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The development and validation of the One Health Community Assessment

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ABSTRACT

Interdisciplinary collaborations to address human, animal, and environmental health have been emphasized since the inception of the One Health framework. A quantitative survey instrument was developed to measure perceptions of the impacts of pets on One Health. Using the exploratory sequential mixed methods approach, 20 interviews were conducted with individuals from a racially diverse and low-socioeconomic status community in the U.S. to understand their perceptions of One Health. Data from those interviews informed the development of a Likert scale survey measuring individual perceptions of community, human, pet, and environmental health and welfare, as well as the connections between the domains of the One Health triad (human, animal, and environment). The resulting One Health Community Assessment (OHCA) was administered in two urban and two rural underserved U.S. communities longitudinally (2018–2021) through door-to-door data collection as well as phone, email, and text surveys. Validation of the instrument was completed using data collected in the third and fourth years of the study (n = 654). Factor analysis with orthogonal varimax rotation was used to assess the structure and internal consistency of the OHCA. Five subscales explained 42.4% of the variance in our 92-item instrument: community health (Cronbach's α = 0.897), human health (α = 0.842), pet health (α = 0.899), environmental health (α = 0.789), and connections between domains of One Health (α = 0.762). The OHCA represents the first reliable and validated instrument to measure the impacts of pets on One Health.

1. Introduction

The conceptual framework now widely known as "One Health" was formalized through the development of the Manhattan Principles, which sought to establish recommendations for a more holistic approach to supporting ecosystem integrity for humans, other animals, and the broader living ecosystems they are embedded within [1–4]. Since its inception, the One Health approach has emphasized the importance of interdisciplinary collaborations in addressing human, animal, and environmental health to optimize outcomes [2]. Many One Health initiatives focus on a variety of public health issues within this collaborative framework, including zoonotic and vector-borne diseases, food safety, and comparative medicine (e.g., [5–12]). While such initiatives have served as pragmatic approaches to global health efforts, two limitations persist in the related research. First, One Health studies commonly treat the human-animal relationship as a purely biological phenomenon instead of situating itself in a broader *biocultural* context [13], and second, they usually do not account for all three components of the triad, with environmental health dismissed most often [14–20]. Further, most One Health studies focus on understanding how the health of other species and the environment present health risks or opportunities to humans and not vice versa [21–23]. Human-centric uses of the One Health framework prevent holistic understanding of health issues across socioecological systems and create unintended vulnerabilities in the framework [22,24,25]. This is especially pertinent with growing global awareness of how dominant human society has altered the natural world (e.g., climate change, biodiversity loss, pollution), creating the need to rethink how human-animal interactions are understood [13,24,26,27]. One Health initiatives and research would benefit from situating themselves in a broader approach that considers everyday practices and the multitude of cultural, social, political, and material contexts in which health practices for humans, animals, and the

Abbreviations: CBRA, Community-Based Research Assistant; GIS, Geographic Information System; OHCA, One Health Community Assessment.

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environment are developed and enacted [13,25,26].

Although recent research has tried to incorporate the full One Health triad in its conceptualization of health issues, instrumentation that captures change across all three components of the triad remains lacking [25,28]. Further, while there have been attempts to understand the experiences of marginalized and underserved communities, which are particularly affected by One Health challenges, few studies have centered the priorities, local knowledge, and practices of those communities that are being directly impacted [29,30]. As highlighted by Lebov and colleagues [26], incorporating community input in local One Health efforts can capture the historical context and on-the-ground experience of interrelated issues. Centering those with lived experiences of One Health issues in the process of gathering and synthesizing information, community-specific interventions for adaptation and resilience, as they relate to human-animal-environment interactions, can be better informed [13,26]. This approach presents an alternative to human-centric uses of the One Health paradigm by realizing community-specific perspectives that allow for a more nuanced understanding of the sociocultural factors that intimately impact animal and environmental health [23,31]. Thus, co-creating instrumentation with community member input is critical to monitoring the evolution of One Health issues, as they are deeply embedded in unique socio-cultural landscapes and ecosystems that are simultaneously generalizable to communities with similar demographics.

Several studies have attempted to approach One Health through the human-companion animal relationships (e.g. animal sheltering, animal protection, veterinary care, and behavior training) [32–34]. No studies to date have holistically examined community members' perspectives of how petkeeping informs their daily experiences of the three One Health domains. In human healthcare settings, integrating individuals' perspectives is important to increasing communities' access to services because barriers to accessing care vary significantly in the context of one's health needs and the material and cultural settings in which they are embedded [35,36]. Therefore, community perspectives must be examined to accurately assess how access to services can be improved and positive impacts attained [36]. Variability in access to veterinary care and other supportive pet services (e.g. grooming, behavior, training, pet supplies) presents a substantial barrier to the health and welfare of companion animals [37]. Thus, animal welfare efforts could benefit from research aimed at identifying community-centric One Health interventions that incorporate individuals' perspectives on how best to increase pet owners' access to needed care and resources for their companion animals. A valid and reliable instrument that is equipped to measure One Health as it is operationalized in multifaceted, community-centric contexts is needed.

