



Evaluating how varied human-wildlife interactions affect physical, mental, social, and spiritual health

Jose-Benito Rosales Chavez^{a,*}, Kelli L. Larson^b, Jorge Morales Guerrero^c, Jeffrey A.G. Clark^{d,e}

^a School of Geographical Sciences and Urban Planning, Arizona State University, 975 S Myrtle Ave, Coor Hall Tempe, AZ, 85281-5302, USA

^b School of Geographical Sciences and Urban Planning, School of Sustainability, Arizona State University, 975 S Myrtle Ave, Coor Hall Tempe, AZ, 85281-5302, USA

^c School of Sustainability, Arizona State University, 975 S Myrtle Ave, Coor Hall Tempe, AZ, 85281-5302, USA

^d Central Arizona-Phoenix Long-Term Ecological Research Program, Arizona State University, Tempe Arizona, 777 E. University Dr, Tempe, AZ, 85281, USA

^e Natural Areas Conservancy, New York, New York, 10029, USA

ABSTRACT

Research on human-animal interactions has often focused on rural residents or health outcomes in captive settings. Meanwhile, relatively few studies have focused on how diverse human-wildlife interactions in non-captive settings and among urban residents affect health outcomes. Additionally, previous human-wildlife research on health outcomes has lacked attention to positive and non-material health impacts. This unidirectional negative outcome limits knowledge about the full scope of how wildlife affects human health. Situated in metropolitan Phoenix, Arizona, in the arid southwestern U.S., our study examines residents' (n = 24) narratives about their experiences with wildlife—both lived and perceived and their impact on health outcomes. Specifically, we evaluated interview transcripts for direct and indirect references to well-being along four commonly recognized dimensions of health. Observational interactions with wildlife were more commonly described by our research participants than attitudinal and physical interactions, representing 64%, 31%, and 19% of the interview segments, respectively. Combined positive health outcomes from human-wildlife interactions were more common among our participants (52%) than negative outcomes (39.6%). These trends contrast with a predominance of research on human-wildlife interactions, which emphasizes physical conflicts and other negative interactions. The positive health benefits associated with observing and interacting with wildlife centered on mental health and understudied spiritual benefits. Our results showed that everyday human-wildlife interactions in urban areas create positive health outcomes, especially in the mental and spiritual realms. Thus, preserving current opportunities to interact with nature and creating additional experiences with wildlife is important for encouraging positive interactions between people and wildlife.

1. Introduction

In many countries around the world the portion of urban residents exceeds 80 percent (United Nations, 2018; United States Census Bureau, 2019). As people concentrate in cities, many residents lose the opportunity to interact with and experience nature (Pett et al., 2016; Soga & Gaston, 2016). This disconnection with the natural world may negatively impact human well-being in urban areas (Abbott, 2012; Colléony et al., 2020). Recently, researchers aimed to quantify how experiences and exposure to different types of nature influence the health and well-being of people (Cox et al., 2017; Shanahan et al., 2015). Findings show how exposure to nature can positively impact human health, yet the results are often mixed and highly context-specific (Farrier et al., 2019; Hedblom et al., 2017).

The differences in how researchers evaluate interactions with nature may be a potential reason for the highly variable research on human-nature interactions. Most studies indirectly quantify people's interaction with nature by asking participants about their visitation to parks and

green spaces or the number of parks and greenspaces in the vicinity of their homes (Beyer et al., 2014; Lewis, 1994; World Health Organization, 2017). Many studies also utilize indirect experiences such as viewing plants or vegetated landscapes through a window or virtually (Browning et al., 2020; Grinde & Patil, 2009), while others have tested the effects of hearing the sounds of nature such as birds chirping (Hedblom et al., 2019). Research on animals often focused on interactions with pets or captive animals (Charnetski et al., 2004; Crawford et al., 2006). Further, papers that highlight the interaction between humans and wildlife tend to focus on the conflicts and damages on human property resulting from these interactions (e.g., livestock kills, agricultural losses) (Conover, 1997; König et al., 2020; Messmer, 2009; Soulsbury & White, 2015), or in negative physical health impacts among community members (e.g., attacks, vehicle collisions) (Conover et al., 1995, pp. 407–414; Messmer, 2009). Furthermore, specific taxa, mainly birds, have received significant study in understanding how people perceive and interact with them in positive and negative ways (Cox and Gaston, 2015, 2016; Fuller et al., 2013, pp. 249–266). However, people are also likely to encounter other

* Corresponding author.

E-mail address: joserosaleschavez@gmail.com (J.-B. Rosales Chavez).

<https://doi.org/10.1016/j.ssmqr.2023.100302>

Received 15 November 2022; Received in revised form 27 June 2023; Accepted 27 June 2023

Available online 28 June 2023

2667-3215/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

types of wildlife on their day to day routines.

In evaluating health outcomes, studies vary widely and include physiological measurements such as reduced cortisol levels (Jones et al., 2021) and improvements in vital signals and length of hospitalization (Park & Mattson, 2009). Improved self-reported physiological and psychological measures have also been found in reduced stress levels (Yang et al., 2020) and increase happiness (Van Herzele & De Vries, 2012). In some cases, health outcomes are interrelated. For example, reducing stress hormones (as a measure of physical health) is positively associated with the mental health benefits of reduced tension and anxiety (Roe et al., 2013). Overall, previous research has typically focused on the physical and mental aspects of health-related interactions with nature using quantitative measures. We, therefore, examine various positive and negative health outcomes associated with human-wildlife interactions using a qualitative approach.

We specifically focus on urban residents' interactions with diverse wildlife since previous research has focused largely on rural areas, with particular attention to conflicts among people and carnivores (Carter & Linnell, 2016; Frank, 2016; Larson et al., 2023; Pooley et al., 2021). Moreover, regarding health outcomes, human-wildlife research has primarily focused on *either* negative *or* positive outcomes (Methorst et al., 2020). This unidirectional focus may limit knowledge about the full scope of how nature can impact human health and well-being, including the many understudied non-material effects of wildlife on people. The focus of many studies on quantitative measures may also limit understanding of the nuanced impacts of human-wildlife interactions, including emotional or spiritual effects, which may be best understood via qualitative methods. Situated in metropolitan Phoenix, Arizona, in the arid southwestern U.S., our study examines residents' narratives about their experiences with wildlife—both lived and perceived, along with the full array of realized and potential positive and negative health outcomes. Specifically, we evaluated interview transcripts for direct and indirect references to well-being along four commonly recognized dimensions of health. In addition to the physical and mental health outcomes that have been more commonly studied in relation to nature interactions, we also analyze spiritual and social health outcomes linked to interactions with wildlife (Dhar et al., 2011; Huber et al., 2011).

1.1. Health dimensions in relation to human-wildlife interactions

Physical health refers to maintaining a healthy or functional body that is essential in carrying out daily activities and recovering from illness or injury (Huber et al., 2011). Positive physical health outcomes linked to wildlife experiences include hiking, running, or other physical activities (Pietilä et al., 2015), often involve viewing or interacting with wildlife in natural areas. Negative physical health outcomes entail injury due to attacks, bites, stings, or illnesses associated with wildlife-borne diseases (Bradley & Altizer, 2007). Disease exposure is often the focus of negative health outcomes, and given the increasing encroachment of urbanization in rural and wildland areas, the instances of wildlife-borne diseases may continue to increase (Bradley & Altizer, 2007). This is likely to be exacerbated as climate change increases pandemic risks (e.g., COVID-19) (Leal-Filho et al., 2020; Pamukcu-Albers et al., 2021).

Along with physiological measures, the *mental health* benefits of human-wildlife interactions include negative outcomes associated with fear or danger (Lambertucci et al., 2021; Sreetheran & Van Den Bosch, 2014), or affective or mood disorders such as anxiety, stress, fear, uncertainty, or other psychological ailments (Dhar et al., 2011). While wildlife might lead to negative mental health outcomes if people perceive threats to their safety or otherwise fear wildlife, interactions with wildlife can also lead to nuisances or conflicts related to property damage or related impacts that cause frustration or worry. Meanwhile, positive mental health impacts include reduced stress or anxiety (Yang et al., 2020), and feelings of peace, enjoyment, and stress-relieving experiences associated with fascination and appreciation of wildlife (Tyrväinen et al., 2014).

