heat mats, immunotherapy, red light therapy, Reiki and stem cell therapy (n = 1 each).*

TABLE 4 | Numbers (%) of respondents who potentially needed, considered, sought, accessed and did not manage to access veterinary care for acute, preventative, chronic health issues and end-of-life-care for their dogs during the COVID-19 pandemic.

Type of issue	Acute	Preventative	Chronic	End of life
Potentially needed treatment (*n*)	549	479	354	119 (116 continued with this section)
Did not consider seeking care (%)	21 (4)	54 (11)	23 (7)	13 (11)
Considered seeking care, but decided against it (%)	17 (3)	28 (6)	21 (6)	9 (8)
Sought care (%)	508 (93)	394 (82)	310 (88)	94 (81)
Accessed care (%)	489 (89)	359 (75)	295 (83)	86 (74)
Did not manage to access care (%)	18 (3)	34 (7)	15 (4)	7 (6)

TABLE 5 | Comparison of how care for acute, preventative, chronic health issues and end-of-life health issues was received during the COVID-19 pandemic (%, *n*).

Type of issues/ how was care received (% or n)	Acute	Preventative	Chronic	End-of-life-care
Treated as usual (%)	128 (15)	97 (20)	89 (21)	33 (28)
Treated outdoors (%)	68 (8)	41 (8)	40 (10)	23 (20)
Treated without the owner (%)	369 (44)	200 (40)	179 (43)	12 (10)
Telephone advice only (%)	91 (11)	24 (5)	37 (9)	0
Email/app advice only (%)	25 (3)	6 (1)	9 (2)	0
Telephone advice & called into practice (%)	68 (8)	21 (4)	19 (5)	0
Collected meds only (%)	84 (10)	96 (19)	44 (11)	0
Other (%)	10 (1)	13 (3)	6 (1)	22 (19)*
TOTAL (across all categories, n)	843	498	417	110

**Of the 22 dogs, 6 were euthanised at home, 2 died before owner reached the vet practice and in the case of 9 owners decided not to euthanise at that point.*

treatment ($n = 72$, 15%), flea treatment ($n = 60$, 12%), neutering ($n = 14$, 3%) and nail trimming ($n = 12$, 2%). The corresponding chronic health issues were: osteoarthritis and other orthopedic conditions ($n = 128$, 41%), epilepsy ($n = 38$, 13%), endocrine disorder, allergies ($n = 24$, 7% each) and skin problems ($n = 23$, 7%). Finally, the most common reasons for potentially needing end-of-life care were: cancer ($n = 38$, 31%), age-related poor health ($n = 29$, 24%), heart failure ($n = 11$, 8%), epilepsy ($n = 7$, 6%) and kidney disease, osteoarthritis ($n = 5$, 4% each).

There was no difference in the monthly number of veterinary visits for dogs with chronic issues when comparing before and since the pandemic (pre-pandemic and during-pandemic median number of visits 0.30 and 0.33, respectively, $p = 0.8$). Dogs without chronic health conditions reported significantly more veterinary visits since the pandemic began than before (pre-pandemic and during-pandemic monthly median number of visits 0.2 and 0.3 respectively, $p < 0.001$).

Significant differences in healthcare seeking decisions between health conditions were identified (**Table 4**; $X^2 = 32.5$, $p < 0.001$). Compared to acute health issues, those who potentially needed preventative treatment more often did not consider seeking it ($p < 0.001$) and did not manage to access it ($p = 0.03$). Those who potentially needed end-of-life care more often did not consider seeking it compared to those who needed care for acute issues ($p = 0.01$).

There were significant differences in how treatment was delivered between health issues (**Table 5**; $X^2 = 167.6$, $p < 0.001$). Compared to acute health issues and preventative treatments, seeking end-of-life care more often involved treatment as usual (including with small precautions i.e., wearing a mask/ using a hand sanitiser and maintaining social distance within the clinic; $p < 0.001$for both acute and preventative healthcare). Compared to acute health issues and preventative treatments, seeking end-of-life care was more often carried out outdoors, e.g., in a carpark or practice garden ($p < 0.001$ for both acute and preventative healthcare). Compared to acute health issues and preventative treatments, seeking end-of-life care less often involved handing a dog over for the consultation ($p < 0.001$ for both acute and preventative healthcare). A similar pattern was observed for a comparison between end-of-life care and treatment for chronic health issues; end-of-life care was significantly more often received as usual ($p = 0.01$), outdoor ($p < 0.001$) and less often involved owner handing a dog over ($p < 0.001$). No other significant pairwise comparisons of how treatment was received between health issues were identified. The other modes of accessing care were not compared due to a small sample size/ not being utilized for all health issues (see **Table 5**).

Qualitative Findings - Experiences of Seeking Veterinary Care During the Pandemic

Owners' experiences of seeking and accessing care were very varied, reflecting different ways in which veterinary practices adapted their work to be COVID-19 secure and possibly differences in restrictions dependent on the time of when care was sought. The main qualitative themes that reflect dog owners' experiences of accessing and using healthcare are: "Accessing appointments," "Change in consultation settings," "Experience of quality of care" and "Impact on owner's finance." Overall, the first three themes were discussed commonly. Albeit the fourth theme was not brought up frequently, it is important to discuss it as impact on owner's finance may have been more prevalent in the general population than in our data.

Accessing Appointments

Approximately half of the respondents who commented on the subject of appointment accessibility said they had no difficulties accessing check-up appointments for chronic issues and even preventative care:

> *"I feel confidant [sic] that I can contact my vet via phone if required or get an appointment for an acute or worsening chronic condition. The emergency service is still in operation which reassures me."* (Respondent 107)

However, roughly half of respondents who shared their experiences of accessing appointment said that booking an appointment for preventative treatments or regular check-up (for chronic issues or an annual health check) was difficult or impossible:

> *"Would really like to be able to have regular check-ups again, but I have no idea when that will be possible. Would be nice to feel that the vet was welcoming whatever the issue, but that's not the case at the moment. Very much feels like non-emergency issues are slipping through the gaps as vets are pushing the 'emergencies only' approach hard."* (Respondent 606)

In addition, owners of dogs with chronic health issues often relied on complementary therapies or additional non-veterinary services which were also hard to access:

> *"(. . .) I take him to hydrotherapy [for dog's arthritis] and manage it that way as it's not bad and he doesn't seem in pain from it as such. Every lockdown the pool has to close which is awful as the longer he misses his swims the more his muscle wastes away. We build it back up once we can go swimming again but it's stressful and a worry for me."* (Respondent 405)

Change in Consultation Settings

The vast majority of respondents commented on at least small changes in consultations settings. Many described how their consultation was carried out remotely via telemedicine solution:

> *"I consulted verbally [over the phone] and sent photos because it was not life-threatening. Prior to Covid I would have visited the vet."*(Respondent 188)

However, the main change to owners' experiences of accessing care was that often, owners were unable to accompany a dog into the practice. When allowed in, owners were not always permitted to be close to their dog due to social distancing measures. For a small number of dog owners this was not a problem: they believed that their dog had a good relationship with veterinary staff and was happy to go into the clinic alone and they themselves emphasized trusting their veterinarian and having a good relationship with them:

> *"The rapport and mutual trust built up with same vet over a number years has enabled continued care of chronic condition to be managed effectively and efficiently during C19 restrictions."* (Respondent 287)

A small number of all respondents (but close to a quarter of those whose dogs required or was suspected of needing end-of-life care) described changing vets in order to be able to be with their dog during consultation:

> *"I've left the vet I was with for 20 years and have joined another one that allows you to go in with your pet as long as you have a mask on which is what should have happened all along."* (Respondent 600)

Respondents who were able to accompany their dogs within the practice also described changes in how procedures were carried out to enable them to accompany their dogs. These changes were more common for end-of-life treatments. The adaptations included the vet stepping away from the dog for part of the procedure, conducting consultations outside (e.g., in the car park), leaving the door open so owners could see the dog and using a long line to carry out a euthanasia procedure:

> *"The vet and nurse carried her into the practice and inserted a cannula with a long line. They brought her outside onto a blanket where I could be with her, talking to her and holding her in the drizzle when she died. It was awful but I understand that it was the best they could do for us and they were so empathetic."* (Respondent 51)

The most prominent sub-theme identified within the "Change in consultation setting" theme captures experiences of being unable to be with the dog during the consultation, which majority of the respondents found very distressing. Respondents thought that separation from them added to theirs and dog's stress:

> *"Situation made even more stressful because I couldn't be with my dog when the vet checked her (she is a nervous dog)."* (Respondent 542)
>
> *"It was dreadful because I couldn't be with her. I feel I let her down by not being there at the end."* (Respondent 705)

Approximately a third of respondents who experienced outdoor consultations also worried about lack of privacy in

these cases. This was especially salient among owners who sought end-of-life-care:

> *"Dealing with the passing of a much loved family member was very hard during the pandemic as it felt heartless. Being stood in the car park in view of other people waiting to see the vet whilst my dog died was horrific. Didn't feel we got a chance to say goodbye. The vets assistants just came and took him away. Gave us a couple of leaflets and told us to ring them when we had made a decision on cremation etc."* (Respondent 409)

Experience of Quality of Care

More than half of respondents who commented on this subject did not experience any change in the quality of care provided, despite numerous changes in how veterinary practices were able to operate:

> *"My dog was receiving ongoing chemo for a condition which presented before covid. As covid appeared the way we accessed the vet changed, such as phone calls and dropping him off in the car park, but his care was excellent and I was always made to feel welcome. He probably received better care than humans as his treatment was not interrupted because of covid"* (Respondent 384)

However, the difficulties in booking appointments, delays in accessing care and being unable to seek regular check-ups, impacted on the experienced quality of care and dog's health among approximately a third of owners:

> *"The pandemic caused delays in appointments for the specialist. It took 8 months for hip dysplasia to be diagnosed."* (Respondent 539)
> *"Seeked [sic] antibiotic treatment for ongoing otitis. Took my vet 10 days to dispense medication due to furloughed vets and staff. Ended up having emergency TECA resulting in permanent vestibular and neurology issues. Angry beyond belief."* (Respondent 87)

Most of those negatively affected cared for dogs with chronic health issues, who were particularly reliant on regular check-ups to monitor dog's health. Some expressed feeling like they were left alone to monitor their dog's health and a small number said that they needed to wait for their dog's health to deteriorate to access care:

> *"It was very difficult. Prior to March 2020, our dog had regular blood tests at least monthly along with very close monitoring of his medication. Since March we have had no blood tests and pretty much left to sort his medication levels ourselves."* (Respondent 447)
> *"During the first lockdown we had to stop our dog's Cushings medication completely as our vet was only seeing emergencies. When we told the receptionist the medication could kill our dog without a blood test to check her levels we were told they would see her in an addisonian crisis or to put her to sleep (we later complained to the vet about the receptionist's attitude) but as a blood test isn't an emergency they weren't allowed to do it. We had to stop the medication altogether and wait for the Cushings symptoms to return, by which point the lockdown restrictions had relaxed a bit and we were able to get our dog tested."* (Respondent 524)

In addition, a combination of telemedicine, being unable to accompany a dog within the practice, face coverings and consultations being conducted outdoors, resulted in challenges in client-vet communication, reported by approximately a quarter of respondents:

> *"The lack of face to face consultation resulted in me not knowing how ill she was. If I had known I would have been more insistent on her treatment."* (Respondent 573)
> *"Working with the vet was so hard as I had to try to describe her symptoms over the phone and email, with photos and video, and not have the reassurance that I was doing a good enough job. It was new ground for all parties."* (Respondent 339)

Another dog owner who believed that their dog died as a result of disruptions to their care caused by the pandemic, emphasized the impact of being unable to accompany dog into the practice:

> *"If covid was not happening after my dogs mouth continued to bleed for several days I feel more would have been done if I had been able to speak to the vet in the practice like normal but again the dog was taken off me and then brought back with some antibiotics"* (Respondent 318)

Impact on Owner's Finance

A small number of owners in this study (mostly those carrying for dogs with chronic health issues) said that COVID-related restrictions had a negative impact on their finance. This was due to vet practices increasing the cost of consultations, practices restricting their operating hours (meaning that more consultations were treated as out-of-hours and charged at a higher rate), owners needing to seek care outside of their regular practice or having to travel further than usual as their regular practice was closed or unable to offer appointments:

> *"Due to the elderly age of my dog with underlying chronic conditions, seeking regular veterinary treatment and monitoring is key for my dogs to continued health and happiness as can be! Covid 19 restrictions has impacted the services my [veterinary charity] can offer (emergencies only), which in turn severely effects my personal finances seeking an alternative private vet. My dog's conditions are very costly to treat and monitor, but essential to [their] quality of life. I am looking forward to [charity] treatment limitations from Covid to be lifted."* (Respondent 363)
> *"I have been disappointed with local vets who have increased prices and won't allow face to face covid safe appointments (…)"* (Respondent 222)
> *"My Veterinarian was not open for treatment, so we had to travel 20 miles for treatment at an emergency vet hospital."* (Respondent 268)

Reasons for Not Seeking Veterinary Healthcare During the Pandemic

The main reasons for not seeking or being unable to access care are summarized in **Table 6**. Typically owners did not seek care because vets were only seeing emergencies and because the owner did not want the dog to go in alone.

TABLE 6 | Reasons for not seeking/ being unable to access care for different health issues; *n* (%).

Type of issues/ Reason	Acute *n* (%)	Preventative healthcare *n* (%)	Chronic *n* (%)	End-of-life-care *n* (%)
Dog's health improved	7 (12)	1 (2)	3 (5)	4 (44)
Fear of contracting COVID-19	2 (3)	2 (4)	1 (2)	0
More precautious financial situation	1 (2)	12 (21)	0	1 (11)
Vets were only seeing emergencies	27 (44)	4 (7)	25 (42)	0
Vets assured it's ok to miss out treatment	3 (5)	14 (25)	4 (7)	0
I found out it's ok to miss out treatment	1 (2)	8 (14)	1 (2)	0
Picked up medications from the vets/ordered online	0	2 (4)	0	0
Found advice online	1 (2)	1 (2)	2 (3)	0
Used home remedies	3 (5)	0	4 (7)	0
Used leftover medications	4 (7)	0	2 (3)	0
Didn't want the dog to go alone	8 (13)	11 (19)	16 (27)	3 (33)
Dog's behavior is difficult to manage especially with social-distancing	4 (7)	2(4)	2 (3)	1 (11)
TOTAL	61 (100)	57 (100)	60 (100)	9 (100)

Fear of contracting COVID-19, feeling unwell with COVID-19 symptoms or shielding were rarely listed.

Qualitative analysis helped to understand factors owners considered when deciding whether to seek care during the pandemic and reasons for not seeking care. These are summarized below by reviewing the main themes: "Deciding to seek care," "Fear of dog being alone," "Coping with dog loss."

Deciding to Seek Care

The vast majority of respondents stated that pandemic had no impact on how they made a decision to seek care. Owners reported seeking veterinary care for acute health issues when home treatments did not work, when the dog's condition deteriorated or was not improving. Almost all owners said they would seek care if they thought their dog was ill, in pain (i.e. for acute issues) or their life was at risk:

> *"She was in pain and we had taken usual treatments such as cleaning and antihistamine."* (Respondent 67)

A small number of respondents sought preventative healthcare because their insurance was dependent on continuity of treatment, for a primary vaccination for a new puppy and to make sure their dog's vaccination was up-to-date in case they needed to be hospitalized and their dog needed to be taken care of by someone else::

> *"It is important to keep up to date on vaccinations for health and insurance."* (Respondent 64)
> *"She was a puppy who needed 1st vaccinations, had to be done."* (Respondent 79)
> *"[T]he pandemic which was what led to feeling the extra need around vaccinations being brought up to date in case we many potentially have both required hospitalisation had we both been hospitalised due to Covid 19 when the risks around the virus became understood to realise that could potentially increase the risks of all pet carers becoming potentially hospitalised at once."* (Respondent 232)

Approximately a quarter of those who shared their views on this subject described considering whether veterinary care is necessary, or could be avoided (e.g., looking for relevant treatment options online or on social media, or by contacting the vet on the phone first):

> *"Due to the pandemic I'm using my own herbal & homeopathic remedies and dietary supplements ie turmeric etc, to help until I can get her in to see the vet accompanied by me. If pain increases I'll take her and hand her over to be seen without me. Without the pandemic restrictions she would have seen a vet already."* (Respondent 366)
> *"Care was not urgent so was postponed until after lockdown due to advice from the vet."* (Respondent 344)

A small number of respondents additionally considered how easy it is to travel to the vet:

> *"Travelling to the vets was more difficult as we do not own a car and could not ask friends"* (Respondent 5)

More than a quarter of respondents also described a delay in seeking care or not seeking care being caused by uncertainty if their dog needed veterinary support:

> *"The pandemic has certainly made me wait to call the vet rather than call straight away. The most recent bout of diarrhoea should probably have been seen about at least a few days before we called. I feel bad about leaving it but didn't want to cause more work for the vets when it's so difficult at the moment."* (Respondent 663)

Only a small number of owners reported considering the COVID-19 related risk (to themselves and the veterinarian) when seeking care:

> *"I considered whether an appointment was required before attending site. I considered how many people could enter. I considered what may be needed when attending to ensure minimal visits. I considered the potential impact swallowing an object could have on my dog if medical advice was not sought."* (Respondent 315)

Fear of Dog Being Alone

Across all health conditions (acute/ preventative healthcare/ chronic and end-of-life care), the main reason for not seeking care or delaying seeing care, expressed by approximately three quarters of those who commented on this subject, was not wanting a dog to go to the vet alone. This was particularly the case among owners who were considering euthanasia and among those whose dogs were fearful of vets:

TABLE 7 | Multiple logistic regression model of seeking veterinary healthcare during the COVID-19 pandemic.