This manuscript describes the development and initial validation of an instrument, the One Health Community Assessment (OHCA), designed to measure individuals' perceptions of how pets impact community, human, pet, and environmental health and welfare and the connections between the domains of the One Health triad. The OHCA was designed to measure changes in residents' perceptions of One Health as it is epitomized through community members' access to care. This study was completed as a subset of a broader study that aimed to assess the effects of a community-focused program that was intended to increase individuals' access to pet-supportive services and, subsequently, improve the health of pets, humans, and the environments upon which they depend. The OHCA provides a tool for assessing how animal-focused programs and other types of interventions affect perceptions of each component of the One Health triad and the relationships that exist between them.

2. Materials and methods

Data were collected under a University of Denver Institutional Review Board-approved protocols (DU IRB #1160710 [interviews] and #1234950 [surveys]) using an exploratory sequential mixed methods approach. In February and March of 2018, semi-structured qualitative interviews were conducted with an interview guide in Spanish and English with 20 clients of a community-based animal welfare intervention (The Humane Society of the United States Pets for Life program [PFL]) in Denver, CO. The researchers asked participants five questions geared toward understanding their perspectives on how pets impact the health of people, other animals, and the natural environment. The interview recordings were transcribed and coded using standard, software-mediated qualitative analysis methodologies (Dedoose, Inc., Hermosa Beach, CA). In vivo coding methods were used for the first round of coding, followed by axial coding methods to refine the final sub-scales for use in the quantitative instrument. Themes identified in the analyses of the qualitative interviews and related validated instruments [38] were used to inform the development of a 170 Likert scale One Health survey instrument. This version was administered in a pilot study with a convenience sample in the Denver, CO PFL focus community. There were 105 participants who completed the pilot version of the survey in person or online. Name information was not collected from survey participants; therefore, while it cannot be verified, it is possible, though unlikely, that an individual who participated in the qualitative interviews also participated in the survey. Since the survey instrument was constructed after qualitative interviews took place, pre-exposure bias from a potential overlap of participants who may have participated in both the qualitative and quantitative versions of the study is negligible. Following data collection, the research team conducted a series of statistical analyses (e.g., Cronbach's alpha and factor analysis) using IBM SPSS Statistics (Version 24) to assess the validity and reliability of individual items. Factor analysis with a rotated component matrix (Varimax) was employed to correctly assign items to factors and assess the internal structure of the instrument. Five factors were extracted, based on the theoretical construct guiding the study, eigenvalues greater than 1, and careful inspection of the scree plot. The final version of the instrument consisted of 115 items with factor loadings greater than 0.4 [39]. The instrument was theorized as consisting of five subscales: community health, human health, pet health, environmental health, and connections between aspects of One Health. The response scale was structured to have seven options presented to respondents, with 1 = "Strongly Agree", 2 = "Agree", 3 = "Neutral", 4 = "Disagree", 5 = "Strongly Disagree", 6 = "Prefer not to answer", and 7 = "Not Applicable". The English version was directly translated into Spanish and cognitive interviews were then conducted to improve translation and the cultural appropriateness of items [40].

The resulting OHCA, consisting of 115 items, was administered in four communities, each defined based on zip code. The four study sites were selected based on specific criteria. First, the regional focus of the funder restricted the search to include only eight states (AK, ID, MT, MN, ND, OR, WA, WI). Second, communities were selected based on the criteria of being underserved, given that this was the intended use of the instrument. Underserved community was defined as the absence of local pet care resources, which was determined through Geographic Information Systems (GIS) mapping of local veterinarians and pet care service providers. Communities were also evaluated for residents' demographic factors to identify communities with low socioeconomic status and high rates of racial and ethnic diversity. Lastly, two urban and two rural communities with similar demographic profiles (Table 1) were chosen to allow for an initial assessment of the generalizability of findings across communities. The pair of urban study sites included Madison, WI (53713) and Seattle, WA (98108), and the rural sites were Granger, WA (98932) and Wilder, ID (83676).

Participants were recruited for the study through door-to-door outreach by bilingual community-based research assistants (CBRAs). Systematic sampling grids, consisting of half of the households in the urban communities and all the households in the rural communities, were used to guide CBRAs recruitment efforts. A minimum of three recruitment contact attempts were made at every household to maximize response rates. Community members were eligible to participate if

Table 1
2017 Demographics of the four study communities (U.S. Census Bureau).

