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How animals affect us: examining the influence of human-animal interactions on human's health

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Table of contents

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Editorial: How animals affect us: examining the influence of human-animal interactions on human's health

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Editorial on the Research Topic
How animals affect us: examining the influence of human-animal interactions on human's health

Introduction

In the history of human societies, the most important and decisive stage was certainly the transition from the appropriation of spontaneous resources to the production of domesticated resources. Animal domestication definition is not unique and can be based on several criteria and thought of in several pathways (1–3). Through domestication man learned to take advantage of the potential of the animal that best suited his needs, which allowed us to understand that domestic animals are not the result (only) of natural selection but rather of so-called artificial selection (4). Practiced over thousands of years, artificial selection gave rise to the large number of breeds of different domesticated species that are currently known, mostly reflecting the different ways of using animals according to different regions (5, 6).

The first domesticated species was the dog (7), probably domesticated by hunters, followed later by the most economically important species—sheep, goats, cattle and pigs,—for their primary products, meat and leathers. Later, appeared horses, used mainly to transport people and goods/products and for traction, a phase that corresponds to a period in which man began to exploit animals for their secondary products, such as strength, milk, wool and manure (5).

Certain behavioral and temperament characteristics, namely ease of environmental adaptation, tendency to escape or aggression, tameness, docility, sociability, emotional reactions toward humans, have made certain animal taxa, and certain individuals within taxa, better candidates for domestication and a lasting relationship with humans (1). In addition to these interactions, more of a material and instrumental nature, others

emerged from an affective point of view, giving rise to animals kept as pets including the aforementioned and newly domesticated mammals and birds as well as species of wild mammals, birds, fishes, reptiles and arthropods (1).

These kind of Human-Animal Interactions (HAI) of an affective nature have developed and consolidated (8) to such an extent that some species are currently used as Animal Assisted Therapy (AAT) in humans, in certain situations, and with great potential for healing, or at least alleviating and improving their symptoms. AAT are practices that incorporate HAI in a structured and goal-oriented manner into patient treatment plans for the benefit of their health (9). On the other hand, Animal Assisted Activities (AAA), another type of HAI, can be performed by HAI professionals or volunteers in a variety of settings to improve participants' quality of life, with or without consideration of health-related goals (9). It is also known that the bonds between humans and animals are mutually beneficial relationships for people, as well as for the animals involved, so in this context health is seen from a broad perspective, including not only physical benefits, but also mental, emotional and social wellbeing. In other words, domestication, which initially had an essentially "utilitarian" character, always aiming at a specific objective (source of food, protection, etc.), gradually acquired a new facet linked to the affective aspect, thus giving rise to pets, which today represent a decisive factor in combating one of the main problems of contemporary society: loneliness. In this context, animals represent companionship and affection, especially for the elderly (10) and children (11–13), with enormous physical and emotional benefits. Several scientific studies have proven a positive relationship between living with an animal and a reduction in cases of depression and suicide rates, improved blood pressure control, etc. Thus, the HAI/AAA/Animal Assisted Interventions (AAI) are a growing, multifaceted and multidisciplinary sector made up of industries and complementary professionals who work alongside animals as a fundamental part of their service and interventions (14, 15). AAI professionals use the inclusion of animals in their services to obtain therapeutic gains and improvements in the health and wellbeing of their clients, and of the animals themselves. Their approaches are diverse, including animal-assisted therapies in families, hospitals, institutions and organizations created for this purpose, in sports and at work, with vulnerable populations, etc. All these kinds of interactions/interventions have been widely used with excellent results, using the most diverse animal species, namely horses, dogs, cats, dolphins, or through simple contact with nature and its plant and animal biodiversity. However, from whatever perspective we consider interactions/interventions, we must always do so based on ethical principles and with respect for their wellbeing (16, 17).

Frontiers has given extensive emphasis to this topic, with several Research Topics having been published in recent years, which we will cite when deemed appropriate. Included in this *Research Topic*, whose aim was to contribute to a better understanding of the healing power of the bond between humans and animals and how these interactions affect each other, are 12 articles: 8 Original research, 1 Systematic review, 1 Mini review, 1 Brief research report, and 1 Perspective. However, we will present and explain these articles, not by their typology, but by subjects/species in which there is something in common between them, covering a wide variety of themes, appropriately identified.

Dogs and cats

The first domesticated species was the dog (*Canis familiaris*) and, given its propensity to form secure and strong bonds with humans, it consolidated a privileged status as a companion animal and was used as a working animal in various activities, including hunting, rescue, military, man tracking, sled dogs, cinema, etc (18–25). On the other hand, dogs are considered the most important species in AAT, and there are several benefits linked to their involvement in different therapeutic areas (19, 26).

Although in today's modern societies, both dogs and cats have similar roles as pets in the lives of humans, there are some important differences between the two species (27), making the cat an exception to generalizations of development and settlement of animal-human interactions (5). The cat (*Felis catus*) is a relatively solitary species, individuals interact very little with each other, with minimal contact, except during the reproductive period, and they are very fierce in relation to the territory, maintaining a strong connection to it (5, 27). A domestic cat is more linked to the home occupied by its owners/guardians than to human beings themselves (5) and this behavior and other behavioral characteristics (28) may partly explain its lower use in HAI/AAA/AAI, compared to dogs. Even so, domestic cats are immensely popular companion animals in households around the world, in the USA (28, 29) and in the European Union, where the population of pet cats is estimated to be 113 million (29).

In this Research Topic, four manuscripts on therapies using dogs/cats were published. Late adolescence is a crucial period of individual development and growth, in which new relationships are established, and in which involvement with family and the local community contributes to wellbeing, playing a significant role in the formation of personality. On the other hand, pets, such as dogs and cats, also increase interactions with family and the local community, thus contributing to increased wellbeing in adolescents. Using questionnaires administered to high school and college students, Koyasu et al. assessed the effects of the experience of having pets on involvement with family and the local community, wellbeing and general confidence. The results obtained revealed that girls who had dogs or cats had greater wellbeing and general confidence through involvement with their families, but this did not happen with boys. The authors suggest future cohort studies examining the effects of pets in each age group.

Some studies evaluating the association between pets and cardiovascular disease have produced inconsistent results, which may be explained, at least in part, by variations in age and sex among study populations. The study by Watson et al. included 6,632 American Gut Project participants who are US residents $\geq$40 years old. The authors, using multivariable adjusted logistic regression, estimated the association between pet ownership and the risk of cardiovascular disease and assessed the effect of age and sex. The results indicated that cat ownership, but not dog, is significantly associated with a lower risk of cardiovascular disease. Conversely, significant interactions were observed between cat and

dog ownership with age but not sex, indicating that cardiovascular risk varies by the combination of age and pet ownership. This study emphasizes the importance of pets in human cardiovascular health, suggesting that the ideal choice of pets depends on age, although, according to the authors, more studies are needed to assess causality.