Variable	Odds (95% CI)	*p*-value
MDORS emotional closeness sub-scale	1.0 (0.94–1.0)	0.05
Dog diagnosed with a chronic condition (comparison: not diagnosed)	0.5 (0.3–0.7)	<0.001
Urgency to seek care (total)	1.1 (1.0–1.1)	0.005
Self-efficacy (total)	1.1 (1.0–1.2)	0.009

"I would have taken dog for vaccinations if I could stay with dog during appointment. I decided risk of disease is less likely than distress at dog being taken from me." (Respondent 335)
"Altho (sic) this was handled sympathetically, we thought about (dog's name), getting progressively more paralysed and incontinent, and decided not to have her pts (put to sleep) until COVID restrictions allowed us both to be in the surgery with her (…) we perhaps let her go on for too long, we have no regrets." (Respondent 86)

A small number of respondents did not want their dog to go to vets unaccompanied, because they were not confident that their dog would be handled in a stress-free way:

"I expect to be able to support my pet by being with them with a mask for safety. I have been able to do this at my vets. If this option was not available I would consider whether I needed to attend (…) I believe vets have a long way to go to understand pet handling needs and stress less handling." (Respondent 202)

Coping With Dog Loss

A handful of owners who had a recent experience of having to euthanise their dog also considered whether they can cope with another loss during the pandemic:

"I had had a very traumatic time with having one dog severely attacked and having to rehome another dog and I couldn't face losing another dog." (Respondent 615)

Predictors of Seeking Care and Urgency to Seek Care

Predictors of Seeking Care for Any Health Issues

Multivariable logistic regression model for seeking care for any health issue ($X^2_{(5)} = 38.9$, $p < 0.001$, $R^2 = 0.1$, $n = 695$) is shown in **Table 7**. The model accurately categorizes 65% of those who reported intention to seek care (C-statistic= 0.65), and Hosmer-Lemenshow $p = 0.2$, indicating a good model fit. The odds of seeking care (compared to considering and deciding against or not considering it) were marginally lower for those who scored higher on MDORS emotional closeness sub-scale, and for dogs who were previously diagnosed with a chronic condition. The odds of seeking care were higher with a higher score on urgency to seek care questions and with a self-efficacy construct score.

TABLE 8 | Multiple logistic regression model of urgency to seek care given symptoms that could indicate common chronic health conditions.

Variable	Odds (95% CI)	p-value
MDORS emotional closeness sub-scale	1.04 (1.01–1.07)	0.006
MDORS perceived costs sub-scale	0.92 (0.89–0.96)	<0.001
Perceived susceptibility construct (total score)	1.14 (1.03–1.26)	0.013
Perceived benefits construct (total score)	1.07 (1.01–1.13)	0.019

TABLE 9 | Multiple logistic regression model of urgency to seek care given symptoms that could indicate common chronic health conditions performed on the subset of dogs with chronic health condition diagnosis.

Variable	Odds (95% CI) not scaled	p-value
MDORS cost sub-scale	0.92 (0.87–0.98)	0.01
MDORS shared interactions sub-scale	1.07 (1.00–1.15)	0.001
MDORS emotional closeness sub-scale	1.07 (1.02–1.12)	0.04
Perceived susceptibility construct	1.22 (1.06–1.41)	0.002
Perceived severity construct	1.23 (1.07–1.41)	0.02
My dog's health has deteriorated since the beginning of the COVID-19 pandemic	0.75 (0.63–0.90)	0.003

Predictors of Urgency to Seek Care for Any Health Issues

The remaining two models assessed urgency to seek care (above mean score on urgency to seek care questions compared to below). The model fitted for the whole dataset ($X^2_{(5)} = 69.5$, $p < 0.001$, $R^2 = 0.12$, $n = 712$, **Table 8**) shows that the odds of above mean urgency to seek care were positively associated with score on MDORS closeness scale, Perceived benefits construct score, Perceived susceptibility construct score and owners stating they were vulnerable to COVID-19. Above mean urgency to seek care was negatively associated with MDORS Perceived Cost scale; as this scale is reverse-scored, odds of higher urgency to seek care are associated with lower perceived cost of dog ownership. The model accurately categorized 60% of those who reported intention to seek care (C-statistic = 0.60), and Hosmer-Lemenshow $p = 0.4$, indicating a good model fit.

Model sub-setted to the data of dogs with chronic health issues ($X^2_{(5)} = 65.4$, $p < 0.001$, $R^2 = 0.23$, $n = 350$, **Table 9**) shows that the odds of above mean urgency to seek care were associated with an increasing score on MDORS closeness and interactions sub-scales, Perceived susceptibility and severity constructs scores. As in the earlier model, above mean urgency to seek care was negatively associated with MDORS cost scale, indicating that those who see costs of dog ownership as low seek care more urgently than those who see the cost as high). The urgency to seek care was associated with lower score in response to the statement "My dog's health has deteriorated since the beginning of the pandemic," showing that those who generally disagreed were less likely to say they would seek care urgently. Model accurately categorizes 61% of those who reported intention to seek care

(C-statistic = 0.61), and Hosmer-Lemenshow $p = 0.4$, indicating a good model fit.

Future Plans

Qualitative analysis showed that, overall, respondents did not intend to alter their future healthcare plans because of their pandemic experiences. In fact, most owners of dogs with chronic conditions (as well as any other health issues) wished to continue to visit their veterinarian for regular, periodic healthcare checks, vaccinations, flea/ deworming treatments, and to weigh their dogs, when needed. Owners of dogs with chronic conditions also stated that they wish to regularly test their dogs and to attend specialist clinics to monitor their dogs and any impacts of medications (and in some cases, to carry out the tests that were unavailable during the pandemic):

> *"I'll continue as normal, annual check ups and as and when required."* (Participant 720)

Owners who relied on complementary therapies (physiotherapy and hydrotherapy in particular) were very keen to access these as soon as possible. A small number of owners with dogs with behavioral issues stated they wished to socialize their dogs to the veterinary practice when restrictions are lifted and to continue with behavioral management plans.

Few respondents stated that the pandemic made them reflect on their relationship with the veterinary healthcare team and that, from now on, they wish to be less dependent on them s:

> "*COVID has enabled me to become less reliant on vets and to take on more responsibility for my dog's health myself. Hopefully this will lead to less consultations required throughout the year.*" (Respondent 726)

DISCUSSION

This study aimed to explore impacts of the COVID-19 pandemic on dog owners seeking veterinary healthcare in the UK, focusing in more depth on the experiences of owners caring for dogs with chronic health conditions. Although most of those who responded were able to access veterinary healthcare, delays in appointment availability and changes in how consultations were run had a disproportionate impact on dogs with chronic conditions, who rely on regular veterinary care to monitor and manage their health. Dog-owner relationship, owner's vulnerability to COVID-19 and owner's urgency to seek care given symptoms that could indicate common chronic conditions assessed through response to a hypothetical scenario were associated with veterinary healthcare seeking behavior during the pandemic. In addition, constructs derived from the Health Belief Model: self-efficacy in relation to seeking healthcare, dog's perceived susceptibility to illness, perceived benefits of seeking care, and perceived severity of the condition predicted urgency to seek care. Below we discuss our findings within the context of previous research.

Experiences of Caring for Dogs With Chronic Health Problems Before and During the Pandemic

Owners of dogs with chronic conditions reported adapting their home and lifestyle to care for their pets. Caring for dogs with chronic conditions often involved frequent veterinary consultations. Whereas owners of dogs without such diagnosis reported seeking veterinary healthcare when required (i.e., in the case of emergency) and for annual health check-ups where preventative healthcare is provided, those caring for dogs with chronic conditions relied on their veterinarian to monitor their pet's health and provide ongoing treatment. In addition, owners of dogs with chronic health problems utilized a range of complementary treatments, supplements and medications to maintain their dog's health, which often requires substantial financial commitment. Our findings echo previous research, which shows that, if they can, owners of dogs with chronic conditions adapt their lifestyle, modify their home and seek non-prescription therapies to support their dog's health (28, 53, 54).