Study Site	Population (2017)	Ethnicity							Median Household Income	% Individuals Below the Poverty Level
		Native American	Asian	Black	Latino/a	White	Multi-ethnic	Other		
Granger, WA (98932)	5335	2.9%	0.3%	0.9%	76.7%	17.6%	1.6%	0%	$47,302	27.3%
Wilder, ID (83676)	4511	0.3%	0.2%	0%	35.7%	62.5%	1.0%	0.2%	$45,645	15.4%
Seattle, WA (98108)	24,134	0.6%	37%	18.7%	10.1%	26.4%	5.8%	1.3%	$55,314	23.3%
Madison, WI (53713)	23,097	0.6%	7.6%	15.6%	25.6%	46%	4.5%	0.1%	$38,843	27.8%

they lived in one of the study zip codes and if they were current pet owners or owned pets within the past 12 months. In the participant's preferred language, English or Spanish, the CBRA executed the informed consent procedures, collected human and pet demographic data, and administered the OHCA. CBRAs recorded survey responses on an electronic tablet using a HIPPA-compliant data management system hosted at the University of Denver (REDCap) [42]. Participants received a $20 incentive for participating in the study. Due to the COVID-19 pandemic, the survey was administered by phone, email, or text from 2020 to 2021. The duration of the survey administration ranged from 20 to 40 min. Across the four years of data collection, fidelity checks were conducted with each of the CBRAs to ensure data collection procedures were implemented consistently across the four study sites.

Item-scale correlations, item variances, item means, Cronbach's α, and an exploratory factor analysis of the structure of the questionnaire were completed after the first year of administration (2018). This evaluation led to the exclusion, revision, and addition of items. These items were field tested in the second year of administration (2019) and their performance was evaluated. Further review and revisions to the scale were made, resulting in a 107-item version. This final version was used in years three (2020) and four (2021). The results of that administration are presented below.

A participant could participate in a different version of the survey across multiple years and, therefore, become familiar with the tool. However, this familiarity bias was mitigated through the review and revisions of the survey that took place (with only the final version of the survey being used for validity calculations), the amount of time that passed between surveys taken (a minimum of one year), and the administration of the survey by phone, email, or text (due to the Covid-19 pandemic), which differed substantially from previous surveys which were only administered by CBRAs and collected via electronic tablet. Data were combined across the third and fourth years of the survey administration to increase the sample size for analysis. If a participant provided responses in the fourth year but not in the third year, those data were included in the analysis sample. If they did not participate in the fourth year but did participate in the third year, those responses were included in the sample. If a participant provided responses in both the third and fourth years, only their third-year response was included in the sample. Consequently, this led to an overall sample size of $N = 654$ respondents, spanning both the English and Spanish versions of the survey. Of these, 578 participants completed the English version (88.4%), and 78 participants completed the Spanish version (11.9%). The data were stratified to limit the influence of language and potential differences in survey administration between the two versions. Information was not collected from non-respondents, and no survey changes occurred between these two years.

Frequency distributions, percentages, and item means were used to describe the variables. Pearson's r correlation coefficients between items were evaluated for negatively worded items; negative correlations indicated the need for reverse coding. The internal consistency of each theoretical subfactor was then assessed by Cronbach's α. Finally, factor analysis was employed to assess the structure of the assessment.

3. Results

Of the 654 participants, 217 (33.2%) resided in Madison, WI, 193 (29.5%) in Seattle, WA, 133 (20.3%) in Granger, WA and 111 (17.0%) in Wilder, ID. There were 233 (35.6%) surveys completed in-person, 205 (31.3%) by phone, 162 (24.8%) through email, 52 (8.0%) through text, and 2 (0.3%) over Zoom Video Conference. Descriptive statistics for the demographics of the sample are presented in Table 2.

Descriptive analyses were completed on a series of demographic variables. Due to the unbalanced percentages across sex, place of birth, and race and ethnicity, these variables were evaluated against expected counts using a chi-square test of independence. The expected and observed counts for the variable for sex were found to be statistically significantly different, $\chi_1^2 = 95.06, p < .001$, using an alpha level of 0.05. This p-value, in addition to the p-values for place of birth and race and ethnicity, are presented in Table 2. Since the variable for sex was found to be statistically significantly different, further investigation of this variable was completed. Given the categorial nature of the demographic data and the use of a Likert scale for the survey instrument, chi-square tests of independence were conducted to investigate whether responses to items were independent of this demographic grouping. A significant difference was not seen in responses to items when evaluating the item responses by sex when the alpha level was set at 0.05, and the familywise error rate was controlled for through a Bonferroni correction.