Although interacting with animals has been shown to have benefits for human health, there are limitations to physical interaction for safety reasons due to zoonosis risks, including COVID-19 (30). As an alternative, Na and Dong created three types of human-animal interaction (HAI) content based on mixed reality (MR) and experimentally evaluated their effect on reducing mental stress: observation of the movement of a non-reactive virtual cat, interaction with a virtual cat whose responses can be viewed and interaction with a virtual cat whose responses can be viewed or heard. Thirty healthy young women underwent a mental arithmetic task in order to induce mild mental stress before experiencing each content, and during the experiment the electrocardiogram was recorded continuously, and the psychological state was assessed using a questionnaire. The results showed that MRI-based virtual cat content significantly reduced mental stress and induced positive emotions after stressful situations, in particular, when the virtual cat provided audiovisual feedback. Based on the results obtained, the authors suggest that this method should be investigated further to see if it can replace real HAI in the management of human mental health.

Aging is a continuous process of natural changes, during which many physiological functions begin to gradually decline, including decline in cognitive function (memory, learning, perception, consciousness) and risk of frailty and comorbidities that may require careful nutritional planning (31). Organ failure is the leading incurable, life-limiting condition of older dogs and cats, many suffering from the same illnesses as humans (32). On the other hand, improvements in veterinary healthcare in recent decades, through advances in diagnostics and treatments, mean that we now have a significant population of small geriatric companion animals. This necessarily means that owners increasingly face the challenges of caring for elderly pets with life-limiting illnesses and making end-of-life decisions. In the article by Lam et al. its two first authors, based on their own experience, present their personal perspective and what they consider to be the veterinarian's perspective on these issues. In order to improve the quality of life of both animals and their owners, they suggest that three communication elements are primary, namely: empathic communication and shared decision-making; managing progressive symptoms, and; advanced directives.

Horses

Although the horse (*Equus caballus*) was domesticated after dogs, cattle, pigs, sheep, and goats, it represents the domestic animal that had the most impact on the development of human civilization, providing rapid transportation, considerably altering the speed and magnitude of the circulation of goods and people, revolutionizing war and agriculture, and profoundly influencing the political-economic trajectory of human societies (33, 34). There are currently around 60 million horses on the planet which are mainly confined to the sports and leisure industries in most developed countries, although in developing countries they fulfill their traditional roles, providing transport, draft power, meat, milk, hair and leather (**34**). Horses are also a species widely used and important in animal-assisted therapies, which can be divided into two broad categories: therapy aimed at improving mental health and therapy aimed at improving physical health (35–37).

In this Research Topic, five manuscripts on therapies using horses were published. Smith et al. used qualitative methods to assess the experiences of owners and veterinarians of older horses, considering that the importance of veterinarian-owner interactions in establishing future veterinary care needs may be underestimated. Analysis of the data, collected between 2019 and 2022, identified that owners carried out an ongoing and interactive process of assessment, monitoring and decision-making in relation to the animal and any observed changes. The results obtained demonstrate how issues of health, disease and the role of professionalized forms of medical knowledge are not static, but constantly change, interacting over time.

Stergiou et al. evaluated the efficacy of Equine Assisted Therapy (EAT) in children with Cerebral Palsy, in terms of gross motor function, performance, and spasticity as well as whether this improvement can be maintained for 2 months after the end of the intervention. Five measurements were considered: Gross Motor Function Measure-88 (GMFM-88), Gross Motor Performance Measure (GMPM), Gross Motor Function Classification System (GMFCS), Modified Ashworth Scale, Wechsler Intelligence Scale for Children and statistically significant improvements were achieved for some children in Gross Motor Function Measure and all its subcategories (which remained consistent for 2 months after the last session of the intervention), also in total Gross Motor Performance Measure and all subcategories. According to the observed results the authors conclude that EAT improves motor ability (qualitatively and quantitatively) in children with Cerebral Palsy, with clinical significance in gross motor function.

Mattila-Rautiainen et al. evaluated the impact of Equine Facilitated Therapy (EFT) on perceived physical performance, pain level, pain acceptance, depression and anxiety, and quality of life in a 12-week intervention in a sample of 22 patients with chronic low back pain (LBP). Participants received EFT, supervised by physiotherapists, combining quantitative and qualitative methods, and data were collected through questionnaires, interviews, and patient data repositories. Horse welfare was taken into account in the basic training and in the research environment. The results of this work indicate a significant increase in satisfaction levels and a decline in the amount of perceived depression, and only two of the 22 participants returned with recurrent symptoms after 6 months to the pain clinic. The participant interviews revealed three important domains of experience during coding: physical-, psychological-, and social that link to the research question and suggest impact for the recovery from the human-animal interaction.

Rigby reviews the effect that continued and repeated stress can have on the rider during equine-assisted services, evaluating different neuroendocrine biomarkers, namely immunoglobulin A, serotonin, cortisol, progesterone and oxytocin. The results are mixed regarding the effects of these hormones on the rider's

physiology before, during and after equine-assisted services. The author suggests that future work should adopt an interdisciplinary approach, with properly controlled studies, appropriate treatments and experimental rigor, considering exogenous and endogenous factors that influence the rider's physiology.

Adaptive or therapeutic riding (A/TR) is a recreational activity that provides mounted and ground-based horsemanship opportunities adapted to the abilities of the participants and providing physical and psychological benefits to participants with diverse disabilities, promoting higher quality of life. The aim of the study of Hanson et al. was to identify whether, and how, professionals in A/TR, standardize the assessment of participant outcomes, and the advantages and barriers to this standardization. According to survey results, assessments are not standardized, although the A/TR professionals believe that their establishment would strengthen the profession, obtain funding, and communicate about A/TR services to a broad audience, aspects relevant to all age groups and populations that use these services. Respondents identified several barriers to implementing standardized assessments, including time, system and expertise constraints, cost, time required, and not being available in article or computer format. The authors conclude that standardized assessments can be a strong support for the A/TR profession, although they must meet the unique needs of these professionals.

Animal-assisted interventions and education programs

Educational programs and courses on animal-assisted interventions (AAI), their ethical and practical principles, and models and theories that support the psychophysiological effects of human-animal interactions (HAI), are being implemented worldwide.

A growing number of studies in the field of Social Work (SW) address incorporating the presence of animals into the practice and understanding of social support and therapeutic components. Rusu and Davis present a step-by-step approach to including HAI knowledge and practice in teaching Yalom principles and therapeutic factors in group therapy to SW students. Based on a qualitative analysis of existing literature and the results of several research projects in the area of HAI, the authors propose a strategy to include examples and research-based theories that support the beneficial effects of HAI toward interdisciplinary understanding of the primary factors of Yalom in the therapeutic process, such as: instillation of hope, corrective recapitulation of the primary family group, development of socialization techniques, imitative behavior, interpersonal learning, and group cohesion. For each of these factors, the authors discuss the applied values of HAI, emphasizing the added value of the presence of animals in group therapy environments from the perspective of the dynamics of interspecific social networks. Based on the results of their qualitative analysis, the authors recommend that Yalom's group therapy factors be fostered in AAI-group providing information/psychoeducation to professionals and group participants about the theories that support the beneficial effects of direct contact with animals and about the potential mechanisms of positive interspecific interactions.

In the United States of America, a growing number of higher education institutions offer courses on adaptive/therapeutic riding and the incorporation of horses into human services areas, namely education, psychotherapy, occupational therapy, physical therapy, and speech-language pathology. Since the first study to identify courses in these areas was published in 2018, Connolly and Ekholm Fry publish a scoping review to evaluate the evolution, in these types of institutions, of courses on the use of horses in human services. The authors identified 122 courses offered by 48 higher education institutions in 29 states in the following areas: adaptive/therapeutic riding, mental health, education/learning, and equine movement in physical therapy, occupational therapy, and speech-language pathology (hippotherapy), most of which offered at both the undergraduate and graduate levels. The results suggest avenues for reflection and discussion about changes over time, as well as challenges and opportunities for academic programs of courses on the use of horses in human services.