Our study found that during the pandemic, owners were often forced to change care routines for their pets: some reported that they could not take their dog for usual walks and those caring for dogs with chronic conditions reported that their pet's health suffered due to lack of access to physiotherapy or massage-therapy. Previous research demonstrates that caring for dogs with chronic conditions can lead to caregiver burden, which in turn is associated (possibly causally) with the owner's stress, depression and lower quality of life (53, 55, 56). For example, caring for a dog with osteoarthritis, among the most common health issues enumerated in this study, has previously been described as possibly contributing to owners feeling socially isolated and sometimes reporting difficulties in receiving a respite (28). Past studies show that difficulties in adhering to a pet's care routine correlate with higher caregiver burden (53). Therefore, given the challenges in maintaining a pet's routine reported in our study, the pandemic is likely to have worsened the caregiver burden and had a negative impact on the mental health of owners of dogs with chronic health issues in particular. Whilst delivery of ongoing treatment (such as chemotherapy or injections aimed to manage skin conditions) was rarely disrupted in this study, a large proportion of owners stated that they were unable to consult with their vet to monitor their dog's health. A small number of owners stated that this led to a deterioration of their dog's health and a large proportion explained that this was a cause of anxiety, isolation and a sense that they are alone in making decisions about their pet, further highlighting how pandemic-related restrictions to accessing veterinary healthcare may have contributed to caregiver burden. To better support all dog owners, we recommend that any future restrictions classify veterinary consultations aimed at monitoring chronic illness, as well as complementary therapies with proven efficacy, as essential work. Greater awareness of the importance of movement for dogs with chronic conditions is also needed.

Experiences of Seeking and Accessing Veterinary-Healthcare During the Pandemic and Reasons for Not Seeking Care

Similar to other studies (12, 13, 57), we identified that a number of dog owners struggled to book non-emergency veterinary appointments and appointments with non-veterinary healthcare providers, which disproportionally affected owners of dogs with chronic health conditions. The vast majority of those who responded to our online survey were able to access a consultation for acute, preventative or chronic health issues and end-of-life care when needed; however, this may not have been the case for all UK pet owners.

Our study found that owners who needed to access preventative care were significantly more likely not to seek it, were unable to access it, and those who needed end-of-life care were significantly more likely not to seek it, compared to other health issues. This suggests that previously identified pandemic-related delays in provision to preventative care (13) may have been due to changes in owners' healthcare veterinary seeking behavior as well as actual accessibility of services. Whilst short-term delays in preventative care are unlikely to have a negative impact on the welfare of otherwise healthy dogs (58), delaying euthanasia has been identified as a serious welfare concern (59). Previous findings suggest that when dog owners refuse or delay euthanasia, palliative treatment is provided to protect animal welfare (60). The manner in which information about life-limiting conditions in dogs is communicated is vital to ensure owner understanding of dog's health (61). To be effective, communication about end-of-life care should be direct, delivered in multiple ways, in clear language, in an unrushed and ongoing manner, i.e., enabling owners to ask additional questions after the consultation (61). It is unlikely that these conditions were easy to achieve during the pandemic, possibly impacting upon owner's decisions regarding euthanasia and palliative care options. This further corroborates the impact of delays in seeking end-of-life care on animal welfare. In addition, a small number of owners delayed end-of-life care for their dogs as they feared they would not be able to cope with pet loss during the pandemic. Whilst this is also a likely influence on delayed euthanasia pre-pandemic, general deterioration of dog owners' mental health during the pandemic (62) and the importance that pets played in maintain owners' wellbeing during the pandemic (20–25, 63–65) is likely to have made this factor more pertinent.

Although close to half of those who needed care for an acute/preventative issue were unable to accompany their dogs into the clinic, the majority of those who sought end-of-life care were able to, which demonstrates that many clinics worked hard to ensure that owners could be present with their dogs during the consultations. Respondents described a number of ways in which veterinary practices adapted to enable owners to be present with pets, e.g., by carrying out consultations outdoors, using a long line for euthanasia (enabling the vet to carry out the procedure in a socially-distant manner), or by altering the protocol so that vet and owner were taking turns in being near the dog. This shows that the interpretation and enactment of the official guidelines for social-distancing and COVID-19-safety (1, 7, 66) was not fixed, but involved developing protocols and practices (67) that worked within the local environment. Most owners in our study were grateful for this opportunity to be with their dog; however, some found lack of privacy during outdoor consultations difficult. This could be ameliorated by using privacy screens when carrying consultations outside of the clinic and having baskets ready with items such as tissues for the owner and a small cloth bag for pet's collar or container to place hair clippings in (68). Access to grief resources (69) and having a veterinary social worker on staff for follow-up calls and to care with potential compassion fatigue as experienced by veterinary team members is also advisable (70).

The vast majority of respondents showed high levels of trust in their veterinarian's skills and valued their opinion. Some owners reported that they were happy for their dog to be seen without them as they trusted their vet's opinion and handling skills. In addition, respondents generally trusted in their vet's reassurance that postponing seeking care would not affect their dog's welfare. However, the most common reasons for not seeking care, or delaying access, was being unable to accompany a dog into the practice and uncertainty if care was available. Separation of the dog and owner impacts on likelihood and timing of healthcare seeking and dog's distress during consultations (71, 72). Owners preferred to be present with their dog in order to manage their behavior and some worried about their veterinarian being able to handle their dog in a stress-free manner, in particular if a dog was already anxious. Many owners who sought end-of-life care switched healthcare provider to one who allowed them to be present during the procedure. These findings reflect previous research which showed that being unable to accompany dogs into the practice was stressful and resulted in delays in seeking care (12, 13). Veterinary practices should therefore strive diligently to enable owners to accompany their pets during consultations wherever possible. Our findings also add weight to the value of socializing dog to the formal handling and within veterinary clinics and show that veterinarians' stress-free handling skills are central to building trust in owner-vet relationship.

Our study echoes previous findings in showing that COVID-19-related restrictions impacted on owner-vet communication (13, 17). As clear communication with veterinary clients emerged as important in maintaining and continuity of care when normal operating protocols are disrupted, veterinary training in this area should be extended to communication via telehealth. Additionally, although a minority of respondents were considered lower income, this study nevertheless identified that changes in how care was provided could impact owner's finances. Owners who previously relied on subsidized treatments offered by veterinary charities were particularly affected, as access to their regular (subsidized) veterinarian was not available and seeking healthcare privately sometimes meant paying out of hours fees and traveling further to access healthcare. In our sample, only a small number of respondents pointed this out as a problem. Lack of accessible pet-friendly transport, in addition to financial constraints, is a barrier to veterinary healthcare seeking within underserved and marginalized communities which were under-represented in our convenience sample. This echoes the pattern identified in the USA that shows that owners from most

underprivileged backgrounds were potentially most affected by changes in care provision for their pets during the pandemic (14, 15).

Finally, there was no significant difference in the number of veterinary visits before and since the pandemic for dogs with a chronic health issue diagnosis; dogs without this diagnosis visited their veterinarian significantly more often since the pandemic began than before. This result should be interpreted cautiously. The observed pattern could reflect an annual variation in the number of vet visits [which are known to peak in spring and dip over winter; (73)]. Owners may have also noticed more health problems as a result of spending more time with their dogs during the pandemic. In this survey, we did not define what constitutes a vet visit, therefore it is possible that this increase can be attributed to contacting a vet using telemedicine. Finally, owners who visited their veterinarian recently during the pandemic may have been more inclined to complete our survey.

Overall, the pandemic did not change how majority of owners in our study intend to engage with veterinary services in the future. However, a small number of respondents believe that they can now be more independent of their vet and take on more veterinary tasks themselves. They may have also switched veterinary practices during the pandemic because of perceived poor experiences and because they were able to. A few respondents may have lasting impacts due to how euthanasia was handled.

Using Health Belief Model to Predict Intentions and Urgency to Seek Care

Strong associations between the behavior of seeking care and score on the urgency to seek care shows that owners who report high urgency on hypothetical scenarios likely apply a similar rule when deciding if their dog needs to seek care in real life. Self-efficacy to seek care was identified as an important predictor of seeking veterinary care in other contexts, such as adherence to elimination diet trial (74), showing that improving dog owners' health literacy, i.e., dog owner's ability to seek, evaluate, and apply knowledge regarding dog health, could increase their engagement with veterinary care. Changes in how care was delivered and difficulties in accessing care for non-emergency conditions identified in the qualitative analysis could lead owners of dogs with chronic health conditions to delay seeking care, reflected here. The effects of the owner's relationship with a dog on odds of seeking care was very weak, albeit significant. This finding may reflect that those who reported being emotionally closer to dogs were more likely to delay seeking care due to anxiety related to being separated from the dog during the consultation, which emerged as an important qualitative theme.

Our findings show that urgency to seek care for chronic conditions is driven primarily by the strength of relationship with a dog and HBM constructs. Previous studies utilized the HBM in exploring factors related to seeking healthcare focused primarily on seeking vaccinations and preventative care (33, 34, 74). Our study shows that HBM constructs are useful in predicting healthcare seeking for chronic health issues. None of the owner's or dog demographic variables, or household-related variables (such as income or fear of income loss due to pandemic) were significant predictors of intentions to seek healthcare or urgency to seek care, similar to findings reported by Park et al. (75) but at odds with other findings which identified that engagement with preventative healthcare could be predicted from owner demographic variables (33). COVID-19 variables were also not identified as significant predictors of seeking care. The strength of the relationship with the dog has also been previously identified as important factor predicting veterinary healthcare seeking (33), owners' likelihood of seeking healthcare for themselves, should they be infected with COVID-19 (24), further emphasizing the importance of "one health" approach to veterinary and human medical care. Our findings suggest veterinary practices could draw on the dog-owner relationship when designing communication and interventions that aim to encourage veterinary healthcare seeking. In addition, clear communication around severity of the condition and dog's susceptibility to it, and bolstering the owner's perception of efficacy in management of dog's health and healthcare seeking, could improve urgency to seek care.