Factor analysis with orthogonal varimax rotation was performed. Five factors were extracted based on information gathered from visual inspection of the scree plot, eigenvalues greater than 1, and the theoretical constructs guiding the study. Items with a factor loading greater than 0.4 were retained. This resulted in a reduction of the number of items from 107 to 92 items. Table 3 displays the item means, standard deviations, and item loadings for the five factors found in the final solution. Overall, 42.40% of the variance in responses to this instrument could be explained by this set of factors.

Information from the factor analysis confirmed the theoretically proposed subscales of community health, human health, pet health, environmental health, and connections between the components of One Health. As highlighted in Table 4, Factor 1 primarily consisted of the items proposed for the community and environmental health subscales, Factor 2 contained only pet health items, Factor 3 consisted primarily of human health items, and most Factor 4 items came from the theoretical connections between the components of overall health subscale. Due to this internal structure, the theorized subscales are supported by the results of the factor analysis. A description of each of the factors is included below.

Subscale 1. Community health.

This subscale was part of the first factor and consisted of 12 items. These items focused on the level of connectedness within the community as well as general attitudes toward the respondent's community, with items such as "I feel welcome in my community" and "I trust my neighbors".

Subscale 2. Environmental health.

Table 2
Demographics of the sample (N = 654).

Sex	$p < .001$*
Female	454 (69.4%)
Male	191 (29.2%)
Other	3 (0.5%)
Prefer not to answer	6 (0.9%)
Ethnicity	$p = .052$
White/Not Hispanic or Latino	348 (53.2%)
Latino/a	193 (29.5%)
Other (e.g., American Indian, Black/Not Hispanic or Latino, Asian, Multi-ethnic)	107 (16.4%)
Prefer not to answer	6 (0.9%)
Age	
60+ years old	149 (22.8%)
46–60 years old	189 (28.9%)
31–45 years old	194 (29.7%)
18–30 years old	120 (18.3%)
Prefer not to answer	2 (0.3%)
Preferred language	
English	550 (84.1%)
Spanish	101 (15.4%)
Other	3 (0.5%)
Highest level of education completed	
Less than a high school degree	108 (16.5%)
High school degree or equivalent	329 (50.3%)
Bachelor degree or higher	200 (30.6%)
Prefer not to answer	17 (2.6%)
Annual household income	
$0–$15,000	99 (15.1%)
$15,000–$30,000	114 (17.4%)
$30,000–$45,000	80 (12.2%)
$45,000–$60,000	75 (11.5%)
Greater than $60,000	162 (24.8%)
Prefer not to answer	124 (19.0%)
Housing Type	
Homeowner	368 (56.3%)
Renter	223 (34.1%)
Other (e.g., Temporary housing, emergency shelter, currently houseless)	53 (8.1%)
Prefer not to answer	10 (1.5%)
Born in the U.S.	$p = .475$
Yes	518 (79.2%)
No	121 (18.5%)
Prefer not to answer	15 (2.3%)

This subscale was also part of the first factor and consisted of 15 items. While statistically grouping with the community health subscale, this subscale focused on one's connection to the natural environment. Items such as "I have plenty of options in my community for how I enjoy nature".

Subscale 3. Human health.

The human health subscale consisted of 18 items and primarily comprised the second factor. Questions in this factor also mimicked the questions in the pet health subscale. Example items include "I trust my health care provider to take care of whatever I need" and "I have been satisfied with the health care services I have received".

Subscale 4. Pet health.

This subscale consisted of 28 items and made up the third factor. This subscale seemed to focus most on services for one's pet. Examples of items include "I have been satisfied with the services my pet(s) has received" and "My pet care services provider communicates clearly with me".

Subscale 5. Connections between components of One Health.

The fourth factor was comprised primarily of the connections between components of overall health subscale and highlighted a more relational aspect between other various components with items like "My relationship with my pet(s) is important" and "I think it's important to protect the natural environment". This subscale consisted of 19 items.

Integrating the statistical results from the factor analysis with the theoretical rationale for the items, the theoretical subscales of community health, human health, pet health, environmental health, and connections between components of One Health were reassessed for Cronbach's α. This resulted in the values of 0.897, 0.789, 0.842, 0.899, and 0.762, respectively. The items that made up the theoretical subscales, along with Cronbach's α noted, are recorded in Table 4. Item means, standard deviations, and how that item loaded on that respective factor are also noted.