Wildlife immersion experiences

The health benefits of contact with nature, particularly mental health, have long been recognized (38), especially in urban populations where people are exposed to excessive stimuli such as noise, light pollution, time pressure and a fast pace of life (39). The relaxing potential of immersion in nature appears to be an essential protective factor, through slow walks through a forest landscape, and the enjoyment of odorants generated by nature (40), nature sounds (41, 42), nature-based mindfulness and therapeutic ornithology (43). The results of Simonienko et al. (43), indicated that forest therapy, nature-based mindfulness and therapeutic ornithology act differently, although they have many common characteristics, so they can work as an effective combination to deal with different types of stress and anxiety symptoms. The results of Peterson et al. (44) show that even half an hour of birdwatching can make us happier, healthier and help foster a deeper connection with nature. On the other hand, listening to birdsong was linked to perceptions of lower stress and attention recovery (45). In this way, visits to bird-rich habitats can become part of social prescribing protocols, playing an important role in preventing mental health problems, complementing interventions (46).

In the manuscript included in this Research Topic, Perry et al. explore the potential of Animal Assisted Interventions (AAI) in improving the physical and psychological health of veterans with post-traumatic stress disorder (PTSD). To this end, they followed, for an average of 15.1 weeks, 19 veterans with PTSD/PTSD symptoms through a series of 8 immersion experiences in nature and wildlife to assess their feasibility and effectiveness. The intervention comprised an initial forest walk, assisting with wildlife rehabilitation, observation in a wildlife sanctuary and bird watching. This AAI nature/wildlife immersion intervention proved to be viable, acceptable and safe, with participants expressing pleasure and satisfaction with the activities, while also highlighting their concern for the welfare of the animals. The authors conclude

that these wildlife AAI immersion experiences are feasible and can be safely administered to veterans with PTSD/PTSD symptoms.

In summary

Human-animal bonds are mutually beneficial relationships that hold the potential to nurture One Health for People as well as the animals involved. Health in this context includes not only the physical benefit, but the mental, emotional, and social wellbeing of both people and animals. Animal-Assisted Interventions (AAI) is a growing, multi-faceted and multi-disciplinary sector comprised of complementary industries and professionals working alongside animals as a key part of their service. The goal of this Research Topic is to contribute to a better understanding of the Healing power of connecting with animals and how the interactions involving humans and animal affect each other.

Author contributions

FC: Writing – original draft, Writing – review & editing. EK: Writing – review & editing. AS: Writing – review & editing. IP-F: Writing – review & editing.

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

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Interdisciplinary approach of Yalom's group therapy factors: A theoretical model for including animal presence in social work education and practice

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An increasing number of studies in the field of Social Work (SW) address the incorporation of animal presence in practice and improved understanding of social support and therapeutic components. Education programs on the ethical and practical principles of animal-assisted interventions, including models and theories supporting the psycho-physiological effects of human-animal interactions (HAI), are being implemented around the world, especially in the US. While designing and implementing a new interdisciplinary curriculum can be time-consuming and, depending on the many variables, integrating elements of HAI components in existing curricula can be a more efficient approach. We present a step-by-step approach for inclusion of HAI knowledge and practice in teaching Yalom's principles and therapeutic factors of group therapy to SW students. Based on a qualitative analysis of the existent literature and on the results of several research projects in the field of HAI, we propose an approach for infusing research-informed examples and theories supporting the beneficial effects of HAI in the direction of the interdisciplinary understanding of the Yalom's primary factors in the therapeutic process, such as: instillation of hope, corrective recapitulation of the primary family group, development of socializing techniques, imitative behavior, interpersonal learning, and group cohesion. Applied values of HAI are discussed for each factor, emphasizing the added value of animal presence in group therapy settings from the perspective of the dynamic of interspecific social networks, i.e., animal-handler-group members.

KEYWORDS

group therapy, human-animal interactions, education, social work, qualitative analysis

Introduction

An increasing number of studies in the field of Social Work (SW) address the incorporation of animal presence in education and practice, in the direction of improving the understanding of the social support components. Education programs that familiarize students with ethical and practical principles of animal-assisted interventions (AAI), including models and theories supporting the psycho-physiological effects of positive human-animal interactions (HAI), such as interactions with companion, emotional support and therapy animals, have started to function around the world.

Animals represent a significant presence in the history of human lives (families, homes, communities, societies). The increasing number of programs and scientific publications in the field of human-animal bond stem from the fact that knowledge and awareness about HAIs can offer important insights to the understanding and adjust the functionality of social systems. The potential mechanisms of change behind the benefits of HAIs on human mental and social wellbeing can motivate Social Work professionals and students to consider their inclusion in their practical approach to addressing problematic functioning of individuals in various interactional contexts, both intraspecific ones (interpersonal human-human interactions) and interspecific ones (human-animal interactions). This assumption is supported by the emergence of fields of SW practice addressing aspects of HAI have emerged in the last decade in the U.S., such as *animal-assisted social work* (1–3) and *veterinary social work* (3).

As indicated by several authors and practitioners combining AAI with clinical psychology and clinical SW, the most prevalent arguments for the integration of HAIs, especially of the relationships with companion animals, into SW education and practice are: (1) animals are part of family systems/human ecologies; (2) there is a growing evidence base for the links between animal cruelty and forms of family dysfunction and criminal behavior; and (3) companion animals add therapeutic value to interventions across diverse age and special needs categories (2, 3).

In a previous study (4), we performed a qualitative analysis of the existent literature on civic engagement (Service-Learning) programs for Social Work students in connection to animal-assisted activities in order to identify the elements that could be used for the development of an interdisciplinary curriculum addressing the civic development of students through the inclusion of animal presence in education and community practice. The proposed learning objectives for the above-mentioned interdisciplinary curriculum were the following (4):

- Identify and apply theories of human behavior and principles of ecological social work animal-assisted interventions with individuals, families, and groups;
- Demonstrate empathy, reflection, and interpersonal skills through the connection between HAI and civic engagement activities;
- Use and translate research evidence on animal inclusion in social work practice to inform and improve practice;
- Demonstrate engagement, assessment, and intervention practice skills through positive human-animal interactions based activities.

The aim of our current study is to provide a transversal learning objective as an addition to the four learning objectives above, by introducing SW students and practitioners interested in the AAI field to a research-informed body of work coming from the field of group work and group therapy. This transversal learning objective refers to Yalom's eleven (5) therapeutic factors of group therapy (6). This framework is proposed in order to facilitate a better understanding of the mechanisms of change related to the benefits that animal presence can bring to group interventions.

The proposed transversal learning objectives informed by a group therapeutic intervention is important because all of the current explanatory theories and models behind the benefits of HAIs on aspects of human life are based on the social nature of interactions, i.e., meaningful social encounters with others (humans and animals). Examples of theories that are commonly found in the SW practice literature supporting the inclusion of HAI (1, 2, 7, 8) are: ecological-systems theory (9), family theory and family-centered practice (10), social support theory (11), and the strengths perspective (5).