Study Limitations

Data for this study was collected retrospectively, therefore comparisons with the pre-pandemic care routines and interactions with veterinary healthcare need to be interpreted cautiously, as these reports may have been affected by recall bias. The survey format enabled collection of both qualitative and quantitative data, but compared to other methods of data collection (e.g., in-depth interviews), the richness of qualitative data is somewhat limited, as for example follow-up questions cannot be asked for deeper exploration of an issue. During the period when the survey was open for completion, another lockdown in England was introduced (from January 2021); this was not captured by our data. Although care was taken when advertising the survey to recruit a diverse range of owners (e.g., geographic location/ breed/ health issues), response bias cannot be precluded. The survey was completed by 70% of those who started it. It is unclear whether those who started the survey differed with respect to their experiences from participants who completed the study, which may have further contributed to a response bias. It is possible that owners who had particularly strong opinions about veterinary care, or during the pandemic, were more likely to complete the survey than those with more moderate views.

The results of multivariable regression models need to be interpreted cautiously. The c-statistic in all three models is relatively low (0.6–0.65), meaning that models can accurately classify 60–65% of outcomes. In addition, the pseudo R^2 statistic in all three models is also low (0.1–0.23), meaning that <23% of the variability in the dependent variables (seeking care and urgency to seek care) can be predicted from these models and suggesting model under-fitting. Although a very high R^2 may indicate model over-fitting and poor generalisability, our results suggest that all three models have a relatively low predictive power and accuracy. Unfortunately, low R^2 (<0.5) are common in human-animal interactions research, possibly due

to the complex nature of these relationships and measurement-related challenges (76). Low R^2 values may additionally reflect a large number of additional factors possibly associated with the outcome variables that were not measured here. These factors could include, for example, the owner's personality, access to transport, digital literacy skills and access to subsidized veterinary healthcare. These factors warrant further investigation in the future. We decided to include these models in the current publication despite their limitations as the area of veterinary healthcare seeking is understudied and therefore even limited models may aide future studies.

Like most human-dog-interactions-related research (77), our sample was biased toward well-educated women with above median income and therefore was not representative of the broader UK dog-owning population. This limits the generalisability of our findings and recommendations. COVID-19 pandemic exasperated structural inequalities within the UK: compared to prosperous areas, the most deprived areas of England suffered more than twice as many deaths from COVID-19; ethnic minorities and those with pre-existing disabilities were more likely to die and suffer post-infection complications (78, 79). Despite government interventions, a near-decade of austerity measures that preceded the pandemic in the UK meant that the incomes of the lowest-earning households and those working on zero-hours contracts were significantly more affected by the pandemic than incomes of those on higher salaries and on permanent contracts (80), adding to food (81, 82) as well as fuel poverty (83, 84) and possibly squeezing the budget available for pets' healthcare. Although our study did not identify any associations between income or income concerns and healthcare seeking, it is likely that the characteristics of our sample made it impossible to detect this effect. Barriers to accessing veterinary healthcare identified in this study were most likely far greater among those most heavily impacted by the pandemic and those experiencing financial pressures. Owners on low income may have also been unable to change the veterinarian when their veterinarian was not taking appointments or to travel further to access veterinary care. Moreover, prior to the pandemic 22% of the UK's population lacked basic digital skills (85), needed when booking veterinary appointments or using telemedicine, (as many practices required using a phone or tablet-based application for this purpose). As the access to the internet is strongly related to household income [with just 51% of households earning between £6,000–10,000 able to access the internet compared to 99% of households on income above £40,000; (86)], it is likely that for the most financial disadvantages dog owners reliance on telemedicine was a further barrier to veterinary healthcare. Therefore, the impact of the pandemic on the owner's finance and the role of finance on owner's ability to care for their dog warrants further exploration using different tools of data collection that enable stratified or random sampling. Ten percent of the UK's dogs are not registered with a veterinarian (87). As most of this study participants visited their veterinarian regularly, this research does not inform about the impact of the pandemic on the health and welfare of dogs who do not receive regular veterinary care.

Human (and consequently pet) health is affected by multiple layers of interrelated factors, including individuals' biological characteristics (e.g., their genetics) and lifestyle, but also structural factors. These include individual's social and community networks (through which dog owners may, for example, seek information or help), living and working conditions (including employment, the structure of healthcare service, housing) and general socio-economic, cultural and environmental conditions, which may encompass national policies regarding veterinary care (88). Constructs derived from the Health Belief Model use in this study help to highlight ways in which individual behavior can be changed to encourage seeking veterinary healthcare. However, this approach does not account for structural influences that impact on veterinary healthcare seeking, including structural inequalities outlined earlier. The individual-based approach may also place undue emphasis on individual responsibility to improve their access to veterinary healthcare without highlighting structural changes (88, 89) that may be needed to ensure serving all socioeconomic groups, including those who cannot travel to access their veterinarian, those unable to use telemedicine and those on low income. This study did not explore the nature of structural changes needed, however it is plausible that subsidized or free-of-charge, mobile and face-to-face veterinary care may play an important role.

Finally, studies show that the veterinary community across the globe was under immense pressure to delivery care during the pandemic, with many veterinarians feeling under-valued, experiencing more stressful moments at work, struggling to communicate with clients and experiencing lower levels of mental wellbeing compared to before the pandemic (16–18, 90–92). Our study did not explore their important experiences.

CONCLUSIONS

This study shows that during the COVID-19 pandemic in the UK, veterinary practices managed to support the needs of the vast majority of those seeking urgent care and accommodated most of those looking for preventative care, for appointments to monitor dog's chronic conditions and for end-of-life care. Some veterinary practices worked creatively to adapt the way appointments were delivered to enable dog owners to be present during consultations in a COVID-19-secure way. However, this was not always possible and led some owners to delay seeking preventative care, euthanasia and for chronic health conditions, and in some cases resulted in traumatic experiences. Owners of dogs with chronic health issues, who relied on regular consultations for monitoring conditions, listed delays in accessing veterinary healthcare and complementary therapies, impacts of COVID-19-related restrictions on client-vet communication and being unable to accompany a dog during a consultation, as reasons for deterioration in their dog's health. The main predictors of seeking care and urgency to seek care were the dog-owner relationship and Health Belief Model constructs. This suggests that individual-level behavior interventions aimed at promoting veterinary healthcare seeking could include targeting attitudes

related to benefits of seeking care, promoting health literacy and self-efficacy and capitalizing on the dog-owner bond. Seeking veterinary healthcare during the pandemic was also associated with higher costs, which is particularly problematic for owners who rely on subsidized services or who may find themselves needing to in the future. Further consideration toward affordability of care is needed (93), in particular in the light of a growing population of dogs in the UK, raise in costs of living and reported shortages of veterinary staff. Future population-level interventions aimed at improving access to veterinary care needs to consider how costs of care may affect the decisions of the most underprivileged owners, particularly those caring for dogs with chronic conditions. Risk of COVID-19 transmission was rarely cited as a reason for not seeking care and seems to have little impact on owners' decision-making. Finally, the pandemic did not seem to impact future healthcare plans of the majority of dog owners who responded to our online survey.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Approval Application number: VREC1044. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SCO-G, TF, TMG, DAS, LW, and CW: conceptualization, methodology, and writing—original draft. SCO-G and IL: formal Analysis. SCO-G: data curation. SCO-G, TF, TMG, and CW: writing—review and editing. SCO-G and CW: funding acquisition. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fvets.2022.902219/full#supplementary-material

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Payment options: An analysis of 6 years of payment plan data and potential implications for for-profit clinics, non-profit veterinary providers, and funders to access to care initiatives

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Analyzing a dataset of payment plans disassociated with traditional credit scoring, this research, for the first time, offers insights into the mitigation of cash flow and credit ineligibility challenges in access to veterinary care. Specifically, this paper explores financial fragility among pet families and whether payment options offer substantial bridges in access to care challenges for veterinarians and clients. Researchers introduce a veterinary care multiplier to estimate the potential increase in veterinary care that may be provided by for-profit and non-profit clinics from additional payment options. The implications for non-profits working to address access to care is that by directing donor dollars to cover the 6.9% that is potentially left unpaid in meeting pet families simply facing cash flow challenges, a non-profit clinic could provide 14.5 times the veterinary care vs. full subsidies. In *for-profit* clinics, allocating some of a clinic's discount budget may similarly yield 14.5 times the care for clients likely to be declined by the traditional credit options. Further research is recommended to explore how deeply these options penetrate all financially fragile pet owners and outcomes in the absence of these tools for credit-declined clients. Additional research to determine the levels at which payment options reduce economic euthanasia decisions, reduce the client and staff stress, increase the value perception and compliance with suggested care, enable better outcomes for patients, and increase clinic revenue is also recommended. The researchers conclude that payment options that are independent of traditional credit scoring mitigate financial barriers to obtaining veterinary care.