4. Discussion

Previous One Health research and programming has focused on mitigating disease emergence and transmission [5–12], whereas the present study aimed to develop a One Health instrument that can be used to measure the perspectives on a much wider variety of preventive health interventions, including pet ownership. The OHCA instrument offers two unique opportunities for measuring One Health: (1) it includes the ability to identify individuals' perceptions of how pets influence health-promoting behaviors that impact humans, other species, and environmental health (e.g., vaccinations, physical exercise); and (2) it measures the perception of structural factors (e.g., affordability, geographic proximity) that can impact individuals' One Health-promoting behaviors. Further, the OHCA instrument could be applied to opportunities measuring 'One Welfare,' which, similar to One Health, seeks to understand the synergistic relationship between human and animal welfare [41].

The methods used for developing this instrument centered on the voices of those with lived experience of One Health issues that impact the human-companion animal bond. Studies using a similar approach have highlighted how incorporating the perspectives and lived expertise of local community members in One Health efforts is necessary to realize potential mechanisms of change within those communities [13,26]. Moreover, by accounting for essential contextual factors that shape intervention efficacy, a community can be empowered to identify and address its own health needs, disparities, and goals [26,30]. The present questionnaire was developed for use with individuals with companion animals (cats, dogs) who reside in historically marginalized communities (e.g., low socioeconomic status, racial/ethnic diversity). The incorporation of "local knowledge" of One Health into this instrument represents a comprehensive and contextually relevant understanding of mechanisms for health promotion for people, other species, and the environment that can support community-specific policymaking [29,44]. The OHCA explained 42.40% of the variation in responses to the instrument. Ideally, this value would be higher but for the social sciences where information is not as precise, it is acceptable to consider a solution that accounts for lesser amounts of explained variance [43].

Table 3
Results of the factor analysis (statistically derived subscales).

	Variable Name	Mean	Standard deviation	Factor Loading	Variance explained (%)	Cronbach's α
Factor 1: Community and Environment Health		78.24	17.4		12.94%	0.942
	Neighbors get along	2.04	0.86	0.51		
	Neighbors look out for each other	1.98	0.77	0.57		
	Neighbors help each other	1.94	0.73	0.48		
	Proud of community	2.12	0.84	0.69		
	Raise kids	2.25	0.94	0.71		
	Feeling safe	2.22	0.94	0.65		
	Feeling welcome	2.13	0.89	0.72		
	Neighbors help with pet/children	2.48	1.09	0.41		
	Positive occurrence	2.20	0.83	0.69		
	Trust neighbors	2.28	0.91	0.61		
	Government understands needs	2.71	0.91	0.52		
	Frequency of exercise	2.32	0.90	0.46		
	Enough exercise	2.82	1.02	0.40		
	Regular exercise for pets	2.14	0.79	0.61		
	Enough exercise for pets	2.35	0.85	0.58		
	Connected to the environment	2.00	0.74	0.52		
	Respect for the environment	2.55	1.06	0.75		
	Recycle/compost	2.44	0.98	0.45		
	Abundance of plants	2.07	0.91	0.60		
	Proximity to outdoors	1.86	0.77	0.49		
	Wildlife presence	1.91	0.86	0.42		
	Wildlife movement	2.11	0.91	0.45		
	Improvement of environment	2.71	0.87	0.64		
	Dispose of hazardous materials	2.85	0.93	0.50		
	Affordable options to enjoy nature	2.01	0.71	0.47		
	Options to enjoy nature	2.11	0.84	0.57		
	Pet-friendliness	2.10	0.75	0.49		
	Quality of care for pets	2.17	0.78	0.57		
	Respect for animals	2.09	0.65	0.51		
	Walks in community	2.02	0.90	0.52		
	Community gardens	2.05	0.95	0.48		
	Efforts to protect the environment	2.07	0.79	0.57		
	Police help	2.36	0.87	0.43		
	Easy to enjoy the outdoors	1.89	0.71	0.54		
	Government communication	2.76	0.98	0.46		
	Enjoy the environment	1.72	0.71	0.50		
Factor 2: Pet Health		35.58	8.78		9.58%	0.917
	Grooming services	1.75	0.62	0.41		
	Annual checkup for pet	1.78	0.73	0.55		
	Cat altered	1.79	0.93	0.40		
	Dog altered	1.83	0.96	0.40		
	Proximity of pet care services	2.17	0.94	0.51		
	Trust pet care provider	1.88	0.74	0.78		
	Pet care treatment options	1.88	0.79	0.68		
	Pet care provider communication	1.86	0.75	0.80		
	Received needed pet care services	1.86	0.69	0.69		
	Satisfaction with pet care services	1.87	0.72	0.79		
	Pet care service provider referral	2.02	0.88	0.62		
	Pet healthcare information	1.81	0.59	0.64		
	Discuss services for pets	2.00	0.80	0.62		
	Reminders for pet care appointments	2.04	0.83	0.49		
	Choices for pet care services	2.01	0.73	0.67		
	Proximity to pet supply stores	1.87	0.87	0.49		
	Health of pet	1.83	0.64	0.51		
	Pet care services in preferred language	1.68	0.71	0.53		
	Affordable pet care	2.30	0.88	0.60		
Factor 3: Human Health		25.30	6.91		9.12%	0.91
	Annual checkup for self	1.72	0.76	0.44		
	Trust healthcare provider	1.88	0.75	0.72		
	Healthcare treatment options	1.90	0.79	0.77		
	Healthcare provider communication	1.76	0.67	0.79		
	Received needed healthcare services	1.87	0.86	0.76		
	Satisfaction with healthcare services	1.87	0.80	0.84		
	Healthcare provider referral	1.80	0.70	0.67		
	Healthcare information	1.81	0.65	0.83		
	Reminders for healthcare appointments	1.86	0.79	0.53		
	Affordable healthcare	2.26	0.95	0.52		
	Payment options for healthcare	2.19	0.79	0.43		
	Payment options for pet care services	2.44	0.95	0.43		
	Accomplish dreams	2.12	0.88	0.42		