Spiritual health, is a relatively recently defined concept that refers to connectedness with self, others, and the sacred that transcends and empowers the self (Dhar et al., 2011; Methorst et al., 2020). Spiritual health encompasses a sense of meaning and purpose in life, including a sense of belonging or connectedness to nature and the planet derived from positive experiences observing or interacting with different wildlife. Specific wildlife interactions, especially with species of cultural or religious importance, may positively influence spiritual health (Lopes & Atallah, 2020). Superstitions, often influenced by cultural or religious beliefs, may also relate to supernatural positive or negative associations (e.g., good or bad luck) with wildlife (Colding & Folke, 1997; Jones et al., 2008). Additionally, negative spiritual outcomes are typically associated with limited engagement with wildlife or natural spaces that have spiritual or cultural importance (Cunsolo Willox et al., 2012).

Social health refers to comforting and positive interactions with other people or interpersonal interactions that affect confidence, trust, and comfort (Huber et al., 2011). In terms of human-wildlife interactions, social health might be affected by positive or negative group experiences (e.g., camping or hunting) when wildlife is encountered. When wildlife species are used as mascots, this may also increase social health by providing individuals with a form of connection to their local or regional community (Baltz & Ratnaswamy, 2000). The impacts of wildlife on social health are often indirect. On the negative side, conflicts with wildlife that result in the displacement of people may result in reduced social health when community structures and support are lost (Barua et al., 2013). As a whole, interactions with nature may shape individuals' identity and social well-being, which may influence spiritual or other health outcomes (Jennings & Bamkole, 2019).

Using the four dimensions of health as an analytical lens, we present a content analysis of individuals' interview-based narratives about their experiences with wildlife in urbanized and undeveloped settings. We consider instances of *physical contact* with and in-person *observations* of wildlife as relatively direct interactions with wildlife. We also analyzed indirect interactions as *attitudes* toward wildlife that reflect broader positive and negative judgments, including people's emotions or beliefs (Fishbein & Ajzen, 1974; Larson, 2010). Emotional responses to wildlife—such as happiness and feelings of connectedness, or anxiety and stress—are important since they reflect impacts on mental health. Similarly, cognitive attitudes are important since they indicate the perceived value or danger associated with wildlife, which can also impact mental or other dimensions of health.

2. Methods

2.1. Recruitment, sampling, and the study area

The data analyzed in this paper are part of a qualitative study exploring the attitudes, experiences, and actions of urban residents toward wildlife in their everyday lives and in their past. The research team conducted semi-structured interviews during the spring of 2021 with residents of metropolitan Phoenix, Arizona, which is situated in the Sonoran Desert. A convenience sample recruited family members, friends, and acquaintances of the research team. We employed a convenience-based approach partly due to the COVID-19 context in which interviews were conducted (via Zoom; see below) for this research. As discussed below, we recognize that this sampling design limits our ability to generalize the results to the population of metro Phoenix.

A total of 24 residents participated in the project (see Table 1 for the demographic breakdown of our participants). The average age in the group was 28 years old. Most participants were female (54%). The remaining 42% were male, however, 4% of participants identified themselves as non-binary. The most prevalent racial self-identified category was white (75%). Latinx/Hispanic, while technically not a racial group, was the second most prevalent group (25%), followed by Asian (8%), Black (4%), and Indigenous (4%). Single-family households

Table 1
Participant demographics.

Gender	Percentage
Male	42%
Female	54%
Non-Binary	4%
Race	
White	75%
Latinx/Hispanic	25%
Asian	8%
Black	4%
Indigenous	4%
Residential Setting	
Single family	57%
Apartments	43%

Notes: ¹One participant identified as both female and non-binary. ²Percentages do not add up to 100% due to mixed race/ethnicity participants, e.g., people identifying as White Hispanic.

were the main type of residency among participants (57% vs. 43% in apartments). Participants were not asked about their socioeconomic status. While we did not ask for information about the participants' socioeconomic status, participants described a range of contexts, including living in or experiencing rural-to-urban locations across the U.S. and Mexico. Although our sample is not representative, we do not aim to generalize the results to the Phoenix-area population as a whole. Instead, in our discussion of findings, we emphasize the trends across positive and negative health outcomes associated with particular types of physical, observational, and hypothetical human-wildlife interactions, as explained further below.

2.2. Data collection

The interview protocol asked participants about the types of wildlife they encounter in and around their homes and neighborhoods, along with how they felt during those encounters. We also prompted participants to discuss their childhood experiences with wildlife, in addition to sharing their most memorable experiences and any negative experiences they have had with wildlife. Lastly, participants were asked to think about hypothetical interactions or encounters with different wildlife and to describe their comfort level living near them. The interviews each lasted about 40–60 min.

A team of students conducted the interviews primarily via Zoom (n = 22) and in-person (n = 2). Zoom software features generated the interview transcripts for all interviews. Students then reviewed the interview transcripts to clarify and edit any narrative that was not accurately captured. Interviews were conducted in English (n = 20) and Spanish (n = 4), according to the language our participants preferred. Spanish interviews were translated into English. All procedures were approved by Institutional Review Board following federal law. All data were anonymized to protect participants' confidentiality.

3. Content analysis

Interview transcripts were imported to Dedoose, a web-based content analysis program, for content analyses. The research team used a three-stage thematic analysis method. In stage one, we conducted a general coding scheme using a codebook with initial themes based on the overall project objective of understanding human-wildlife interactions, primarily in residential and urban areas. In stage two, we narrowed our focus to the interview narratives that directly or indirectly related to health outcomes, as further detailed below. In stage three, we analyzed the health-related text to identify the main themes and synthesize the study results. The following sections elaborate more on each step.

3.1. Coding process

In the first stage of this study, we deductively developed a codebook for our content analyses while also allowing codes to emerge inductively. Three sets of codes focused on positive, negative, and neutral perceptions associated with health dimensions derived from physical, observational, and attitudinal 'interactions' with wildlife (Table 2). We also coded the wildlife discussed by our research participants since different wildlife will invoke differential responses and associated health outcomes. We intentionally left it up to our research participants to decide how they define wildlife. While birds and mammals were most commonly discussed across the interviews, respondents also referred to insects, herpetofauna, and other wildlife (see Larson et al., 2023 for more details).

The codebook included the definition of the codes, inclusion and exclusion criteria, and example quotes for typical, atypical, and 'close but not relevant' statements. In the preliminary stages of analyses, a graduate student researcher applied the coding scheme to one interview at a time. Following discussions with the principal investigators, the code definitions, criteria, and examples were refined for clarity before moving on to the next interview transcripts. These steps were repeated until code saturation was achieved, wherein no new codes emerged, and inclusion/exclusion criteria and exemplar quotes were established (Deterding & Waters, 2021; Gioia et al., 2013; Hennink et al., 2017).

Table 2
Codebook structure and definitions.

Health code definitions		
Health Dimension	Physical	Statements indicating a situation where human-wildlife interaction has affected or might affect the maintenance of a healthy or functional body that is essential in carrying out daily activities and in recovering from illness or injury.
	Mental	Statements describing a situation where the outcome of the interaction led to affective or mood disorders including anxiety, stress, fear, and uncertainty, among others.
	Social	Statements indicating situations wherein social or group experiences occur through mutually or collectively exploring, encountering, or learning about wildlife, such as fishing, hunting, hiking, and camping, among others.
	Spiritual	Statements indicating human-wildlife interactions wherein people develop a sense of meaning and purpose in life, which can include a sense of belonging or connectedness to nature and the planet, or the lack, therefore, derived from positive or negative experiences observing or interacting with different wildlife.
Health Perception	Positive Perception	Statements indicating that wildlife/animals can positively affect human health, whether it be physical, mental, social, or spiritual aspects of human wellbeing.
	Negative Perception	Belief(s) indicating that wildlife/animals can negatively affect human health, whether it be physical, mental, social, or spiritual aspects of human wellbeing.
	Neutral Perception	Statement(s) that relate to physical, mental, or spiritual aspects of human health and wellbeing but without explicitly stating or making direct connections with health effects or outcomes.
	Interaction Type	
Interaction Type	Observational	Statement(s) describing situations where the participant and wildlife were near each other but no physical contact happened.
	Attitudinal	Statement(s) describing situations where wildlife was not present. These types of interactions referred to hypothetical situations and included affective sentiments that capture positive and negative emotions.
	Physical	Statement(s) describing relatively direct interactions with wildlife that included physical contact between the participant and the wildlife.