Theories from the field of ethology and evolutionary sciences are often found to contribute to the theoretical explanatory frame of the psychological, social and physiological benefits of positive HAI (e.g., stress reduction, cognitive activation, enhancement of social skills, decrease of performance anxiety, decrease of social isolation, decrease of probability of cardio-vascular diseases etc.). Most of these theories emphasize the intrinsic qualities of animals as social agents, especially of companion animals and their availability for interaction and acceptance of proximity, which are often related to a calming effect and expression of positive affect in humans (12, 13). The *biopsychosocial model of health* supports an integrative conceptual frame for the identified theories in regards to the benefits that animals can bring to several aspects of human quality of life (13, 14). This model argues that health can be seen as the result of a combination of biological, psychological, and social factors that are interrelated, with animals being a significant component of human ecologies. Incorporating ecological-systems theory (9), there are reciprocal benefits (at levels of survival and social functioning) that humans and animals bring to each other.

Group therapy is a therapeutic method applied to clinical social work practice in which individuals are placed in a group, guided by one or more therapists or leaders for the purpose of

bringing about change(s) in each individual through the various group processes. Unique to the group is that it allows for the re-creation of group members' customary roles, behaviors, and interactional patterns (6). The power of groups is that social workers are required to bring the underlying issues and feelings out in the open in a relatively "public way" (15), while building cohesion experienced as togetherness and connection (6). This process can be challenging for groups, especially when dealing with personal topics such as intimate relationships, problem-behaviors, parenting behaviors, and work and career-related issues, etc. (6). Group therapy focuses on the "here and now" (6), utilizing action-oriented problem-solving and decision-making that values a range of activities including art, music, games, theater, etc. (15). This theoretical underpinning supports the introduction of objects, both animate and inanimate, such as dogs, animals into the therapeutic process that has the potential for mutually shared and reciprocal benefits.

The change process in groups refers to the dynamics of the group and the emotional and cognitive processes within each individual, that foster social and emotional functioning and more effective coping abilities. Irvin Yalom, an American existential psychiatrist and currently an emeritus professor of psychiatry at Stanford University, states "therapeutic change is an enormously complex process that occurs through an intricate interplay of human experiences," which he refers to as "therapeutic factors," initially termed "curative factors" [5, p. 1]. Yalom's eleven group therapy factors, although examined separately, are "intricately interwoven" and vary in their importance from group to group [5, p. 2]. The eleven therapeutic factors briefly described here include:

1. *Instillation of Hope*: A belief things can be better; positive expectations;
2. *Universality*: "all in the same boat" phenomenon; "misery loves company";
3. *Imparting Information*: Didactic instruction; advice and direct guidance;
4. *Altruism*: Giving to others; group therapy is unique as it offers members the opportunity to benefit themselves as well as others;
5. *Corrective Recapitulation of the Primary Family Group*: Group resemblance of one's primary family group with authority figures, siblings, strong emotions, intimacy, etc.;
6. *Development of Socializing Techniques*: Learning and testing new ways to interact and engage with each other;
7. *Imitative Behaviors*: Learning by observing other members interacting, solve problems, etc.
8. *Interpersonal Learning*: Learning and experiencing the importance of the human relationships and the reciprocity of secure attachments;
9. *Group Cohesiveness*: The "we-ness" of group therapy; level of solidarity among and between members—a critical group therapy factor;
10. *Catharsis*: Discharge of strong emotions;
11. *Existential Factors*: Transcending suffering and realities of life through faith, relationship, and hopefulness found through something or someone else (6).

Joyce et al. (16) reduce these eleven factors to four more global factors, which include: instillation of hope, secure emotional expression, awareness of relational impact, and social learning.

Methods

The aim of this methodological approach is to provide an example of how SW students and practitioners can identify and apply Yalom's group therapeutic factors to AAI-group intervention studies published in peer review journals (i.e., studies that provided enough data for the calculation of the effect size of the interventions).

This methodological exercise is proposed within the transversal learning objective and it aims to answer the following **research questions**:

- What type of explanatory theories are the authors of the AAI-group based studies providing on the justification of using a group form of intervention?
- Can one identify elements corresponding to Yalom's group therapeutic factors in the text provided by the authors of the AAI-group studies?

According to Erlingson and Brysiewicz (17), the objective of a qualitative content analysis is to systematically transform a large amount of text, considered the raw data, into a concise and organized summary of the key results. The following steps were performed: (1) Reading the written reflections to gain a general understanding of what the participants are expressing; (2) Condensation of the text by division into meaning units (codes); (3) Grouping the codes into categories (i.e., a category is formed by grouping together those codes that are related to each other through their content or context) and themes (i.e., a theme can be seen as expressing an underlying meaning found in two or more categories).

For this study, the thematic qualitative analysis was performed on the *Introduction* and *Discussion parts* of the four publications included in the systematic review performed by O'Haire et al. (18) on empirical studies of AAI for trauma. The ***predefined themes*** in the qualitative analysis are Yalom's 11 therapeutic factors (6). The text was manually condensed by ASR, followed by discussion and agreement between the two authors regarding the codes.

Among the ten studies qualified for inclusion (six peer-reviewed journal articles and four unpublished theses) in the systematic review performed by O'Haire et al. (18), various

forms of **group intervention** were used in five studies, either alone or combined with individual therapy. From the five group intervention studies, the four published scientific papers with full access were included in this analysis (four papers, see Table 1). The fifth study not included in our analysis was an unpublished dissertation thesis. The four studies using AAI-group interventions and with sufficient data to calculate the effect size of the interventions in the meta-analysis research articles (18) are presented in Table 1.

Results

As indicated by the data summarized in the systematic review (18), the participants in the four AAI-group interventions were predominantly survivors of child abuse. The most common animal species were dogs and horses. The activities were described mainly in relation to the animal presence, with no details on the dynamic of the interactions among the group members during the therapy program. All of the interventions had duration of from 7 to 12 weeks, which would have been adequate time for observations of the group process and interactions (Table 1).

Three of the four AAI-group intervention studies reported having a predetermined theme for each session. Among the activities described, two main variation factors were identified: the animal species and whether or not the intervention animal was used as a metaphor for the child's relationship with their usual social partners (18). Two studies with dogs integrated them into the regular therapy sessions, which included both dog-focused activities such as training as well as talking to the dog about personal traumatic experiences (19, 20). In one of the studies, the integration of the dog was done through stories told from the animal's perspective (19). In this case, the effects of the animal presence were generally enhanced by telling a therapeutic story about the dog, attributed to giving the dog a social role and integrated purpose in the therapy session (18). This interpretation is supported by the efficiency of the AAI-group intervention program in this particular study using the therapeutic stories about the dog (S2), as indicated by the significant effect size values calculated for the following pre- and post-intervention outcomes: PTSD symptoms, depressive symptoms and anxiety [(18), Table 1].

The information provided by O'Haire et al. (18) indicates that the effect size was significant for the studies S2, S3 and S4 (pre- and post-intervention), i.e., the AAI-group intervention had a significant effect on decreasing the PTSD symptoms and the anxiety levels. No information on collection and analysis of qualitative data is provided in the four AAI-group intervention

TABLE 1 The characteristics of the four AAI-group intervention studies included in the meta-analysis of O'Haire et al. (18).