(*continued on next page*)

Table 3 (*continued*)

	Variable Name	Mean	Standard deviation	Factor Loading	Variance explained (%)	Cronbach's α
Factor 4: Connections between domains of One Health		22.19	5.22		6.83%	0.865
	Regular exercise	1.67	0.63	0.40		
	Healthcare services in preferred language	1.55	0.56	0.55		
	Entertain pets	1.56	0.61	0.50		
	Collar/microchip	1.75	0.73	0.51		
	Pet vaccinations	1.59	0.58	0.47		
	Connection to animals	1.63	0.59	0.64		
	Tight resources	1.95	0.81	0.46		
	Relationship with pet	1.42	0.53	0.75		
	Pet as family	1.31	0.48	0.72		
	Pet contributes to happiness	1.36	0.51	0.73		
	Movement from pet	1.63	0.79	0.50		
	Enjoy wildlife	1.62	0.56	0.57		
	Protect the environment	1.44	0.51	0.70		
	Basic obedience	1.71	0.56	0.44		
Factor 5: Level of concern for self, community, and pet		30.33	5.91		3.93%	0.724
	Worry daily	2.75	1.18	0.60		
	Worry too much	2.85	1.24	0.68		
	Worry about pet daily	2.93	1.16	0.47		
	Worry about pet too much	3.20	1.10	0.40		
	Animal waste	3.17	1.04	0.57		
	Trash	2.78	1.23	0.52		
	Quantity of loose dogs	3.33	1.14	0.52		
	Quantity of outdoor cats	2.61	1.11	0.43		
	Efforts to reduce loose dogs	3.03	0.97	0.55		
	Efforts to reduce outdoor cats	3.06	1.00	0.56		
Overall		191.17	34.5		42.40%	

The solution proposed here was chosen from a theoretical standpoint while also considering the scree plot and the eigenvalues. Regardless, it is important to consider the impact on validity, as this commonalities value means that there is a fair amount of variance in responses to the instrument that is not explained by this specific set of factors, which could affect the tool's ability to measure what it is intended to measure. Further research or work could be undertaken to investigate underlying themes in the next set of factors to be extracted to see what additional components may be at play.

A strength of the OHCA scale is its inclusion of items that focus on individual-level attitudes alongside ones that ask about structural dimensions and one's ability to access a variety of activities that promote health (e.g., veterinary care, human healthcare providers, green space). Attitudes have been the focus of numerous studies designed to predict or explain behavior more than any other psychological construct because attitudes can be easily measured through fixed format response scales (e.g., Likert-scale), and when accurately measured, attitudes can predict behavior [30,45,46]. Though attitudes are central to more complex psychological concepts, and they have traditionally been used to predict behavior, they are only effective predictors of behavior if the attitude is directed toward a specific behavior. Attitudes as a construct are less useful in predicting behavior when trying to measure generalized attitudes or understand how attitudes are shaped by structural realities experienced by individuals (e.g., systemic racism contributing to occurrences of resource deserts). In some cases, the questionnaires used to measure attitudes can influence the attitudes they are designed to measure [45,46]. In the case of pet ownership, structural barriers are salient to understanding how an individual's attitudes translate to behaviors [37,47]. For example, an individual or community may indicate they would utilize veterinary care services but are unable to "gain access" unless the factors of cost, geographic proximity, and language are mitigated [37]. Effective community-driven interventions rely upon our ability to measure and understand the interplay of individual, community, animal, and environmental factors that shape collective health, as the OHCA is designed to do [30,46].