3.2. Health and related codes

Instances of physical health were coded when the participants experienced events that had some effect on their physical body (e.g., a bite). Mental health was coded when participants experienced affective (mood) effects associated with wildlife experiences (e.g., fear or excitement). Social health was coded for instances when wildlife brought people together (e.g., fishing, hunting, camping). Spiritual health was coded when participants expressed a religious or transcendence experience as a result of their interaction with wildlife. Inside each of the four health dimensions, we also differentiated between positive, negative, and neutral aspects.

In addition to the four health dimension codes, we distinguished between types of interactions involving direct physical contact with wildlife (e.g., bites, stings, touching) and those with no physical contact (i.e., observational) that involved individuals observing wildlife in real-time (e.g., seeing birds or insects, encountering a coyote or bear). While we asked research participants about their encounters with wildlife in different contexts, we did focus part of the interviews on wildlife individuals encounter in and around where they live (for details, see [Larson et al., 2023](#)). Additionally, we distinguished between observations and hypothetical scenarios, or beliefs, wherein no interactions occurred but beliefs about wildlife and health outcomes were mentioned (e.g., “if a snake bites me it would hurt or I would die”). The latter situations were coded as attitudinal interactions.

4. Results

Human-wildlife interactions are summarized by each health dimension in the following sections. First, we describe the demographics of our research participants ($n = 24$), who were relatively young but split by gender with 54% identifying as female, 42% male, and 4% non-binary. Meanwhile, 75% identified as White, 25% as Latinx/Hispanic, 4% as Black, 8% as Asian, and 4% as Indigenous. The average age of our participants was 28 ± 17 years, with a minimum age of 20 and a maximum age of 55. The young demographic is a function of several college-aged participants in our convenience sample. Relatedly, 43% of participants lived in single-family apartments at the time of the interviews, whereas 57% live at home.

4.1. Physical health outcomes

The physical health dimension had 34 coded segments of text across 14 (58%) participants, representing 14.2% of the total coded health segments ($i = 240$) ([Table 3](#)). Statements about positive physical health outcomes were coded across 33% of participants, all of which reported observational interactions with wildlife and only one (4%) each attitudinal and physical interactions. Negative physical health statements were

Table 3
Physical health outcomes.

Physical Health Codes	# of Segments (%)	# of Interviews (%)
Positive	13 (38.2%)	8 (33.3%)
Observational	11 (32.4%)	8 (33.3%)
Attitudinal	1 (2.9%)	1 (4.17%)
Physical	1 (2.9%)	1 (4.17%)
Negative	10 (29.4%)	9 (37.5%)
Observational	5 (14.7%)	4 (16.7%)
Attitudinal	0 (0%)	0 (0%)
Physical	6 (17.6%)	6 (25%)
Neutral	15 (44.1%)	8 (33.3%)
Observational	8 (23.5%)	7 (29.2%)
Attitudinal	6 (17.6%)	5 (20.8%)
Physical	1 (2.9%)	1 (4.2%)
Totals	34 (100%)	14 (58.3%)

coded for slightly more participants (38%). Among these, 25% experienced physical interactions with wildlife, 17% observational interactions, and none reported attitudinal interactions. Neutral physical health segments were reported by 33% of our research participants. Of these, 29% experienced observational interactions, 21% attitudinal interactions, and 4% physical interactions.

A prevalent theme that emerged from the positive physical health segments was interacting with wildlife via physical activity activities. Interacting with wildlife while hiking in natural environments was one popular activity mentioned by participants:

“I went hiking pretty much every weekend when I was a kid. Camping just about once a month. So, I have plenty of experience with wildlife, lots of deer, elk, all of that.”

“I was hiking in South Mountain once and I saw a deer, pretty cool.”

When asked specifically where participants encountered wildlife, some participants mentioned hikes, as in the case of the following interviewee:

“I guess when I am on hikes. ... I have been hiking in the Salt River and I have seen crayfish and fish in it.”

“I only remember [seeing wildlife] on field trips; we went on hikes. We went to the river a lot, so we saw wildlife in the wild.”

Only one participant described interacting with wildlife by consuming it:

“One of the experiences that comes to mind is when we went to catch clams. We caught them with our hands to eat. I did not like them, but I loved that experience.”

Negative physical health outcomes were associated with physical harm (e.g., bites, stings). The most common negative interaction was getting stung by insects including bees, spiders, and scorpions, as in:

“We had black widows here when I was a kid and my brother got bit by one. Yeah, that was bad. And I got bit by some kind of a poisonous spider and that was pretty bad.”

“Everybody who lived in my house, all the members of my family, except for me had been stung by scorpions in the middle of their sleep.”

Observational negative interactions happened with a more diverse set of wildlife, and in most cases, involved a sense of fear.

“I have never been stung by a scorpion, but we did have them in one of our houses. I was terrified I would wake up in the middle of the night to go to the bathroom and step on one.”

“I am always a little worried about a snake or a scorpion or something [while hiking].”

When participants were specifically asked about diseases associated with wildlife, a majority of participants 63% were not concerned about wildlife diseases. These participants stated that diseases were not something that crossed their minds with potential wildlife interactions. Participants also mentioned staying safe by keeping their distance from wildlife or avoiding wildlife.

“I am not particularly [worried] because I think avoiding them and not forcing a direct contact probably eliminates all risk of that.”

Some of the participants were not worried about diseases as a result of the medical advances that society has made.

“If I lived 600 years ago, maybe, but currently, no ... a lot of those things that animals carry we have been carrying it for so long now that we have solutions to it.”

4.2. Mental health outcomes

Mental health was the most coded dimension, with 157 coded segments across all 24 participants. Furthermore, mental health represented 65% of all coded segments ($i = 240$) for health outcomes (Table 4). Positive mental health statements were coded across 83% of participants; 75% experienced observational interactions with wildlife, 25% attitudinal, and 21% physical. Negative mental health was coded across 92% of participants, with 67% attitudinal interactions, 63% observational, and 50% physical. Neutral mental health segments were coded for 75% of participants. Of these, 54% experienced observational interactions with wildlife, while 46% reported attitudinal responses and 21% experienced physical encounters.

One theme in the mental health dimension was that sounds played an important role in positive mental health experiences, since they are often coupled with positive emotions.

"In my house, in the afternoons we hear the noise of many birds, many birds. I will tell you that, one time an owl lived here for almost two weeks. ... They [birds] are part of us. They make me feel good. ... They are part of my life."

Those types of interactions with wildlife created a sense of peace among participants.

"[I have seen] lots of hummingbirds [in my neighborhood], which is awesome. I find a lot of peace and serenity from just watching them buzz around."

In some instances, feelings of peace and serenity were linked to nostalgia and specific memories, as in the following.

"I'm always really nostalgic for, or I always appreciate Arizona wildlife, because I spent a lot of time growing up here."

"I love [cicada's] sound ... in the desert, we had a lot of cicadas during the heat. I remember summer vacations [visiting grandma in Sonora] with my cousins, I remember the popsicle vendor ... and the baker. That sound takes me to ... a jar full of stories, ... I feel nostalgia."

In contrast, fear and danger were prevalent themes that emerged from negative mental health segments.

"My sole concern is that a scorpion is going to nestle up in a shoe of mine and I'm going to put it on and get stung."

"I saw a snake one time when I was going on a hike, my dad and I got freaked out."

For some participants, the fear was quite intense even though they did not recall a previous negative interaction with the wildlife they described.

"I know [bees] are so important in our ecosystem, but I just have an irrational fear of them."

In other cases, fear was not initially present in the participant until someone with them expressed fear.

"I think I was just mostly in awe and I just thought it was so cool to see because bears are one of those animals you always read about as a kid but it's kind of rare to see. I don't remember being that scared until I looked at my parents and I saw that they were scared and then I was like Oh, am I supposed to be scared."

In the above case, the participant was observing the bear from far away and it did not represent any danger to her or her parents. In other cases, the fear and anxiety that participants felt were associated with the location of the encounter (e.g., at home) and the potential danger to property (e.g., pets). Examples include the following.