Title and code of the AAI-group intervention studies	Characteristics of the study (18)
Study 1 (S1, 19): Balluerka, N., Muela, A., Amiano, N., and Caldentey, M. A. (2014). Influence of animal-assisted therapy (AAT) on the attachment representations of youth in residential care.	• Age of participants (12–17 y); Format: individual and group therapy; Animal type: dog, horse, cat, farm animals; Duration: 12 weeks, two-three sessions/ week. • Outcomes: increase of attachment security. • Effect size (d) pre-AAI vs post-AAI: not enough data for calculation of the effect of the intervention.
Study 2 (S2, 20): Dietz, T. J., Davis, D., and Pennings, J. (2012). Evaluating animal-assisted therapy in group treatment for child sexual abuse.	• Age of participants (5, 8–17); Format: group therapy; Animal type: dog; Duration: 7 weeks, one-two session/ week. • Outcomes: decrease of PTSD symptoms, decrease of depressive symptoms, decrease of anxiety, dissociation and anger, decrease of sexual concerns. • Effect size (d) pre-AAI vs post-AAI: for depressive symptoms ($d = 0.92$, $p < 0.001$), for PTSD symptoms ($d = 0.86$, $p < 0.001$), for anxiety ($d = 0.80$, $p < 0.001$).
Study 3 (S3, 21): Hamama, L., Hamama-Raz, Y., Dagan, K., Greenfeld, H., Rubinstein, C., and Ben-Ezra, M. (2011). A preliminary study of group intervention along with basic canine training among traumatized teenagers: a 3-month longitudinal study.	• Age of participants (14–16 y); Format: group therapy; Animal type: dog; Duration: 12 weeks, one session/ week. • Outcomes: decrease of PTSD symptoms, decrease of depressive symptoms, increase of subjective well-being, increase of coping abilities. • Effect size (d) pre-AAI vs post-AAI: for depressive symptoms ($d = 0.47$, $p = 0.06$), for PTSD symptoms ($d = 0.7$, $p < 0.05$).
Study 4 (S4, 22): Kemp, K., Signal, T., Botros, H., Taylor, N., and Prentice, K. (2014). Equine facilitated therapy with children and adolescents who have been sexually abused: a program evaluation study.	• Age of participants (5, 9–17); Format: group therapy; Animal type: horse. Duration: 9–10 weeks, one session/ week. • Outcomes: decrease of depressive symptoms, decrease of maladaptive behavior, decrease of PTSD symptoms, decrease of anxiety, dissociation and of sexual concerns. • Effect size (d) pre-AAI vs post-AAI: for depressive symptoms ($d = 1.31$, $p < 0.001$), for PTSD symptoms ($d = 3.77$, $p < 0.001$), for anxiety ($d = 2.63$, $p < 0.001$).

studies. The results of the qualitative content analysis of the *Introduction* and *Discussion* parts of the four studies are presented in Table 2.

Discussion

The aim of this study was to provide an example of how SW students and practitioners could apply the analytical framework offered by Yalom's group therapeutic factors for the purpose of clinical application of relevant factors in AAI-group interventions. This analysis used existing peer-reviewed studies that provided enough data for the calculation of the effect size of the interventions. Experts in the field of human-animal bond indicate that the beneficial contribution of animals' presence and positive HAI on social capital enhances individual mental and physical health, as well as the interpersonal relationship and cooperation in families, groups (including therapy groups), and communities [e.g., (4, 7)].

This methodological approach provides an analytical framework for SW students and practitioners to enhance understanding of change mechanisms related to the benefits of positive animals' presence in interpersonal contexts and the potential applications in clinical settings. This analysis was based on Yalom's group therapeutic factors as themes for a qualitative content analysis of the *Introduction* and *Discussion* sections of four group intervention studies on the effects of AAI interventions on trauma (18).

A discussion of the findings of the qualitative analysis follows that includes reflections on each of the units of analysis (coded group therapy themes) and recommendations for the facilitation of the inclusion of Yalom's cluster of factors in planning and evaluation of the AAI-group interventions programs. Dietz et al. (19) argues that AAI is not a stand-alone theory, but "augments existing treatment strategies" (p. 667) in which animals contribute to meeting the therapeutic goals.

Instillation of hope

According to Yalom and Leszcz (6), the therapeutic factor *hope* operates differently in the group format through the emphasis on progress of others, i.e., a group member can have the insight that "*others are living inspiration*." This inspirational side of the other members of the group can be revealed by the ways they interact with the therapy animal. Another operational aspect of hope is the mobilization through encouragement, which fosters the development of the "can do" approach. In our qualitative analysis (Table 2), the factor "instillation of hope" was supported by the codes identified in one of the four studies (S1): participants were helped to feel, think and act in new ways by pointing out that their current interpersonal relationships could be modified positively. These codes can also be included in the theme "Imparting information," due to the fact that the information about the expectation of the positive change was communicated by the therapists involved in the group intervention.

As a recommendation to SW students and practitioners, we consider that the factor *instillation of hope* can be activated by the inclusion of animal presence in group therapy by creating opportunities for animals to assist the group members in doing activities (individually and/or together with other members), in facilitating relationships and shared experiences, and in feeling and experiencing something positive and new. Reflection during and after each activity can help in the direction of creating awareness that animals (and the other group members interacting with the animals) *can help one feel hopeful* that things can be different and that one can experience positive feelings again.

Universality

This group therapy factor refers to the fact that individuals enter treatment feeling they are unique (6), often due to extreme social isolation. In a group, learning that "*we are all in the same boat*" can be a powerful source of relief, at least in the early stages of group formation. The qualitative analysis allowed us to identify codes related to this factor in one of the four AAI-group studies (Table 2), in which the authors cited two studies from the AAI literature ."*..animals are capable of providing unconditional positive regard without judgment*" [(21, 22) *cited in* (20)].

For a better understanding and usage of the therapeutic factor "universality," as well as other Yalom's group therapy factors, such as "group cohesiveness," and "existential factors," SW students and practitioners are recommended to become aware of some of the theories and research-informed models behind the idea that animal presence in group therapy can facilitate the interpersonal and human-animal connections through petting and playing with the animal. These play-based activities have the potential to foster feeling and sharing affection and enjoyment in the presence of the animal's unconditional love. As pointed out by Yalom and Leszcz (6), sharing the universal human condition of wanting and needing positive attention and care can be a big step in dealing with shame, guilt, stigma etc.

The effect of a friendly animal on interpersonal interactions is known as *the social catalyst effect* (29). Also, HAI research indicates that direct contact with life forms other than humans appear to have a modulatory effect on the psychological and physiological parameters associated with social interactions [e.g., (29)]. The presence of oxytocin is considered as an optimal method for providing concrete evidence of the positive effects of HAI on human wellbeing. Oxytocin is a peptide hormone that regulates various physiological, psychological and behavioral functions in humans and animals, mainly by

TABLE 2 Codes identified within the predefined themes (Yalom's therapeutic factors) in the four animal-assisted group intervention studies.