KEYWORDS

access to care, credit, payment options, funder, financing, non-profit

Introduction

According to the American Pet Products Association (1), pet ownership continues to increase with 70%, or 90.5 million households in the United States owning a pet in 2021–2022. This is up from 56% in 1986. Access to care research has found that one in four pet families (27.9%) were unable to access needed veterinary care in the previous 2 years (2). Increasingly, research is identifying the inability to access care among select populations, such as homebound seniors receiving food assistance, found to be nearly one in two clients with pets (44.8%) (3). The primary barrier for preventative, sick, and emergency care across age groups, geography, and other population views is consistently financial. The cost of services is not the sole driver of this top barrier. This research discusses the cash flow crisis of care and the inability to access traditional credit options to cover the cost of care as a mitigable barrier by offering insights, for the first time, from an in-depth analysis of empirical client payment plan data. Specifically, this paper explores whether payment options offer substantial bridges in access to care challenges for veterinarians and clients and estimates the potential increase in veterinary care that may be provided by for-profit and non-profit providers from additional payment options to address financial fragility among pet families who may not qualify for traditional credit.

Cash flow and available funds crises among American consumers are found to be common and present across income levels. The term "financially fragile" is used to describe those who could not come up with $2,000 in 30 days (4). In a 2018 study from George Washington University (5), approximately 36% of working adults are found to be financially fragile. A recent national study finds that this is reflected among pet owners at all income levels with one-third of those surveyed reporting that they were "not at all confident" or "only slightly confident" they could come up with $2,000 if an unexpected need arose (6). This study found that financial fragility was a significant predictor of perception of ease in accessing veterinary care and was found at all household income levels. Another often-quoted statistic is the number of American workers living paycheck to paycheck. In a December 2021 survey, six in ten American consumers were found to live paycheck to paycheck. Even among those earning in excess of $100,000, approximately 42% were found to be living paycheck to paycheck. The largest group found living paycheck to paycheck were millennials, at 70% (7). Millennials comprise the largest age segment of pet ownership at 32% according to the American Pet Products Association (1). Financial fragility is widespread among the public and pet owners and, thereby presenting a major barrier to veterinary care.

The common "solutions" in financing veterinary care are inadequate for pet owners with cash flow challenges and an inability to qualify for traditional credit programs. In lieu of personal savings or credit cards, the primary options for pet owners to pay for veterinary services are pet insurance, discounts, or credit-based payment programs. Pet insurance, with premiums paid monthly or annually, most commonly requires owners to pay out of pocket and later be reimbursed for expenses rather than paying the clinic directly as in human healthcare. Discounts may be offered, but owners face the remaining cost of services for immediate payment. Third-party credit (TPC) programs, which pay the clinics directly (minus a percentage as a service fee), are available for owners who qualify and these owners may face interest rates of 26.9%. In a recent study by Bir et al. (8) owners preferred discounts to these TPC programs when considering hypothetical costs of routine and non-routine care, but this study did not consider practice-led lending (PLL) programs, which are not credit-based.

In monetary economics, a money multiplier identifies the potential expansion of the money supply in the economy based upon a reserve amount, the "reserve ratio," banking institutions must hold on hand to cover deposit accounts (9) https://www.investopedia.com/terms/r/reserveratio.asp. When the reserve ratio is lowered, money is "created" by banks being able to lend more dollars and, thereby increasing the money supply. Similarly, when payment options are offered in veterinary practices that bridge the gap in consumer cash flow and financial fragility, we may look at the default ratio to assess what expansion of care is possible when that default rate (a reserve rate) is covered, either by risk tolerance, donor dollars or funds that are otherwise earmarked in practice budgets for discounts to clients.

As the default amount decreases, a practice is able to expand its offering of care to clients that need payment options to access care. At its maximum, non-credit-based payment options for those who would not qualify for traditional credit and where other funds are not obtainable, the care multiplier is (1/default rate). More research is needed to identify the experienced decline rate of TPC and what alternatives clients face in the absence of payment options when declined by TPC to understand the final impact PLLs may have in covering the gap in accessing care due to finances. The expansion of fund potential is illustrated in the following examples:

Example A: A practice budgets $10,000 for discounts per year. If, instead, the practice used those funds to cover potential defaults on PLLs for clients declined by TPCs and the default rate on PLL tools was found to be 5%, then the practice would have $200,000 of care that it could provide and would receive a net of $190,000 in payments from clients.

$10,000 budgeted discount dollars * (1/0.05) multiplier = $200,000 of potential care.
$200,000 of potential care – $10,000 payments defaulted = $190,000 net revenue.

Example B: A non-profit provider has received a $75,000 grant to provide veterinary care to low-income residents of a city. The provider could subsidize the entire cost of care and provide

$75,000 of care to clients at no cost. If, instead, the provider provided PLL options such as "buy now, pay later" payment plans and used the donor's dollars to cover a 15% default rate, the provider could instead provide $500,000 of veterinary care to low-income pet families in the city. A $425,000 increase.

> $75,000 donor dollars * (1/0.15) multiplier = $500,000 of potential care.
> $500,000 of potential care – $75,000 donor dollars = $425,000 increase over full subsidy of care.

Credit scoring tiers are identified by the Bureau of Consumer Finance Protection (10) as Superprime (720 +), Prime (660–719), Near-prime (620–659), Sub-prime (580–619), and Deep subprime (<579). Not all adults are scorable with the term "credit invisible" referring to those who have no credit history and "unscorable" referring to those who have stale or "too thin" credit histories to be scored. Traditional credit financing looks for credit scores at or above Near-prime (620+). According to a 2019 Bureau of Consumer Financial Protection report, four in ten US adults have credit scores under 620 or are unscorable or credit invisible. This signals that only 60% of the US adults may qualify for traditional financing options in use in veterinary practices that are dependent on the credit scores.

This research examines 6 years of unscored and soft-credit-scored payment plan account data across veterinary clinic types, analyzing payment plan usage and default rates and, using the care multiplier, providing estimations of potential impacts on clinics, clients, and access to veterinary care initiatives.

Methodology

We utilize the following descriptions to differentiate between traditional credit-based financing and a practice-based financing option:

Practice-led lending—where the practice extends credit and may use an outside management service to obtain lending recommendations, with or without a soft credit check, and to manage client billing. The practice is not charged a fee on the financed amount but does face the risk of defaults.

Third-party credit—where an outside company offers credit using its own creditworthiness testing, based on credit scores. The practice is charged a fee, typically 5–10% of the financed amount, and does not face the risk of defaults.

A dataset from a PLL option, VetBilling, of 21,225 unique veterinary client accounts with first-payment dates between 2016 and 2021 was analyzed in this research. These accounts are distributed among 397 unique veterinary provider organizations and are scrubbed of personal identification information.

Accounts have statuses of Active (currently open) or Closed (no longer active). Closed accounts have sub-statuses based on the standing of the account: Expired/Canceled (account was paid in full); Collect (account was sent to the collection after 90 days of unpaid balance); Write-Off (WO) (account written off by the client organization). An additional indicator for Expired/Canceled accounts is provided for when the account was paid in full after being sent to collection.

Account data analyzed in the dataset include Total Cost of Services (total amount of the services provided), Down Payment Amounts (amount account holder paid up front), Total Financed Amounts (amount included in the payment plan, i.e., total cost of services minus down payment amount), Term Length (number of months), Financed Amount Remaining (portion of the total financed amount that is remaining as of December 2021, i.e., total financed amount minus total amount of payments made), Financed Amount Past Due (total amount not paid by due date), WO Amount (total amount not paid on the account), and Credit Score Recommendation (soft credit check). Default amounts for accounts in Collect were calculated using an aggregate of Financed Amount Remaining and Financed Amount Past Due. WO Amounts were used for accounts in WO status for default amounts.

Credit Score Recommendations (CSR) codes are optional credit ratings for clinics to run on an account. The rating uses a soft credit check along with VetBilling's internal scoring system that considers valid phone number, address, email, banking information, and payment history with financing companies, if any. The score also takes into account how the contract was signed (manually or *via* phone ID). Scores assigned are A+, A, B, C, D, E, F, and G. While it is not possible to directly map the eligibility for traditional credit-based financing or credit scores since companies keep this proprietary information confidential; VetBilling has advised that E, F, and G ratings would be very likely rejected by credit-based lenders and D ratings are somewhat likely as well. Those with A+, A, B, and C may be eligible for other credit-based financings.

Client organizations self-selected their organization type: small animal clinics, emergency services clinics, non-profit clinics, and other clinics (specialty, mobile, or mixed-animal type clinics).

The analysis of payment default rates looked only at accounts with a status of Closed, whereby the ultimate outcome is known.