"I don't want a mouse living in my apartment; it's gross and can have diseases"

"I don't want to get stung by a scorpion or anything and I certainly don't want them in my house. But I don't think that I would have any concerns about them, so long as they don't come into my house."

4.3. Social health outcomes

Social health was the least coded dimension with only 46% of participants referencing interactions linked to social health outcomes in 24 coded segments, which represented 10% of the total coded health segments (Table 5). Positive social health was coded across 33% of participants, 25% of whom experienced observational interactions with wildlife, 8% physical, and 4% attitudinal. Negative social health statements were coded for 21% of participants. Of these participants, 12% experienced observational interactions, 4% attitudinal, and 4% physical. Neutral social health segments were coded for 25% of participants; 21% experienced observational interactions and 4.2% made attitudinal statements, while none experienced physical interactions.

Social health was coded for group activities that involved interactions with wildlife. Fishing, camping, and hiking were among the most popular activities. Some of these activities were pursued to intentionally interact with wildlife, as in the case of fishing.

"As a family, we went camping a lot. We went out to the Lake in the forest here in Arizona. As far as wildlife, I don't know. Well, that was, we were always looking at different plants and animals and things that were around and yeah, it was just something we enjoyed."

Negative social health interactions also happened during some of the activities associated with positive social health, especially when encounters with wildlife triggered fear.

Table 4
Mental health outcomes.

Mental Health Codes	# of Segments (%)	# of Interviews (%)
Positive	55 (35.0%)	20 (83.3%)
Observational	44 (28%)	18 (75%)
Attitudinal	7 (4.5%)	6 (25%)
Physical	6 (3.8%)	5 (20.8%)
Negative	79 (50.3%)	22 (91.7%)
Observational	38 (24.2%)	15 (62.5%)
Attitudinal	30 (19.1%)	16 (66.7%)
Physical	15 (9.6%)	12 (50.0%)
Neutral	36 (22.9%)	18 (75.0%)
Observational	19 (12.1%)	13 (54.2%)
Attitudinal	14 (8.9%)	11 (45.8%)
Physical	6 (3.8%)	5 (20.8%)
Totals	157 (100%)	24 (100%)

Table 5
Social health outcomes.

Social Health Codes	# of Segments (%)	# of Interviews (%)
Positive	13 (54.2%)	8 (33.3%)
Observational	10 (41.7%)	6 (25%)
Attitudinal	1 (4.2%)	1 (4.2%)
Physical	3 (12.5%)	2 (8.3%)
Negative	6 (25%)	5 (20.8%)
Observational	4 (16.7%)	3 (12.5%)
Attitudinal	1 (4.2%)	1 (4.17%)
Physical	1 (4.2%)	1 (4.17%)
Neutral	6 (25%)	6 (25%)
Observational	5 (20.8%)	5 (20.8%)
Attitudinal	1 (4.2%)	1 (4.17%)
Physical	0 (0%)	0 (0%)
Totals	24 (100%)	11 (45.8%)

"I used to go to a two-week summer camp every year when I was a kid, and we would stay in cabins and the showers were like in a separate cabin. One night in the middle of the night, people started screaming and we didn't know what was going on. Someone had almost stepped on a rattlesnake that was on the path to the bathroom in the middle of the night."

Social experiences generated awareness of the interconnection between humans and nature for some participants.

"For me, it was always kind of like just this mystical learning experience. I really enjoyed it and I think part of it was probably just my parents took me hiking a lot and part of it was financial constraints because that's all we could afford to do."

"My grandma would take us fishing at some of the lakes ... which was fine until I kind of gained consciousness of the fact that I was impaling fish and then releasing them with like broken lips back into the water ... then I stopped once I started developing my personality and beliefs."

For some people, awareness of the positive impacts of interacting with wildlife is linked to the last health dimension: spiritual health.

4.4. Spiritual health outcomes

Spiritual health was coded for 63% of our research participants (Table 6). This dimension was coded in 25 segments, which represented 10% of the total coded health segments. Positive spiritual health was coded across 58% of participants, with 46% reporting attitudinal interactions with wildlife, 33% observational, and 13% physical. Negative spiritual health was coded across 8% of participants' interactions with wildlife, including 4% observational, 4% attitudinal, and 4% physical.

Feelings about connecting with nature were a common narrative among participants. For some, seeing wildlife triggered positive emotions and connections.

"[The bird] was flying in a very peaceful way as if accompanying us. ... it gave me goosebumps, but goosebumps are a feeling that cannot be described. It was like the bird was accompanying you, that the spirit, a spirit is accompanying you. It was such a beautiful feeling that I do not know how to describe."

"As I had a connection with the sea, I felt that the animals came to greet me. They were representing their father, the sea."

Participants also expressed a sense of coexistence between humans and wildlife that was possible through mutual respect.

"This coyote was walking up on the ridge, and I remember how it followed us the whole time. I thought that was interesting because it

didn't like to come close to us or get too far, but it was scouting us the entire time. I kind of felt that we could co-exist with this wildlife. We could be there with the wildlife."

"Learning about ... how my actions could have a lasting impact on wildlife around me ... was always a mystical learning experience."

"I don't know how to describe it. I just had more respect for wildlife. I guess I've always considered myself somebody who has respect for wildlife, but it's hard to respect something that you don't know anything about. So, I think I gained better respect simply through being physically close to it and experiencing it firsthand."

Only two segments were coded for negative spiritual health. One was associated with bad luck when encountering potentially dangerous spiders in the area.

"I've seen black widows in homes that don't have much movement. So, I've seen those in places personally, and that is not okay. That's something that I never want to see. I consider that bad luck"

The second statement about negative spiritual health was associated with extinguishing the life of another living creature.

"I had to [kill an opossum] because there was nobody else. Everyone was scared. It was very big. I still remember how I did it, with a stick and everything. And [yet], back then [with] the education we had, they taught us that we should respect all beings and love each other."

4.5. Types of wildlife and interactions

Participants mentioned 57 different types of wildlife (Table 7), with the number of references to particular wildlife ranging from 1 to 65. The top 10 most cited wildlife included birds ($n = 65$), followed by snakes ($n = 64$) and coyotes ($n = 39$). The top 10 wildlife were mostly discussed in terms of mental health and least cited in the social health dimension. Positive interactions happened most often with birds ($n = 34$), whereas negative interactions happened most often with snakes ($n = 32$).

5. Discussion

In summary, observational interactions with wildlife were more commonly described by our research participants than attitudinal and physical interactions, representing 64%, 31%, and 19% of the interview segments, respectively (Table 8). Combined positive health outcomes from human-wildlife interactions were slightly more common among our participants (52%) than negative outcomes (39.6%). These trends contrast with a predominance of research on human-wildlife interactions, which emphasizes physical conflicts and other negative interactions (Carter & Linnell, 2016; König et al., 2020). The positive health benefits associated with observing and interacting wildlife center on mental health and understudied spiritual benefits (Methorst et al., 2020).

5.1. Mental health effects

Our results show that mental health was the most commonly mentioned health dimension in our interviews. Many negative statements by residents we interviewed were attitudinal expressions involving perceived fear or feelings of anxiety, including self-expressed irrational fears towards bees and snakes. Some studies have posited that fear of specific animals is innate and part of our biological evolution (Hillyard, 1994; Kawai, 2019). In other cases, the fear may be generated by experiences of people in the participants' social networks, as in the case of a participant who became afraid of seeing a brown bear after she noticed the fear in her parents' faces. This particular scenario may have a lifelong

Table 6
Spiritual health outcomes.

Spiritual Health Codes	# of Segments (%)	# of Interviews (%)
Positive	23 (92%)	14 (58.3%)
Observational	9 (36%)	8 (33.3%)
Attitudinal	12 (48%)	11 (45.8%)
Physical	3 (12%)	3 (12.5%)
Negative	2 (8%)	2 (8.33%)
Observational	1 (4%)	1 (4.17%)
Attitudinal	1 (4%)	1 (4.17%)
Physical	1 (4%)	1 (4.17%)
Neutral	2 (8%)	2 (8.33%)
Observational	0 (0%)	0 (0%)
Attitudinal	0 (0%)	0 (0%)
Physical	2 (8%)	2 (8.3%)
Totals	25 (100%)	15 (62.5%)

Table 7

List of most cited wildlife.