Group therapeutic factor—themes	Definition based on Yalom and Leszcz (6)	Information units (codes) identified in the four AAI-group studies (18)
1. Instillation of hope	Process by which hope is inspired through observation of therapeutically advanced group members; provides group members with encouragement that change is possible.	• **S1** "The intervention ended by **helping participants to think, feel, and act in new ways** that were different to those they had used in past relationships. In order to achieve this goal, it was pointed out that **their current relationships could be modified positively** by **building secure relationships** involving **synchrony, reciprocity, trust and mutual support, empathy, and sincerity,** relationships of the kind that they had been able to develop with the animal and the therapist."
2. Universality	Process by which group members feel less isolated in their pain as they connect to others with similar experiences; group members learn that he/she is not alone or unique in problems and suffering.	• **S4** "Studies have shown that animals are capable of **providing unconditional positive regard without judgment**, something that may not be present in the lives of abused children (21, 22)."
3. Imparting of information	Group members receive psychoeducation/ didactic instructions and/or advice from the group leader and/or the other group members.	• **S1** "The aim of the first individual sessions was to enable participants to become familiar with the different animals and the professionals involved, and also to **establish the framework and the rules of conduct**; these latter aspects bring **constancy and predictability to the therapeutic process**" • **S1** "Participants were **guided to reshape the relational style of their interpersonal interactions** (with friends, partners), with attention being paid to different contexts of social interaction, such as the residential care setting (key worker) and school (teachers), in which they could establish new potential attachment relationships. • **S2** "Group therapy **provides children a safe environment** in which they can **receive guidance from therapists while supporting one another as they share and process their experiences** (23, 24). The group setting allows children to develop trust, which has often been eroded by the abuse usually experienced from a trusted individual (23)."
4. Altruism	Group members offer support, reassurance, suggestions and insight to other group members; group members learn that their contributions to the group are significant to the healing of others.	• **S2** "Sharing these feelings with or about the animal can **initiate the emotional sharing process** with the therapist. For the client, the **animal is seen as a friend** and ally, thus presenting a **safe atmosphere for sharing**. Using an animal **offers nurturance** through a presentation of **unconditional acceptance and interaction.**" • **S4** "The arguably innate human interest and desire to interact with animals affords animals the ability to gain a young client's attention (25), as well as **promote pro-social, humane behaviors and empathy toward others.**"
5. Corrective recapitulation of the primary family group	Group member relieves early familiar conflicts in group in a corrective, more satisfying way; the group is experienced as a familial unit allowing for relearning of unhealthy patterns learned within the family of origin.	• **S1** "The participants' past and present r**elationships were explored, including their expectations, feelings, and behaviors.** In this process they were **encouraged to reflect** upon the ways in which they engaged in **relationships with significant figures in their current life**, what their **expectations were regarding their own feelings and behavior and those of other people**. . . (26)." • **S1** ". . . we sought to help **participants become aware of how their current relationship experiences** may be closely related to events and situations faced during childhood (26). . . .Through these exercises the **participant is confronted with his/her own relational strategies**, which are also closely connected with his/ her upbringing and the current relational parenting style he or she is experiencing." • **S4** "Other activities are designed to create a **metaphor between what occurs in the arena and the participant's every-day life** and again are performed at liberty. What emerges during these activities are **patterns of thinking, reactions/responses** to different situations and outcomes, and r**eactions to dynamics within the family group or within the group of participants.**"
6. Development of socialization techniques	The group provides members with an environment that fosters adaptive and effective communication and enhanced social skills.	• **S1** "In this context, the therapist and the animal function as therapeutic tools whose purpose is to **maximize the ability of the young person to develop good attachment relationships,** not only within the therapeutic triangle (therapist–client–animal) but also with his/her current caregivers from the residential care setting, with his/her friends, and in the emerging romantic relationships..."

(Continued)

TABLE 2 (Continued)

Group therapeutic factor—themes	Definition based on Yalom and Leszcz (6)	Information units (codes) identified in the four AAI-group studies (18)
		• **S2** "The creative process of using canines along with group intervention seemed like **enhancing their sense of confidence and belief in their abilities**, **regaining them with a sense of control and ego-mastery**." • **S4 "**Animals have also been known to p**rovide an important emotional bridge to therapeutic alliance,** as a difficult to engage child may find it easier to engage with an animal and eventually transfer this alliance to the therapist (27).
7. Imitative behavior	Group members learn to model behaviors from other group members.	• **S2** "The experience of a client interacting with an animal can **provide knowledge about boundaries and limit setting by observing and imitating the therapist–animal interactions.**"
8. Interpersonal learning	Group members learn about their own maladaptive interpersonal patterns through feedback provided by other members; Members provide an environment that allows interpersonal interactions in a more adaptive manner.	• **S1** "The objective of the first group sessions was **to create a social microcosm of security** within which the group members **could act naturally**, a microcosm that would also serve for the **analysis of their interpersonal behavior in the social world outside the group** (28)."
9. Group cohesiveness	Group member feels connection and solidarity with other group members and the group as a whole.	• **S4 "**The arguably **innate human interest and desire to interact with animals** affords animals the ability to gain a young client's attention (25), as well as **promote pro-social, humane behaviors and empathy toward others**."
10. Catharsis	Group members release of strong feelings about past and/or present experiences.	• **S1** "Storytelling as a part of the therapeutic process has been used to assist children in **expressing themselves**, particularly on difficult topics;" [...]the use of animals in working with child sex abuse survivors helps "them **disclose the abuse and express their feelings by projecting them onto the animal**."
11. Existential factors	Members accept responsibility for life decisions; group members confront issues on the ultimate concerns of existence: death, isolation, freedom, and meaninglessness.	• **S1** "The intervention ended by **helping participants to think, feel, and act in new ways** that were **different to those they had used in past relationships**. In order to achieve this goal, it was pointed out that **their current relationships could be modified positively by building secure relationships** involving synchrony, reciprocity, trust and mutual support, empathy, and sincerity, relationships of the kind that they had been able to develop with the animal and the therapist."

lowering the level of stress hormones such as cortisol [(30), cited in (31)]. Also, oxytocin production promotes positive affective states associated with interpersonal relationships, such as mother-infant bond, couple relationships and positive social interactions (30).

Imparting information

The process of advice-giving/seeking rarely benefits group members and it needs to be managed by group leaders/therapists. The focus of the neophyte group members tends to be on "reasoning" and usually it reflects a resistance to more intimate engagement (6). In our qualitative analysis, codes belonging to the theme "imparting information" were found in two AAI-group studies included in systematic review of O'Haire et al. (18), e.g., professionals involved in leading of the group interventions offered guidance to the participants in different phases of the group interactions (Table 2). In the case of S1, in the beginning sessions, information was offered in order to establish an appropriate level of familiarity with the animals, to establish the framework and the rules of conduct that were considered important to bringing constancy and predictability to the therapeutic process. During the following sessions, participants were guided to reshape the relational style of their interpersonal interactions (32). In the second study (S2), the authors provided references from the literature indicating the importance of group members receiving guidance from therapists while supporting one another as they share and process their experiences in order to provide participants a safe environment (19).