Data were analyzed for summary statistics using Python.

Results

General

The 397 unique client organizations broke down as follows: 332 (83.6%) were small animal clinics, 39 (9.8%) were emergency services clinics, 14 (3.5%) were non-profit clinics, and 12 (3.0%) were other clinics.

TABLE 1 Organization type profiles.

Org type	Account status (as of 12/27/2021)	# accounts	Percentage of org type accounts (%)	Average term	Median term	Total $ financed	Percentage of Org type total financed amount (%)	Average financed amounts	Median financed amount	Average down payment	Median down payment	Down payment % of total cost
Emergency services (*n* = 39)	**Total**	**4,498**		**8.0**	**6**	**$4,979,129**		**$1,107**	**$679**	**$613**	**$255**	**35.6**
	Active accounts	924	20.5	12.0	12	$1,472,638	29.6%	$1,594	$1,194	$684	$329	30.0
	Closed accounts	3,574	79.5	6.9	6	$3,506,491	70.4%	$981	$577	$595	$250	37.7
	Canceled/expired	*3,178*	*88.9*	6.7	6	*$2,989,332*	*85.3%*	$941	$555	$609	$250	39.3
	Collect/WO	*396*	*11.1*	8.7	6	*$517,159*	*14.8%*	$1,306	$805	$479	$175	26.8
Non-profit (*n* = 14)	**Total**	**3,262**		**5.3**	**4**	**$1,325,029**		**$406**	**$265**	**$405**	**$240**	**50.0**
	Active	339	10.4	9.2	6	$201,368	15.2%	$594	$415	$467	$229	44.0
	Closed	2,923	84.8	4.8	4	$1,123,661	89.6%	$384	$256	$398	$240	50.9
	Canceled/Expired	*2,747*	*94.0*	4.7	4	*$1,034,771*	*92.1%*	377	$252	393.9	$240	51.1
	Collect/WO	*176*	*6.0*	5.9	5	*$88,891*	*7.9%*	$505	$302	$467	$289	48.0
Small animal (*n* = 332)	**Total**	**13,217**		**7.8**	**6**	**$10,106,670**		**$765**	**$509**	**$254**	**$120**	**24.9**
	Active	1,560	11.8	13.9	11	$1,941,657	19.2	$1,245	$861	$265	$75	17.5
	Closed	11,657	88.2	7.0	6	$8,165,014	80.8	$700	$480	$252	$126	26.5
	Canceled/Expired	*10,756*	*92.3*	6.8	6	*$7,216,356*	*88.4*	$671	$477	$255	$130	27.6
	Collect/WO	*901*	*7.7*	10.0	7	*$948,657*	*11.6*	$1,053	$675	$215	$50	17.0
Other (*n* = 12)	**Total**	**248**		**9.1**	**6**	**$250,892**		**$1,012**	**$738**	**$335**	**$148**	**24.9**
	Active	23	9.3	11.8	11	$19,115	7.6	$831	$929	$207	$112	19.9
	Closed	225	90.7	8.8	6	$231,778	92.4	$1,030	$728	$348	$150	25.2
	Canceled/Expired	*220*	*97.8*	8.7	6	*$221,760*	*95.7*	$1,008	$696	$345	$148	25.5
	Collect/WO	*5*	*2.2*	10.6	10	*$10,018*	*4.3*	$2,004	$1,736	$446	$300	18.2
Total	**Total**	**21,225**		7.5	6	**$16,661,720**		$785	$490	$354	$170	31.1
	Active	2,846	13.4	12.7	12	$3,634,777	21.8	$1,277	$897	$425	$125	24.9
	Closed	18,379	86.6	6.7	6	$13,026,943	78.2	$709	$448	$343	$172	32.6
	Canceled/Expired	*16,901*	*92.0*	6.5	5	*$11,462,219*	*88.0*	$678	$435	$346	$175	33.8
	Collect/WO	*1,478*	*8.0*	9.2	6	*$1,564,724*	*12.0*	$1,061	$677	$318	$117	23.0

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TABLE 2 Accounts with Credit Score Recommendations (CSR) by organization type.

	Percentage of total accounts (with CSR scores) by org type (%)				
	Emergency ($n = 1,148$)	**Non-profit ($n = 32$)**	**Small animal ($n = 1,738$)**	**Other ($n = 13$)**	**Grand total ($n = 2,931$)**
A+ ($n = 29$)	0.6	0.0	1.5	0.0	1.0
A ($n = 126$)	1.9	10.3	8.1	0.0	4.9
B ($n = 245$)	8.0	0.0	11.5	27.6	9.7
C ($n = 480$)	14.6	12.3	21.3	23.1	17.8
D ($n = 670$)	22.1	17.6	21.6	15.5	21.8
E ($n = 613$)	23.8	4.6	17.3	11.0	20.6
F ($n = 374$)	14.9	28.8	8.8	15.5	12.1
G ($n = 394$)	14.1	26.4	10.1	7.3	12.2
	100.0	100.0	100.0	100.0	100.0

The 21,225 accounts in the dataset broke down as 2,846 (13.4%) were Active and 18,379 (86.6%) were Closed. Of the Closed accounts, 16,901 (92.0%) were Expired/Canceled, 1,249 (8.0%) were listed as Collect/WO. Of the accounts that were Expired/Canceled, 2.3% of these accounts were originally sent to collection and then paid in full. Active accounts total is $3,634,777 in financed amounts, and closed accounts total is $13,026,943 in financed amounts.

Organization type profiles

Over the 6-year period, small animal veterinary clinics have been the primary clients utilizing the PLL option. While small animal clinics make up the majority of accounts each year (79.6% in 2016 and 55.7% in 2021), there has been an increase in accounts held by non-profit clinics (from 2.5% in 2016 to 15.9% in 2021), and emergency clinics (from 17.3% in 2016 to 27.5% in 2021).

Of the three main organization types, emergency clinics had the highest percentage of total accounts that are currently active (20.5%). Emergency clinics have higher financed amounts than the other organization types. The average financed amount for total accounts (active and closed) at emergency clinics is $1,107, which is 44.7% more than small animal clinics ($765) and 172.7% more than non-profit clinics ($406).

As a percentage of the total cost of services, non-profit clinics finance a lower portion, on average, than other organization types. Of the total accounts, the average financed percentage of the total costs was 53.1% for non-profit clinics, 75.9% for small animal clinics, and 68.5% for emergency clinics.

While emergency clinics have a higher down payment amount overall, which they determine with or without a recommendation from the PLL manager, non-profit clinics have a higher average percentage of total cost covered by the down payment than any other organization type. Non-profit clinics have an average of 50% as a down payment for services. Payment plans at emergency clinics and small animal clinics have an average of 35.6 and 24.9%, respectively, as a down payment.

Non-profit clinics average is 5.3 months payment terms from total accounts, while small animal clinics average is 7.8 months and emergency clinics average is 8.0 months. Even though emergency clinic accounts have average higher financed amounts than small animal clinics, their payment term average is very similar. (Table 1: Organization type profile). Further information is provided in the Supplementary Materials.

Distribution of accounts with credit ratings

Less than 15% of all accounts have a CSR rating that was run by the clinic when determining whether to grant the payment plan or how to structure it. Specifically, there are 2,931 accounts (13.8% of all accounts in the dataset) that have a CSR score of A+, A, B, C, D, E, F, or G. Of the scored accounts, 87.4% (2,561) are closed.

Of the total accounts that were assigned a CSR score (active and closed), 70.0% are D–G. There is insufficient information to thoroughly compare if rated accounts are representative of the entire dataset. The breakdown of accounts by clinic type is similar, with 59.3% of accounts having a CSR score through small animal clinics while 39.2% are through emergency clinics. We do see that as the rating decreases, the portion of accounts and financed amounts shift to be heavily emergency instead of small animal clinics as seen through the distribution of accounts by the CSR score (Table 2: Accounts with CSR by organization type).

Default accounts and amounts

As of December 2021, 92.0% of all closed accounts were paid in full, leaving 8.0% that ultimately went to default. In terms

TABLE 3 Default by organization type.

	Accounts in collection			Accounts in write-off (with write-off amounts)			All accounts		
	$ default	Percentage of total financed amount for accounts in Collection (%)	Percentage of total closed accounts financed amounts (%)	$ default	Percentage of total financed amount for accounts in WO (%)	Percentage of total closed accounts financed amounts (%)	Total cost of services (all closed accounts)	Total default	Default % of total cost of services
Emergency	$304,008	74.9	8.7	$87,966	81.9	2.5	$5,632,077	$391,974	7.0
Non-profit	$60,194	74.0	5.4	$3,857	50.9	0.3	$2,287,926	$64,051	2.8
Small Animal	$587,249	74.7	7.2	$106,678	76.6	1.3	$11,106,160	$693,927	6.2
Other	$1,922	53.2	0.8	$4,662	72.8	2.0	$310,017	$6,584	2.1
Total	**$953,473**	**74.7**	**7.3**	**$203,162**	**77.9**	**1.6**	**$19,336,181**	**$1,156,635**	**6.0**

of the total cost of services provided, 94.0% was paid through down payments and monthly installments. The total amount defaulted represents 8.9% of total financed amounts and 6.0% of total cost of services. Non-profit clinics have a default rate of 2.8% of total cost of services for all closed accounts (Table 3: Default by organization type).