Wildlife	Health Dimension				Perceptions		
	Physical	Mental	Social	Spiritual	Positive	Negative	Neutral
Birds	5	46	5	9	34	14	11
Snakes	11	46	4	3	10	32	16
Coyotes	7	25	2	5	17	8	13
Scorpions	6	21	0	1	5	20	2
Fish/Crustaceans	5	8	3	7	14	4	2
Rabbits	2	14	1	1	13	3	2
Javelina	1	15	0	0	5	4	9
Lizards	3	11	0	1	6	8	3
Squirrel	4	9	2	0	7	1	5
Spiders	3	7	0	4	2	12	0

Table 8

Type of interactions described by participants.

Totals	N	%
Observational	154	64.2%
Attitudinal	74	30.8%
Physical	45	18.8%
Totals	240	100.0%

effect on people's perceptions and may condition them for future interactions. In other cases, the media may play a role (Hathaway et al., 2017; Papworth et al., 2015). Amplified reports of rare attacks, for example, may create a shared paranoia and distrust of wildlife. Educational campaigns that teach people about safe responses to wildlife they encounter in their local communities may help address some of the misconceptions and fear that people have.

Positive mental health outcomes were linked with enjoyable observations of wildlife. Participants experiencing positive mental health interactions described emotions and feelings of nostalgia and restorative effects from interacting with wildlife, especially birds and coyotes. Similar observations have been noted for individuals exposed to green spaces such as forests, parks, and natural preserves (Maas et al., 2006; Ulrich et al., 1991). In controlled studies, patients who were exposed to natural environments, even if simulated, recovered from medical treatments at a faster rate than those who did not (Ulrich, 1984). Studies of domesticated animals such as horses and dogs have shown similar positive mental health outcomes (Burgon, 2003; Hoagwood et al., 2017). While our study hints at positive health outcomes associated with wildlife (emphasis on wild), additional studies are needed to further understand which types of wildlife (e.g., varying species of birds, mammals, reptiles) and their characteristics (e.g., size, color, sounds) have different effects on mental health in varied social and environmental contexts.

5.2. Spiritual health effects

Closely coupled with mental health, spiritual health effects were the next most common dimension mentioned by slightly over half of our interviewees, often linked to awe-inspiring interactions with coyote and birds. Spiritual health is the newest and least studied dimension. Public health advocates have pushed for its inclusion as it affects other dimensions of health and a person's overall wellbeing (Dhar et al., 2013). In our study, spiritual health outcomes were largely positive (92%) and rarely negative (8%), with over half of our participants expressing feelings of connectedness to wildlife that transcend the self and can empower the individual (Dhar et al., 2013). Similar findings of respect have been documented in other settings, for example, with monkeys and tigers being revered by some cultures (Athreya et al., 2018; Baker et al., 2014; Lopes & Atallah, 2020; Lutgendorf, 1997). Our study adds to this evidence by showing that everyday interactions with common wildlife in cities of the Global North can also lead to spiritual health outcomes.

Creating a sense of connection and respect toward wildlife can be one of the most important aspects of wildlife conservation, especially as urbanization continues to encroach on natural habitat.

5.3. Physical health effects

Physical health was the third most common dimension mentioned by about half of our interviewees. Unsurprisingly, negative physical health outcomes were primarily linked to physical encounters such as scorpion stings, whereas positive physical outcomes involved observations during physical activities, particularly hiking. These activities are encouraged by health advocates since walking or hiking can provide several benefits including burning calories (Wolf & Wohlfart, 2014). While we cannot determine if participants' motives to engage in hiking were primarily to engage in physical activity or to encounter wildlife, people who hike and spend time outdoors are more likely to observe wildlife and therefore reap the other positive benefits associated with physical as well as mental and spiritual health. Regardless of the motives, public health advocates and planners who create, maintain, and promote spaces that facilitate outdoor physical activities can enhance the enjoyment of local wildlife and associated health benefits.

In contrast to positive physical health interactions, which typically happened outdoors, negative physical health effects were often described as occurring in the participants' households. The majority of these negative interactions happened with small arthropods or insects including scorpions and spiders. This also contrasts with research on human-wildlife interactions that emphasizes negative interactions between people and carnivores (Carter & Linnell, 2016; König et al., 2020). The urban setting of our study may explain why participants commonly described negative interactions with scorpions and insects, since larger mammals are less common in cities than rural areas. To minimize negative urban interactions with wildlife, conservationists and health officials should inform the public of how to avoid and mitigate potential threats such as those from stinging scorpions and black widow spiders in the study region of Phoenix.

Despite an increase in wildlife-borne diseases (Bradley & Altizer, 2007; Leal-Filho et al., 2020; Pamukcu-Albers et al., 2021) and the fact that our interviews were conducted in the middle of the COVID-19 pandemic, our participants were more concerned about poisonous wildlife than with transmitted diseases. Most participants believed that current medical advances (e.g., vaccines) and preventive behaviors (e.g., avoiding wildlife) are sufficient to protect them from diseases wildlife may transmit, even though the interviews occurred prior to widespread COVID-19 vaccinations. These observations may be different from participants in other regions of the U.S. and the Global South, where wildlife-related diseases may be more prevalent and where people may feel more vulnerable to them (Bosch et al., 2013; Vaske, 2010). For example, ticks are a serious concern for thousands of Americans, especially in the northeastern region, since they are responsible for a large number of all vector-borne diseases (Eisen et al., 2017). As

environmental conditions become more ideal for vector-borne diseases, it will be critical to document public experiences and responses to new conditions in order to manage potential, widespread health crises.

5.4. Social health effects

The least commonly identified health dimension was social health, which tended to be observational encounters with wildlife situated in familial or group settings. While our research participants rarely commented about social health effects, they did commonly talk about experiences with nature and observations of wildlife that occurred within a social context. Moreover, as discussed above, social interactions within families, religions, and other social institutions significantly influence responses to human-wildlife interactions. These included learned fears or superstitions. In other contexts, shared beliefs and norms can be powerful influences on a priori attitudes toward specific wildlife and behavioral responses during wildlife encounters (Castillo-Huitrón et al., 2020; Dagle et al., 2002). As such, wildlife conservationist and health officials could create group experiences with wildlife to foster positive outcomes and manage negative interactions. Working with religious organizations and schools, as well as youth groups such as boy scouts and girl scouts, might prove especially effective in the U.S., since many people engage with these organizations (Putnam, 2001). Moreover, creating wildlife experiences for youth is particularly important since wildlife values, norms, and attitudes are often formed early in life, and they become harder to change into adulthood (Manfredo, 2008, pp. 1–27).

5.5. Relationship among health dimensions

Previous studies have typically focused on either the positive or the negative aspects of human-wildlife interactions (Methorst et al., 2020). By doing so, researchers are not capturing a more comprehensive impact of wildlife interactions on a person's wellbeing. While the research team coded for mutually exclusive instances that represented each of the four health dimensions, some of the interactions in one dimension were linked to others. For example, fear towards wildlife (i.e., as a negative mental health effect) is commonly associated with potential danger to their physical wellbeing (e.g., stings, bites, attacks). Likewise, positive mental and spiritual health outcomes were closely linked in people's observations of wildlife. Participants who experienced a deep connection with wildlife also described instances of relaxation and calmness that can be linked to mental health. Generally, our study highlights the interconnectedness of health outcomes associated with experiences of wildlife.

Studies of wildlife and human interactions in urban settings have primarily focused on conflicts that result from such interactions (Conover et al., 1995, pp. 407–414; Nyhus, 2016). Much attention has been given to negative outcomes linked to physical health (e.g., bites, attacks, diseases, collisions) and mental health (e.g., fear) (Elliot et al., 2016; König, 2008; Lambertucci et al., 2021). Like other studies, our participants experienced negative physical health outcomes (e.g., bites) and mental health outcomes (i.e., fear and anxiety). Overall in our study, combined positive outcomes across dimensions of health were higher (52.0%) than negative outcomes (39.6%). Furthermore, the high percentage of negative outcomes were linked to mental health (91.7%). Given that the nature of most of those interactions were observational (i.e., no physical contact with wildlife), educational and outreach campaigns can address misconceptions linked to negative perceptions of wildlife while also fostering positive experiences with wildlife and how to avoid harm (Larson et al., 2023). Effective interventions, therefore, could prevent interactions resulting in negative health outcomes while improving health outcomes and publication of wildlife broadly.