5. Limitations

Several limitations should be considered when using the OHCA. Because these validation analyses were conducted cross-sectionally, it remains to be seen if the scale has sensitivity to intervention-level changes over time. Additionally, the retrospective nature of the instrument that asks individuals to respond based on reflections on their past experiences rather than through assessment of their experience in the present moment, increases the risk of response bias wherein a person's response is influenced by their memory of recent situations, beliefs about how they should respond, and cultural norms [48].

The OHCA contains nearly 100 questions, which require approximately 20–40 min to complete. Long surveys can result in response fatigue, potentially impacting response rates or data quality [49]. The length of this survey is not optimally suited for use in community-based settings that typically have minimal resources allocated toward data collection. Future research will explore the development of a short version of the OHCA. Additionally, a series of data collection modes were used throughout this study (in-person, phone, email, and video conferencing). Different modes of collection carry potential to influence results, as different settings allow for different lengths of time for response, a different level of effort on part of the interviewee—potentially affecting survey fatigue—and a different level of rapport with the interviewer. This is mitigated somewhat by the use of a standard response scale; however, it is still important to note.

Another limitation of the survey is the assessment of reliability on aggregated data. While significant differences were not found by certain demographic variables, the robustness of the scale could be further evaluated by conducting factor analyses on stratified data. This would add to the validation of the tool. Future research will explore this avenue.

One Health literature primarily refers to the environment as the elements (e.g., water, air, soil), wildlife, and the human or built environment [21,30]. While the OHCA instrument employs a more holistic view of the environment compared to other instruments measuring One Health, the use of the environment in the OHCA remains human-centered. However, the OHCA, unlike many other One Health studies, does extend beyond the scope of research by focusing on humans'

Table 4
Theoretical subscales (confirmed by factor analysis presented in Table 3).

	Variable name	Mean	Standard deviation	Factor loading	Cronbach's α
Community Health		26.23	7.16		0.897
	Feeling welcome	2.13	0.89	0.72	
	Raise kids	2.25	0.94	0.71	
	Positive occurrences	2.20	0.83	0.69	
	Proud of community	2.12	0.84	0.69	
	Feeling safe	2.22	0.94	0.65	
	Trust neighbors	2.28	0.91	0.61	
	Neighbors look out for each other	1.98	0.77	0.57	
	Government understands needs	2.71	0.91	0.52	
	Neighbors get along	2.04	0.86	0.51	
	Neighbors help each other	1.94	0.73	0.48	
	Police help	2.36	0.87	0.43	
	Neighbors help with pet/children	2.48	1.09	0.41	
Human Health		36.69	7.68		0.842
	Satisfaction with healthcare services	1.87	0.80	0.84	
	Healthcare information	1.81	0.65	0.83	
	Healthcare provider communication	1.76	0.67	0.79	
	Healthcare treatment options	1.90	0.79	0.77	
	Received needed healthcare services	1.87	0.86	0.76	
	Trust healthcare provider	1.88	0.75	0.72	
	Healthcare provider referral	1.80	0.70	0.67	
	Reminders for healthcare appointments	1.86	0.79	0.53	
	Affordable healthcare	2.26	0.95	0.52	
	Annual checkup for self	1.72	0.76	0.44	
	Payment options for healthcare	2.19	0.79	0.43	
	Accomplish dreams	2.12	0.88	0.42	
	Healthcare services in preferred language	1.55	0.56	0.36	
	Regular exercise	1.67	0.63	0.21	
	Enough exercise	2.82	1.02	0.14	
	Frequency of exercise	2.32	0.90	0.10	
	Worry too much	2.85	1.24	−0.12	
	Worry daily	2.75	1.18	−0.12	
Pet Heath		55.86	11.07		0.899
	Pet care provider communication	1.86	0.75	0.80	
	Satisfaction with pet care services	1.87	0.72	0.79	
	Trust pet care provider	1.88	0.74	0.78	
	Received needed pet care services	1.86	0.69	0.69	
	Pet care treatment options	1.88	0.79	0.68	
	Choices for pet care services	2.01	0.73	0.67	
	Pet healthcare information	1.81	0.59	0.64	
	Pet care service provider referral	2.02	0.88	0.62	
	Discuss services for pets	2.00	0.80	0.62	
	Affordable options for pet care	2.30	0.88	0.60	
	Annual checkup for pet	1.78	0.73	0.55	
	Pet care services in preferred language	1.68	0.71	0.53	
	Proximity of pet care services	2.17	0.94	0.51	
	Health of pet	1.83	0.64	0.51	
	Proximity to pet supply stores	1.87	0.87	0.49	
	Reminders for pet care appointments	2.04	0.83	0.49	
	Grooming services	1.75	0.62	0.41	
	Basic obedience	1.71	0.56	0.41	
	Dog altered	1.83	0.96	0.40	
	Cat altered	1.79	0.93	0.40	
	Payment options for pet care services	2.44	0.95	0.39	
	Entertain pets	1.56	0.61	0.38	
	Collar/microchip	1.75	0.73	0.31	
	Enough exercise for pets	2.35	0.85	0.31	
	Regular exercise for pets	2.14	0.79	0.30	
	Pet vaccinations	1.59	0.58	0.28	
	Worry about pet too much	3.20	1.10	−0.06	
	Worry about pet daily	2.93	1.16	−0.12	
Environment Health		34.80	6.70		0.789
	Respect for the environment	2.55	1.06	0.75	
	Improvement of environment	2.71	0.87	0.64	
	Abundance of plants	2.07	0.91	0.60	
	Options to enjoy nature	2.11	0.84	0.57	
	Easy to enjoy the outdoors	1.89	0.71	0.54	
	Connected to the environment	2.00	0.74	0.52	
	Dispose of hazardous materials	2.85	0.93	0.50	
	Proximity to outdoors	1.86	0.77	0.49	
	Affordable options to enjoy nature	2.01	0.71	0.47	
	Government communication	2.76	0.98	0.46	
	Wildlife movement	2.11	0.91	0.45	
	Recycle/compost	2.44	0.98	0.45	