Accounts assigned a CSR score have a default rate of 4.9% while accounts without a CSR score have a default rate of 6.2%. The majority of closed accounts with a CSR score (70.2%) have a D, E, F, or G score, indicating that they are more likely to have been declined by TPC payment options. As CSR scores decrease, the default rate increases; however, as a group, D, E, F, and G accounts have a default rate of 6.9% of total cost of services (Table 4: Default by CSR Score).

Discussion

The analysis offers insight into the expansion of veterinary care possible for both clients and clinics through the use of a PLL disassociated from traditional credit decision processes and where the client may make installment payments to mitigate the cash flow crises experienced by a large portion of the US adults.

Default rates varied by provider type and CSR; however, 91.1% of financed amounts were ultimately repaid, with 94.0% of total care costs paid *via* installments and down payments.

From an analysis of 2,561 accounts where CSR data are available, we can look to permutations of scores D–G ($n = 1{,}798$) to identify the potential care multiplier solely among pet families who most likely could not have qualified for TPC options.

Analyzing likely credit ineligibles at D, E, F, and G or the most conservative view that clients rated E, F, or G are likely to be ineligible for TPC options, the default amount as a ratio of total care provided is 6.9 and 8.4%, respectively, and the care multiplier is 14.5, or at minimum, 11.9 times the care that could otherwise be provided dollar for dollar by clinics and to pet families who may have had no other option (1/0.069 and 1/0.084). Again, future research is needed to determine the alternatives faced by these pet families, such as economic euthanasia, and whether they would have had other borrowing options, e.g., friends and family.

For the for-profit providers, the ability to meet existing clients in financial crisis offers financial and customer service opportunities. If we assume that those with a CSR of D, E, or F are not able to obtain other TPC financing, the data show that the percentage of total dollars of service that is not repaid is 5.6%. The G-rated accounts, the lowest possible rating, bring this collective default rate up to 6.9%. We note that some access to care models ask for a 20% discount from providers to targeted populations. A practice is financially better off self-insuring against the default at 6.0 or 6.9% of total services than providing 10 or 20% discounts, notably for those where a PLL abates the financial barrier. As previously stated, discounts also do not solve the cash flow issue for pet owners as the remaining cost is still an out-of-pocket expense. Further research is recommended to explore the levels at which providing payment options impacts clinics in terms of economic euthanasia decisions, client and staff stress, value perception and compliance with suggested care, outcomes for patients, and clinic revenue.

For the non-profit provider of veterinary services that procures donor dollars to subsidize part or all of the cost of providing veterinary care, PLL options offer a money multiplier effect to donor dollars, especially for the non-profit that does not offer any middle point on the spectrum between full price

TABLE 4 Default by CSR score.

	Total Down payment	Total financed	Total cost of services	Total amount default	Downpayment % of total cost of services	Financed amounts % of total cost	Amount default % of financed amount	Amount default % of total cost	Percentage of total financed (CSR scores only) (%)	Percentage of total cost of services (CSR scores only) (%)
A+ ($n = 27$)	$9,033.87	$25,466.24	$34,500.11	$0.00	26.2%	73.8	0.0	0.0	1.2	1.1
A ($n = 116$)	$48,232.92	$115,743.50	$163,76.40	$0.00	29.4%	70.6	0.0	0.0	5.4	5.2
B ($n = 199$)	$108,182.97	$193,216.20	$301,399.20	$1,883.59	35.9	64.1	1.0	0.6	9.0	9.5
C ($n = 421$)	$199,693.28	$382,107.50	$581,800.80	$8,829.01	34.3	65.7	2.3	1.5	17.8	18.3
D ($n = 590$)	$244,250.45	$461,680.50	$705,931.00	$28,357.54	34.6	65.4	6.1	4.0	21.5	22.2
E ($n = 534$)	$231,754.67	$446,115.40	$677,870.00	$40,531.63	34.2	65.8	9.1	6.0	20.8	21.3
F ($n = 316$)	$92,436.20	$230,434.20	$322,870.40	$25,839.60	28.6	71.4	11.2	8.0	10.7	10.1
G ($n = 358$)	$104,210.65	$289,687.30	$393,898.00	$50,981.60	26.5	73.5	17.6	12.9	13.5	12.4
A+,A,B,C ($n = 763$)	$365,143.04	$716,533.44	$1,081,676.51	$10,712.60	33.8	66.2	1.5	1.0	33.4	34.0
DEF ($n = 1,440$)	$568,441.32	$1,138,230.10	$1,706,671.40	$94,728.77	33.3	66.7	8.3	5.6	53.1	53.6
DEFG ($n = 1,798$)	$672,651.97	$1,427,917.40	$2,100,569.40	$1,45,710.37	32.0	68.0	10.2	6.9	66.6	66.0
EF ($n = 850$)	$324,190.87	$6,76,549.60	$1,000,740.40	$66,371.23	32.4	67.6	9.8	6.6	31.5	31.4
EFG ($n = 1,208$)	$428,401.52	$966,236.90	$1,94638.40	$1,17,352.83	30.7	69.3	12.1	8.4	45.1	43.8
CSR Score Total ($n =$ 2,561)	$1,037,795.01	$2,144,451.00	$3,182,246.00	$1,56,423.00	**32.6**	**67.4**	**7.3**	**4.9**		
No CSR Score ($n =$ 15,818)	$5,271,442.56	$1,0,882,492.00	$16,153,935.00	$1,000,213.00	**32.6**	**67.4**	**9.2**	**6.2**		
Total Dataset (closed accounts)	$6,309,237.57	$13,026,943.00	$193,36,181.00	$1,156,636.00	**32.6**	**67.4**	**8.9**	**6.0**		

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and full subsidy. If a donor has offered $100,000 to provide accessible sick or emergency veterinary care and those funds are used to cover the potential default of those with D, E, F, or G CSR codes, as a proxy for the inability to access other funding options to abate cash flow barriers, then the non-profit could potentially provide $1,449,275 of care to clients and their pets, nearly 15 times the number of family units (100,000/0.069), all while at a standard affordable price in their community vs. providing free care worth $100,000. Even if the non-profit was to work with the for-profit clinic and underwrite the G-rated CSR accounts alone, the lowest rating, 5.7 times the veterinary care could be provided over directly paying the bills for these pet families. Further research is recommended to identify how deeply PLL options can penetrate the population most challenged with any level of payment over time.

It is interesting that more than eight in ten payment plans are devised by practices without the use of the soft credit feature and CSR scoring. Further, the default rate among those without the CSR score is 6.2% of total service cost while the rate of those with CSR scoring is 4.9%. The majority of scores, where available, are in the range of likely declines for traditional credit suggesting that PLLs and non-credit-based payment options are a viable alternative to credit-based solutions for many clinics and clients. There will remain those that are unable to provide any payment for pet care. By more thoroughly reaching those between that level and people who are eligible for traditional funding, we will allocate scarce funds—such as discount and subsidy dollars—optimally and enable a great deal of veterinary care to those who need it.

Funders of access to care initiatives should look for providers to utilize payment options that address the number of pet families that are not eligible for traditional credit financing. Given the small number of non-profits in this analyzed dataset, it would appear that these clinics are lagging in the use of business tools. Additionally, accounts with non-profit clinics have higher down payment percentages, shorter terms, and lower financed amounts. By decreasing down payment percentages and increasing terms and financed amounts, non-profit clinics could support additional pet families who may require more flexibility in cash flow.

Limitations and areas for further research

The researchers acknowledge several limitations to this analysis and opportunities for additional research. First, these data do not show whether individuals were declined for TCP options and what they would do if PLL payment plans were not an option, including the alternatives they and their pet would face such as economic euthanasia. This is an important area for further research in combination with collecting pet household characteristics and socio-economic data to extrapolate the gap in financial barriers that may be bridged by more payment options in veterinary medicine. Additionally, qualitative and quantitative research that identifies all the payment methods organizations provide and why individuals choose a payment plan over other options, and how payment options may influence decisions to treat are needed to provide clarity into the use of payment options for increasing access to care. Finally, client organizations do not indicate why CSR scores were provided to some accounts and not others. Additional qualitative research on the organization operations would give insight into how payment options are offered and used in practices and how practices communicate options with clients.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The dataset has been made available to Frontiers editors. Other researchers should contact the authors and VetBilling for permission to access data. Requests to access these datasets should be directed to HC, heather@opendoorconsults.org.

Author contributions

SH and HC equally contributed to the analysis of the data and writing of the findings. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fvets.2022.895532/full#supplementary-material

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