In our study, the spiritual dimension was the second highest experienced health dimension. Participants described numerous positive experiences (e.g., a deep connection to nature). The spiritual experiences our participants experienced can be compared to similar outcomes in

other studies (Lopes & Atallah, 2020; Young et al., 2020). The high prevalence of interactions linked to spiritual health is worth pointing out, given that even among public health advocates, spiritual health is often neglected (Dhar et al., 2011; Huber et al., 2011; Jadad & O'grady, 2008). Emphasizing the wildlife-spiritual connection could help frame positive interactions with wildlife species in urban settings, especially in individuals who might not be religious but have positive perceptions of spirituality.

5.6. Wildlife and health dimensions

Birds, coyote, snakes, and scorpions were the most commonly described wildlife in this study. These organisms are native and common in the desert study region of Phoenix, Arizona. The number of interactions with these desert species suggests that people do not have to travel far to interact with wildlife. Some of these interactions happened in the participants' own homes. Other urban HWI studies also reported interactions with smaller species (Cox and Gaston, 2015, 2016; Fuller et al., 2013, pp. 249–266). This can be linked to the fact that as human populations expand, they drive large animals further away from the city, while some may still survive near urban areas (Basille et al., 2009). The reference to wildlife interactions during hiking trips can be linked to the high availability of natural preserves in the city, including the largest municipal park in the US: South Mountain Park. These natural preserves in cities have many trails and outdoor spaces that provide opportunities to encounter wildlife and other natural elements linked to improved human well-being (Brown and Grant, 2005). The preservation of current parks and the creation of new spaces are an important vehicle for encouraging human-wildlife interactions and for the protection of local wildlife as cities continue to expand into new lands. However, in the creation of new green spaces, it is particularly important to understand the historical legacies that resulted in the current distribution of green spaces to ensure the promotion of environmental equity (Schell et al., 2020).

5.7. Limitations and strengths

One limitation of this study is that findings cannot be generalized to a larger population or to other settings due to the small convenient sample. Participant recruitment took place during stay-at-home mandates associated with COVID-19. Thus, we determined that a convenience small sample at the time would be feasible for this exploratory study while keeping everyone safe. Although our findings clearly demonstrate links to the four dimensions of health, additional studies of human-wildlife interactions are needed with larger and more diverse samples. Future research should especially highlight the experiences of people from different backgrounds (e.g., socioeconomic status and cultures), especially marginalized ones who may respond differently to wildlife due to inequities in knowledge and health information/access and therefore have differential health effects. This is especially true since Black and Latinx communities have been subjected to numerous environmental injustices, in addition to having unique experiences of nature (Finney, 2014; Wald et al., 2019). Additionally, further research could also investigate how the geographic and situational context of encounters (e.g., at home or work, spending leisure time outdoors, etc.) affect health outcomes.

The qualitative nature of our study and the rich descriptions of human-wildlife interactions, experiences, and perceptions are a key strength of this study. Participants provided their own interpretations of human-wildlife interactions. For example, some participants mentioned they had not interacted with wildlife but in later passages described interactions with some of the wildlife. The setting is another strength as the team captured interactions with local desert wildlife (e.g., scorpions, rattlesnakes) that may not be found and represented in other studies. The inclusion of spiritual health as the fourth health dimension is another strength of the study. Including all health domains in human-wildlife

interactions can provide a more comprehensive picture of a person's wellbeing.

6. Conclusion

The goal of this study was to document participants' experiences with human-wildlife interactions and their effect across four dimensions of health: physical, mental, social, and spiritual. Interviews with a convenience sample of participants in the Metropolitan Phoenix area showed that interactions with wildlife can affect the four dimensions of health; however, some participants were more likely to have those interactions across all dimensions than others. Mental health outcomes were most commonly mentioned, followed by spiritual, physical, and social health. Overall, our results showed that everyday human-wildlife interactions are happening in urban areas and creating positive health outcomes, especially in the mental and spiritual realms. Thus, preserving current opportunities to interact with nature and creating additional experiences with wildlife are important for encouraging positive interactions for both people and wildlife. In addition, experiential programs are needed to condition and train participants about wildlife so that negative health outcomes can be anticipated and reduced.