Altruism

The "altruism" therapeutic factor refers to people's need to feel that they are needed and useful (6). Altruism can operate in various types of healing and acts of forgiveness that can be done together with the group members, such as preparing a feast together, performing a type of community service, etc. As pointed out by Yalom and Leszcz (6), the neophyte group members do not, at first, appreciate the healing impact of other members, so they may actively resist helping others or receiving help. This factor refers to the process in which group members offer support and guidance to other members and become aware of the healing valence of their contributions. Our qualitative analysis revealed codes corresponding to this factor in two AAI-group intervention studies (Table 2), i.e., animal is seen as a friend and ally that facilitates a safe atmosphere for sharing and initiating the emotional sharing process (S2) that promotes pro-social, humane behaviors and empathy toward others (S4).

Theories that could facilitate a deeper understanding by SW students and practitioners, as well as by the group members (in terms of psycho-education), of the mechanism of change related to altruism as a curative factor in group settings, can be found in the conceptual framework of HAI. One of the theories is the *biophilia hypothesis* (33, 34), which argues that human individuals possess an innate tendency to be attracted to and positively interact with any living organism, including plants. This theory can be also found in the explanatory framework of the positive effects of nature-assisted activities in the fields of rural social work and eco-social work (or ecological social work) (35). Another theory, which is commonly found in the HAI literature, as well as SW's evidence-base, is *attachment theory* (26). Animals are often perceived as important attachment figures, mainly due to their proximity in everyday life and by facilitating a secure affective environment as a source of social support in various interpersonal contexts [e.g., (36–38)].

Interpersonal learning and development of socializing techniques

The "altruism" therapeutic factor is usually connected with the factors "***interpersonal learning***" and "***development of socializing techniques***." In our qualitative analysis, the "interpersonal learning" therapeutic factor emerged in one of the AAI-group studies (S1), i.e., the objective of the first AAI group session was to create a social microcosm of security that motivates the group members to act naturally and build a reference base for the analysis of their future interpersonal interactions. Interpersonal learning is considered the basis of group therapy, in the way insight, transference, and the corrective emotional experience are considered in individual therapy (6).

The "*development of socializing techniques*" factor refers to the environment provided by the group in the direction of fostering adaptive and effective communication and enhanced social skills; the explicitness of the process varies depending on the age of group members, problems presented etc. In our qualitative analysis, codes belonging to this theme were identified in three AAI-group studies (S1, S2 and S4; Table 2). These codes referred to the following aspects: the dyad animal-therapist was as a tool for maximizing the ability of young group members to develop good attachment relationships (S1), the role of canine-assisted therapy in enhancing the sense of confidence in their abilities, including those related to sense of control and ego-mastery (S2), and the role of animals in providing an emotional bridge in therapeutic alliance and social engagement with other group members (S4). Animal presence in the context of this therapeutic factor can operate to teach the group members a series of social abilities, such as patience, waiting one's turn, observation, giving and receiving instructions, etc.

We recommend that a better understanding of these two factors by SW students and educators working in AAI-group contexts can be provided by knowledge regarding the importance of interpersonal relationships. They allow the shift from relief of suffering to change in interpersonal functioning, which is considered an essential early step in the dynamic therapeutic process. In other words, the interpersonal interactions within the group help the members to translate depression into interpersonal terms (e.g., isolation and difficulty reaching out to others). In line with this, we consider that SW students and practitioners should become aware that animal presence can be used in group contexts to transcend these learned cognitions and behaviors, by facilitating the connection with our spontaneous and nurturing "self," i.e., if we cannot reach out to humans, we can start by reaching out to a forgiving and non-judgmental animal.

Animal presence, especially when included in functional group play situations, can help group members transcend the difficulty in expressing a need and asking for attention (spontaneous interactions). According to Leconstant and Spitz (39), interspecific play is considered a fertile venue to explore the capacity to correctly perceive and interpret signals emitted by partners (40). In terms of the mechanism of change, Porges (41) defines interactive play as a neural exercise, which requires synchronous and reciprocal behaviors between individuals as well as an awareness of the level of social engagement of each individual. This explanation coming from neurosciences and ethology supports not only the "***interpersonal learning***" and "***development of socializing techniques***" Yalom's group therapy factors, but also the "***imitative behavior***" factor.

Moreover, interspecific play can offer valuable opportunities for the **"*catharsis*"** factor to operate, i.e., group members can observe in a mindful way the play scenes between the therapy animal and others, or they can immerse themselves in the "now" moment of playing with the animal and the other members of

the group. Reflection can play an important role for processing what is observed, experienced and learned.

Imitative behavior

In line with the factors referring to interpersonal learning and social skills, this factor refers to the process by which group members learn to model behaviors from other group members (6). Codes reflecting the "imitative behavior" factor were identified in our qualitative analysis in one of the four AAI-group studies, i.e., S2, in which the authors specify that the experience of the group members interacting with an animal can provide knowledge about boundaries and limit settings by observing and imitating the interactions of the therapist-animal dyad. No information regarding the observations of other group members interacting with the animals is provided in the four AAI-group therapy studies.

We recommend the inclusion in the explanatory framework of "imitative behavior" Yalom's group therapy factor of the concept *social affordances*. Social affordances are defined as possibilities for social interaction offered by an environment (39), in this case a heterospecific one, due to the animal presence in the group setting. When operating with the social affordances concepts, various authors, see for example [(41, 42) cited in (39)] take into consideration the possibility that the intentionality of actions and the ability to understand the intentions of others are based more on primary and sensorimotor processes than on specialized cognitive abilities. When an individual is observing another individual petting and/or playing with a therapy animal in the context of a group environment, the process of resonance *via* mirror neurons can be understood as part of an intersubjective perceptual process (43).

Corrective recapitulation of the primary family group and existential factors

The factor "*corrective recapitulation of the primary family group*" refers to the group experience as a familial unit allowing for relearning of unhealthy patterns learned and/or maintained in the family of origin. In our qualitative analysis, codes reflecting this factor were identified in two of the four AAI-group intervention studies included in the systematic review of O'Haire et al. (18). In the first study (S1), the codes included information such as: "*the participants' past and present relationships were explored, including their expectations, feelings, and behaviors*," and "*participants become aware of how their current relationship experiences may be closely related to events and situations faced during childhood*," while in the S4, the authors indicated that the activities with the animals allowed the emergence of *"patterns of thinking, reactions/responses to different situations and outcomes, and reactions to dynamics within the family group or within the group of participants*" (Table 2). Related to the factor mentioned above is the Yalom's group therapy factor "*existential factors*," which refers to the group as facilitating a safe environment for the members to confront issues on concerns of existence, e.g., isolation, meaninglessness, freedom, etc. This factor emerged in our qualitative analysis in one of the AAI-group studies (S1, Table 2), i.e., "*it was pointed out to the participants that their current relationships could be modified positively by building secure relationships...relationships of the kind that they had been able to develop with the animal and the therapist.*" This code was included in the "imparting information" factor, too.

Group cohesiveness

Even though the *Group cohesiveness* therapeutic factor was reflected by our content analysis in only one out of the four studies included in the systematic review, O'Haire et al. (18) did mention in the Introduction part that animals have been demonstrated to act as social facilitators that can connect people, thus helping individuals with PTSD to connect to other persons around them. The code reflecting this factor was attributed to the "altruism" group therapy factor, too, because it refers to the innate human interest and desire to interact with animals, which can promote nurturing behaviors and positive affects toward others (S4).