(*continued on next page*)

Table 4 (*continued*)

	Variable name	Mean	Standard deviation	Factor loading	Cronbach's α
	Wildlife presence	1.91	0.86	0.42	
	Animal waste	3.17	1.04	−0.09	
	Trash	2.78	1.23	−0.19	
Connections between domains of One Health		38.74	6.53		0.762
	Relationship with pet	1.42	0.53	0.75	
	Pet contributes to happiness	1.36	0.51	0.73	
	Pet as family	1.31	0.48	0.72	
	Protect the environment	1.44	0.51	0.70	
	Connection with animals	1.63	0.48	0.64	
	Enjoy wildlife	1.62	0.51	0.57	
	Movement from pet	1.63	0.59	0.50	
	Tight resources	1.95	0.56	0.46	
	Enjoy the environment	1.72	0.79	0.41	
	Walks in community	2.02	0.81	0.33	
	Community gardens	2.05	0.71	0.29	
	Efforts to protect the environment	2.07	0.90	0.25	
	Pet-friendliness	2.10	0.95	0.16	
	Respect for animals	2.09	0.79	0.16	
	Quality of care of pets	2.17	0.75	0.14	
	Efforts to reduce loose dogs	3.03	0.65	0.04	
	Quantity of outdoor cats	2.61	0.78	0.03	
	Efforts to reduce outdoor cats	3.06	0.97	0.00	
	Quantity of loose dogs	3.33	1.11	−0.025	
Overall		191.17	34.51		

perceptions of nature and the environment. Many of the environmental measures included in the OHCA addressed the "built" environment, the natural environment, and access and connection to the natural world. The OHCA lacks concrete measures of environmental quality (e.g., clean air and clean water). Future research will refine the OHCA to produce more accurate calculations of One Health perceptions on environmental qualities. In future studies using this instrument, the research team will revise the environmental items to reduce anthropocentric bias.

A final limitation is that a minority (11.9%) of the OHCA responses used for this instrument validation were completed in Spanish. Cognitive interviews were conducted to assess content validity after the development of the instrument. Still, more research is needed to determine the adequacy of the response scale for the Spanish version [40]. Future use of the Spanish version of the instrument should include consultation with local Spanish speakers familiar with the local dialect and idioms to provide their expertise on accurately communicating about the OHCA and its questions [40,50,51].

6. Conclusion

The OHCA represents the first reliable and validated instrument to measure the perspectives of companion animal (cats and dogs) owners' regarding One Health in their community.

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CRediT authorship contribution statement

Sloane M. Hawes: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft. **Tara Rhodes:** Formal analysis, Validation, Writing – original draft, Writing – review & editing. **Tess M. Hupe:** Data curation, Project administration, Supervision, Validation, Writing – review & editing. **Romi Dazzio:** Data curation, Writing – original draft. **Erin Flynn:** Conceptualization, Funding acquisition, Methodology, Writing – review & editing. **Kaleigh M. O'Reilly:** Writing – original draft, Writing – review & editing. **Kevin N. Morris:** Conceptualization, Funding acquisition, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Data availability

Data will be made available on request.

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