Funding

This material is based upon work supported by the National Science Foundation under grant number(s) DEB-2224662, Central Arizona-Phoenix Long-Term Ecological Research Program (CAP LTER). The funders had no role in study design, data collection and analysis, the decision to publish, or the preparation of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Abbott, A. (2012). Stress and the city: Urban decay. *Nature*, 490, 162–164. <https://doi.org/10.1038/490162a>
- Athreya, V., Pimpale, S., Borkar, A., Surve, N., Chakravarty, S., Ghosalkar, M., Patwardhan, A., & Linnell, J. (2018). Monsters or gods? Narratives of large cat worship in Western India. *Cat News*, 67, 23–26.
- Baker, L. R., Olubode, O. S., Tanimola, A. A., & Garshelis, D. L. (2014). Role of local culture, religion, and human attitudes in the conservation of sacred populations of a threatened 'pest' species. *Biodiversity & Conservation*, 23, 1895–1909. <https://doi.org/10.1007/s10531-014-0694-6>
- Baltz, M. E., & Ratnaswamy, M. J. (2000). Mascot conservation programs: Using college animal mascots to support species conservation efforts. *Wildlife Society Bulletin*, 159–163. <http://www.jstor.org/stable/4617298>
- Barua, M., Bhagwat, S. A., & Jadhav, S. (2013). The hidden dimensions of human–wildlife conflict: Health impacts, opportunity and transaction costs. *Biological Conservation*, 157, 309–316. <https://doi.org/10.1016/j.biocon.2012.07.014>
- Basille, M., Herfindal, I., Santin-Janin, H., Linnell, J. D., Odden, J., Andersen, R., Arild Høgda, K., & Gaillard, J. M. (2009). What shapes Eurasian lynx distribution in human dominated landscapes: Selecting prey or avoiding people? *Ecography*, 32, 683–691. <https://doi.org/10.1111/j.1600-0587.2009.05712.x>
- Beyer, K. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., & Malecki, K. M. (2014). Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *IJERPH*, 11, 3453–3472. <https://doi.org/10.3390/ijerph110303453>
- Bosch, S. A., Musgrave, K., & Wong, D. (2013). Zoonotic disease risk and prevention practices among biologists and other wildlife workers—results from a national survey, US National Park Service, 2009 *Journal of Wildlife Diseases*, 49, 475–485. <https://doi.org/10.7589/2012-06-173>
- Bradley, C. A., & Altizer, S. (2007). Urbanization and the ecology of wildlife diseases. *Trends in Ecology & Evolution*, 22, 95–102. <https://doi.org/10.1016/j.tree.2006.11.001>
- Brown, C., & Grant, M. (2005). Biodiversity and human health: What role for nature in healthy urban planning? *Built Environment*, 31, 326–338. <https://www.jstor.org/stable/23289537>
- Browning, M. H., Mimnaugh, K. J., Van Riper, C. J., Laurent, H. K., & LaValle, S. M. (2020). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Frontiers in Psychology*, 10, 2667. <https://doi.org/10.3389/fpsyg.2019.02667>
- Burgon, H. (2003). Case studies of adults receiving horse-riding therapy. *Anthrozoös*, 16, 263–276. <https://doi.org/10.2752/089279303786992099>
- Carter, N. H., & Linnell, J. D. (2016). Co-adaptation is key to coexisting with large carnivores. *Trends in Ecology & Evolution*, 31, 575–578. <https://doi.org/10.1016/j.tree.2016.05.006>
- Castillo-Huitrón, N. M., Naranjo, E. J., Santos-Fita, D., & Estrada-Lugo, E. (2020). The importance of human emotions for wildlife conservation. *Frontiers in Psychology*, 11, 1277. <https://doi.org/10.3389/fpsyg.2020.01277>
- Charnetski, C. J., Riggers, S., & Brennan, F. X. (2004). Effect of petting a dog on immune system function. *Psychological Reports*, 95, 1087–1091. <https://pubmed.ncbi.nlm.nih.gov/15762389/>
- Colding, J., & Folke, C. (1997). The relations among threatened species, their protection, and taboos. *Conservation Ecology*. <https://www.jstor.org/stable/26271644>
- Colléony, A., Cohen-Seffer, R., & Shwartz, A. (2020). Unpacking the causes and consequences of the extinction of experience. *Biological Conservation*, 251, Article 108788. <https://doi.org/10.1016/j.biocon.2020.108788>
- Conover, M. R. (1997). Wildlife management by metropolitan residents in the United States: Practices, perceptions, costs, and values. *Wildlife Soc.*
- Conover, M. R., Pitt, W. C., Kessler, K. K., DuBow, T. J., & Sanborn, W. A. (1995). Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. *Wildlife Soc.B.* https://www.jstor.org/stable/3782947?seq=1&cid=pdfreference#refernces_tab_contents
- Cox, D. T., & Gaston, K. J. (2015). Likeability of garden birds: Importance of species knowledge & richness in connecting people to nature. *PLoS One*, 10, Article e0141505. <https://doi.org/10.1371/journal.pone.0141505>
- Cox, D. T., & Gaston, K. J. (2016). Urban bird feeding: Connecting people with nature. *PLoS One*, 11, Article e0158717. <https://doi.org/10.1371/journal.pone.0158717>
- Cox, D. T., Shanahan, D. F., Hudson, H. L., Plummer, K. E., Siriwardena, G. M., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of neighborhood nature: The benefits for mental health of living with nature. *BioScience*, 67, 147–155. <https://doi.org/10.1093/biosci/biw173>
- Crawford, E. K., Worsham, N. L., & Swinehart, E. R. (2006). Benefits derived from companion animals, and the use of the term “attachment”. *Anthrozoös*, 19, 98–112. <https://doi.org/10.2752/089279306785593757>
- Cunsolo Willox, A., Harper, S. L., Ford, J. D., Landman, K., Houle, K., & Edge, V. L. (2012). “From this place and of this place:” climate change, sense of place, and health in Nunatsiavut, Canada. *Social Science & Medicine*, 75, 538–547. <https://doi.org/10.1016/j.socscimed.2012.03.043>
- Daigle, J. J., Hrubec, D., & Ajzen, I. (2002). A comparative study of beliefs, attitudes, and values among hunters, wildlife viewers, and other outdoor recreationists. *Human Dimensions of Wildlife*, 7, 1–19. <https://doi.org/10.1080/108712002753574756>
- Deterding, N. M., & Waters, M. C. (2021). Flexible coding of in-depth interviews: A twenty-first-century approach. *Sociological Methods & Research*, 50, 708–739. <https://doi.org/10.1177/0049124118799377>
- Dhar, N., Chaturvedi, S., & Nandan, D. (2011). Spiritual health scale 2011: Defining and measuring 4th dimension of health. *Indian Journal of Community Medicine: Official Publication of Indian J. Community Med.*, 36, 275. <https://pubmed.ncbi.nlm.nih.gov/22279257/>
- Dhar, N., Chaturvedi, S. K., & Nandan, D. (2013). Spiritual health, the fourth dimension: A public health perspective. *WHO-SEAJPH*, 2, 3. <https://pubmed.ncbi.nlm.nih.gov/28612816/>
- Eisen, R. J., Kugeler, K. J., Eisen, L., Beard, C. B., & Paddock, C. D. (2017). Tick-borne zoonoses in the United States: Persistent and emerging threats to human health. *ILAR Journal*, 58, 319–335. <https://doi.org/10.1093/ilar/ilx005>
- Elliot, E. E., Vallance, S., & Molles, L. E. (2016). Coexisting with coyotes (*Canis latrans*) in an urban environment. *Urban Ecosystems*, 19, 1335–1350. <https://doi.org/10.1007/s11252-016-0544-2>
- Farrier, A., Baybutt, M., & Dooris, M. (2019). Mental health and wellbeing benefits from a prisons horticultural programme. *International Journal of Prisoner Health*. <https://doi.org/10.1108/IJPH-11-2017-0055>
- Finney, C. (2014). *Black faces, white spaces: Reimagining the relationship of African Americans to the great outdoors*. UNC Press Books.
- Fishbein, M., & Ajzen, I. (1974). Attitudes towards objects as predictors of single and multiple behavioral criteria. *Psychological Review*, 81, 59. <https://doi.org/10.1037/h0035872>
- Frank, B. (2016). Human–wildlife conflicts and the need to include tolerance and coexistence: An introductory comment. *Society & Natural Resources*, 29, 738–743. <https://doi.org/10.1080/08941920.2015.1103388>
- Fuller, R. A., Irvine, K. N., Davies, Z. G., Armsworth, P. R., & Gaston, K. J. (2013). *Interactions between people and birds in urban landscapes*. Berkeley: Urban Bird Ecology and Conservation, University of California Press.
- Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16, 15–31. <https://doi.org/10.1177/1094428112452151>
- Grinde, B., & Patil, G. G. (2009). Biophilia: Does visual contact with nature impact on health and well-being? *IJERPH*, 6, 2332–2343. <https://doi.org/10.3390/ijerph6092332>
- Hathaway, R. S., Bryant, A.-E. M., Draheim, M. M., Vinod, P., Limaye, S., & Athreya, V. (2017). From fear to understanding: Changes in media representations of leopard incidences after media awareness workshops in Mumbai, India. *Journal of Urban Economics*, 3. <https://doi.org/10.1093/jue/jux009>
- Hedblom, M., Gunnarsson, B., Schaefer, M., Knez, I., Thorsson, P., & Lundström, J. N. (2019). Sounds of nature in the city: No evidence of bird song improving stress recovery. *IJERPH*, 16, 1390. <https://doi.org/10.3390/ijerph16081390>

- Hedblom, M., Knez, I., Ode Sang, Å., & Gunnarsson, B. (2017). Evaluation of natural sounds in urban greenery: Potential impact for urban nature preservation. *Royal Society Open Science*, 4, Article 170037. <https://doi.org/10.1098/rsos.170037>
- Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2017). Code saturation versus meaning saturation: How many interviews are enough? *Qualitative Health Research*, 27, 591–608. <https://doi.org/10.1177/1049732316665344>
- Hillyard, P. D. (1994). *The book of the spider: From arachnophobia to the love of spiders*. Random House Incorporated.
- Hoagwood, K. E., Acri, M., Morrissey, M., & Peth-Pierce, R. (2017). Animal-assisted therapies for youth with or at risk for mental health problems: A systematic review. *Applied Developmental Science*, 21, 1–13. <https://doi.org/10.1080/10888691.2015.1134267>
- Huber, M., Knotterus, J. A., Green, L., Van Der Horst, H., Jadad, A. R., Kromhout, D., Leonard, B., Lorig, K., Loureiro, M. I., & Van der Meer, J. W. (2011). How should we define health? *BMJ*, 343. <https://pubmed.ncbi.nlm.nih.gov/21791490/>
- Jadad, A. R., & O'grady, L. (2008). How should health be defined? *BMJ*, 337. <https://doi.org/10.1136/bmj.a2900>
- Jennings, V., & Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. *IJERPH*, 16, 452. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6388234/>
- Jones, J. P., Andriamarivololona, M. M., & Hockley, N. (2008). The importance of taboos and social norms to conservation in Madagascar. *Conservation Biology*, 22, 976–986. <https://doi.org/10.1111/j.1523-1739.2008.00970.x>
- Jones, R., Tarter, R., & Ross, A. M. (2021). Greenspace interventions, stress and cortisol: A scoping review. *IJERPH*, 18, 2802. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8001092/>
- Kawai, N. (2019). *The fear of snakes: Evolutionary and psychobiological perspectives on our innate fear*. Springer.
- König, A. (2008). Fears, attitudes and opinions of suburban residents with regards to their urban foxes: A case study in the community of Grünwald—a suburb of Munich. *European Journal of Wildlife Research*, 54, 101–109. <https://doi.org/10.1007/s10344-007-0117-z>
- König, H. J., Kiffner, C., Kramer-Schadt, S., Fürst, C., Keuling, O., & Ford, A. T. (2020). Human–wildlife coexistence in a changing world. *Conservation Biology*, 34, 786–794. <https://pubmed.ncbi.nlm.nih.gov/32406977/>
- Lambertucci, S. A., Plaza, P., & Speziale, K. (2021). Minimizing fear of wildlife in urban areas. *Science*, 374, 947, 947. <https://www.science.org/doi/10.1126/science.abm6560>
- Larson, K. L. (2010). An integrated theoretical approach to understanding the sociocultural basis of multidimensional environmental attitudes. *Society & Natural Resources*, 23, 898–907. <https://doi.org/10.1080/08941920903373524>
- Larson, K. L., Rosales Chavez, J.-B., Brown, J. A., Morales-Guerrero, J., & Avilez, D. (2023). Human–wildlife interactions and coexistence in an urban desert environment. *Sustainability*, 15, 3307. <https://doi.org/10.3390/su15043307>
- Leal-Filho, W., Nagy, G. J., & Ayal, D. Y. (2020). Climate change, health and pandemics—a wake-up call from COVID-19. *Int. J. Clim. Chang. Strateg. Manag.*. <https://doi.org/10.1108/IJCCSM-08-2020-212>
- Lewis, C. A. (1994). Human health and well-being: The psychological, physiological, and sociological effects of plants on people. *Horticulture in Human life, Culture and Environment*, 391, 31–40. https://www.actahort.org/books/391/391_2.htm
- Lopes, A. A., & Atallah, S. S. (2020). Worshipping the tiger: Modeling non-use existence values of wildlife spiritual services. *ERE*, 76, 69–90. <https://doi.org/10.1007/s10640-020-00416-1>
- Lutgendorf, P. (1997). Monkey in the middle: The status of Hanuman in popular Hinduism. *Relig*, 27, 311–332. <https://doi.org/10.1006/reli.1997.0095>
- Maas, J., Verheij, R. A., Groenewegen, P. P., De Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? *Journal of Epidemiology & Community Health*, 60, 587–592. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2566234/>
- Manfredo, M. J. (2008). *Who cares about wildlife? Who cares about wildlife?*. Springer.
- Messmer, T. A. (2009). Human–wildlife conflicts: Emerging challenges and opportunities. *Human-Wildlife Conflicts*, 3, 10–17. <https://www.jstor.org/stable/10.2307/24875682>
- Methorst, J., Arbieu, U., Bonn, A., Boehning-Gaese, K., & Mueller, T. (2020). Non-material contributions of wildlife to human well-being: A systematic review. *Environmental Research Letters*, 15, Article 093005. <https://doi.org/10.1088/1748-9326/ab9927>
- Nyhus, P. J. (2016). Human–wildlife conflict and coexistence. *Annual Review of Environment and Resources*, 41, 143–171. <https://doi.org/10.1146/annurev-enviro-110615-085634>
- Pamukcu-Albers, P., Ugolini, F., La Rosa, D., Grădinaru, S. R., Azevedo, J. C., & Wu, J. (2021). Building green infrastructure to enhance urban resilience to climate change and pandemics. *Springer*, 36, 665–673. <https://doi.org/10.1007/s10980-021-01212-y>
- Papworth, S. K., Nghiem, T., Chimalakonda, D., Posa, M. R. C., Wijedasa, L. S., Bickford, D., & Carrasco, L. R. (2015). Quantifying the role of online news in linking conservation research to Facebook and Twitter. *Conservation Biology*, 29, 825–833. <https://doi.org/10.1111/cobi.12455>
- Park, S.-H., & Mattson, R. H. (2009). Ornamental indoor plants in hospital rooms enhanced health outcomes of patients recovering from surgery. *Journal of Alternative & Complementary Medicine*, 15, 975–980. <https://doi.org/10.1089/acm.2009.0075>
- Pett, T. J., Shwartz, A., Irvine, K. N., Dallimer, M., & Davies, Z. G. (2016). Unpacking the people–biodiversity paradox: A conceptual framework. *BioScience*, 66, 576–583. <https://doi.org/10.1093/biosci/biw036>
- Pietilä, M., Neuvonen, M., Borodulin, K., Korpela, K., Sievänen, T., & Tyrväinen, L. (2015). Relationships between exposure to urban green spaces, physical activity and self-rated health. *J. Outdoor Recreat. Tour.*, 10, 44–54. <https://doi.org/10.1016/j.jort.2015.06.006>
- Pooley, S., Bhatia, S., & Vasava, A. (2021). Rethinking the study of human–wildlife coexistence. *Conservation Biology*, 35, 784–793. <https://conbio.onlinelibrary.wiley.com/doi/pdf/10.1111/cobi.13653>
- Putnam, R. D. (2001). *Bowling alone: The collapse and revival of American community*. Simon and Schuster.
- Roe, J. J., Thompson, C. W., Aspinall, P. A., Brewer, M. J., Duff, E. I., Miller, D., Mitchell, R., & Clow, A. (2013). Green space and stress: Evidence from cortisol measures in deprived urban communities. *IJERPH*, 10, 4086–4103. <https://doi.org/10.3390/ijerph10094086>
- Schell, C. J., Guy, C., Shelton, D. S., Campbell-Staton, S. C., Sealey, B. A., Lee, D. N., & Harris, N. C. (2020). Recreating Wakanda by promoting Black excellence in ecology and evolution. *Nat Ecol Evol*, 4, 1285–1287. <https://doi.org/10.1038/s41559-020-1266-7>
- Shanahan, D. F., Fuller, R. A., Bush, R., Lin, B. B., & Gaston, K. J. (2015). The health benefits of urban nature: How much do we need? *BioScience*, 65, 476–485. <https://doi.org/10.1093/biosci/biv032>
- Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human–nature interactions. *Frontiers in Ecology and the Environment*, 14, 94–101. <https://doi.org/10.1002/fee.1225>
- Soulsbury, C. D., & White, P. C. (2015). Human–wildlife interactions in urban areas: A review of conflicts, benefits and opportunities. *Wildl*, 42, 541–553. <https://doi.org/10.1071/WR14229>
- Sreetheran, M., & Van Den Bosch, C. C. K. (2014). A socio-ecological exploration of fear of crime in urban green spaces—A systematic review. *Urban Forestry and Urban Greening*, 13, 1–18. <https://doi.org/10.1016/j.ufug.2013.11.006>
- Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology*, 38, 1–9. <https://doi.org/10.1016/j.jenvp.2013.12.005>
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224, 420–421. <https://pubmed.ncbi.nlm.nih.gov/6143402/>
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, 11, 201–230. [https://doi.org/10.1016/S0272-4944\(05\)80184-7](https://doi.org/10.1016/S0272-4944(05)80184-7)
- United Nations. (2018). *United Nations department of economics and social affairs* (New York).
- United States Census Bureau. (2019). *Population estimates program*.
- Van Herzele, A., & De Vries, S. (2012). Linking green space to health: A comparative study of two urban neighbourhoods in Ghent, Belgium. *Population and Environment*, 34, 171–193. <https://doi.org/10.1007/s11111-011-0153-1>
- Vaske, J. J. (2010). Lessons learned from human dimensions of chronic wasting disease research. *Human Dimensions of Wildlife*, 15, 165–179. <https://doi.org/10.1080/10871201.003775052>
- Wald, S. D., Vázquez, D. J., Ybarra, P. S., Ray, S. J., Pulido, L., & Alaimo, S. (2019). *Latinx environmentalisms: Place, justice, and the decolonial*. Temple University Press.
- Wolf, I. D., & Wohlfart, T. (2014). Walking, hiking and running in parks: A multidisciplinary assessment of health and well-being benefits. *Landscape and Urban Planning*, 130, 89–103. <https://doi.org/10.1016/j.landurbplan.2014.06.006>
- World Health Organization. (2017). *Urban green space interventions and health: A review of impacts and effectiveness*. Regional Office for Europe.
- Yang, L., Ho, J. Y., Wong, F. K., Chang, K. K., Chan, K. L., Wong, M. S., Ho, H. C., Yuen, J. W., Huang, J., & Siu, J. Y. (2020). Neighbourhood green space, perceived stress and sleep quality in an urban population. *Urban Forestry and Urban Greening*, 54, Article 126763. <https://doi.org/10.1016/j.ufug.2020.126763>
- Young, J. K., Coppock, D. L., Baggio, J. A., Rood, K. A., & Yirga, G. (2020). Linking human perceptions and spotted hyena behavior in urban areas of Ethiopia. *Animals*, 10, 2400. <https://doi.org/10.3390/ani10122400>