Conclusions

Based on the findings of the qualitative analysis aiming to identify codes reflecting Yalom's group therapy factors in four evidence-based AAI-group studies, we recommend that Yalom's group therapy factors be fostered in AAI-group interventions by offering information/ psycho-education to the professionals and to the group participants about the theories supporting the beneficial effects of direct contact with the animals and about the potential mechanisms of interspecific positive interactions, i.e., the recently published *Integrative Model of Human-Animal Interactions* [IMHAI; (39)].

The IMHAI provides an interdisciplinary conceptual framework for the study of interspecies interactions (including animal-assisted interventions), which is based ."..*on a systemic approach to the study of primary-process emotional affects during interspecies social interactions, through the processes of emotional transfer, embodied communication and interactive emotional regulation*" [IMHAI; (39)]. The authors specify that emotions can be generated in social contexts and that they have an important social dimension and a high communicative value [(44), cited in (39)]. In developing the IMHAI model, the authors have approached the primary emotions according to the individual's perception of the physical and social environment

in which the interactions are taking place. In social species, interactions with familiar individuals, that can be peers or family members (in this case, the other group members), are critically important to the healthy development and functionality of individuals (45, 46).

We consider that the interactionist approach to interspecies social phenomena offered by the IMHAI model represents an excellent connecting element of Yalom's group therapy model with the other explanatory theories of the beneficial effects of animal-assisted interventions, not only in terms of better understanding the mechanism of change, but also in terms of documenting and planning animal-related engagement (ARE) group interventions. Through this interactionist approach, SW students and practitioners can gain a valuable point of view where, according to Leconstant and Spitz (39), the basic unit of social analysis is not the individual action, but rather the system, in this case a heterospecific social system, formed by the set of actions that occur between individuals. The ways in which individuals respond to each other to generate a situation can be observed and analyzed from the perspective of Yalom's therapeutic factors.

It is important to mention that the authors of IMHAI point out that the communication process is considered "*as a global phenomenon and integrates all patterns of behavior that can have a communicative value, such as speech, facial expressions, gaze, gestures, interpersonal distance, etc.*" (39). Therefore, knowledge on the species-specific behavior of the animals included in AAI (e.g., type of social organization, body language, pacifying behaviors, etc.) is important to be considered in developing an interdisciplinary curriculum for the incorporation of animal presence in the education and practice of Social Work students. Moreover, any conceptual model referring to the mechanism of change in the area of animal-assisted interventions should include considerations of the positive and negative effects of the interspecific interactions on both humans and animals (2, 47), with clear references to investigations of the behavioral indicators of the wellbeing of animals included in AAI, as well as on the ethical standards associated with AAI in social work [e.g., (3, 48)].

A particular type of animal-assisted group intervention in which Yalom's therapeutic factors could serve as a guiding framework for SW professionals involved in the implementation of the interventions is represented by prison-based animal programs. The inclusion of animal presence in group therapy in criminal justice settings might foster a climate of social support among inmates and prison staff. In line with this, the interpretation offered by Allison and Ramaswamy (49) regarding the potential of AAI to strengthen the intersubjectivity between inmates and prison staff, including social workers, reflects some of the Yalom's therapy factors, such as hope, connectedness and interpersonal learning. The authors recommend that future studies on animal-assisted group therapy in prison settings should pay attention to standardizing procedures to measure empathetic alliances, connections to the therapeutic content and other motivational aspects related to the therapy process (49). These procedures could include questionnaires allowing the identification of the Yalom's therapeutic factors [e.g., (16, 50)].

Data availability statement

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

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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

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The impact on physical performance, pain and psychological wellbeing of chronic low back pain patients during 12-weeks of equine-facilitated therapy intervention

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Equine - Facilitated Therapy (EFT), an equine environment, and horses themselves can meet many physical and mental health needs beyond diagnostic categories. The horse's ability to produce a walk-like movement and the participant's ability to connect to non-judgemental living creatures, both of which can benefit participation and construct a positive self-image for chronic pain patients. The objective of this study is to evaluate the impact of EFT on perceived physical performance, level of pain, pain acceptance, depression and anxiety, and quality of life within a 12-week intervention for chronic low back pain (LBP) patients. Twenty-two LBP patients received EFT led by physical therapists as part of the public health services. A mixed method design combining quantitative and qualitative methods was employed to detect the outcome of the intervention. The data were collected *via* questionnaires, interviews, and patient data repositories. An interview was voluntary for participants and included questions of one's health, visits to the pain clinic during 6 months and an open-ended question about the intervention. The coding of the data was completed independently by two persons using thematizing. The welfare of the attending horses was taken into consideration in basic training and for the research setting. Statistical analysis and paired *t*-tests detected the changes during a 12-week intervention. The results suggest a significant increase in Canadian Occupational Performance Measure (COPM) levels of satisfaction with self-selected performances. The Raitasalo's version of Beck's Depression Inventory (RBDI) level of anxiety and Chronic Pain Acceptance Questionnaire (CPAQ) did not change, whereas a decline in the amount of perceived RBDI depression was found combined with increased levels of SF-36 Mental Change Scores and COPM satisfaction with performance. Only two of the 22 participants returned with reoccurring symptoms after 6 months to the pain clinic. The participant interviews revealed three important domains of experience during coding: physical-, psychological-, and social that link to the research question and suggest impact for the recovery from the human-animal interaction.

KEYWORDS

animal-assisted therapy, human-animal bonding, wellbeing, performance, mental health

1. Introduction

Pain-related fear may lead to avoidance of spinal motion for chronic low back pain (LBP) patients (1) and limit daily physical activities like social contact, self-care and communication (2). Avoidance of performance, high levels of kinesiophobia and irrational fear of movement cause further physical disability with elevated levels of pain (3) as fear motivates defensive responses such as escape from an external stimulus (4). Physical exercise is found to be the most effective treatment for the management of spinal pain, offering small to moderate short-lasting treatment effects (5). Additionally, medication is widely used to provide significant pain relief, and patients with prolonged pain tend to take multiple medicines (6). Management of life and pain (7) is important not only at the individual level but also economically at the society level, as the prevalence of low back pain, together with mental health and social problems is high (8). Psychological wellbeing is the connection between physical and psychological functioning (9), as cognitions and emotions play a significant role in the perception of chronic pain (10) and body awareness (11). Emotions are produced by processes which include emotional awareness, labeling, expression, processing, and integration influencing mental, behavioral and physical health (12). Sophisticated models recognize the brain as an organ where pain is modulated. It develops a basis of psychosocial and biological processes allowing individuals to experience and report somatic pain (13).

The process of learning cognitive, emotional, and environmental influences and experiences are key elements for a change (14), suggesting that chronic LBP is a multidimensional biopsychosocial problem including various factors, such as negative pain cognitions, pain-related fear and emotional distress, avoidance and protective behaviors in movement, and sleep problems (15). Physical exercise therapy is the most recommended treatment for chronic LBP if the patients are matched with the appropriate exercise and safety for recovery (16, 17). The recommendation for patients with chronic LBP who do not benefit from primary care treatment should be referred to interdisciplinary biopsychosocial pain rehabilitation in secondary care settings (15).

Therapy conducted with an equine is not usually the first recommendation of physical therapy for an LBP patient (18) despite history being rich with horses' curative effects (19). However, orthopedic hippotherapy has already been used as a conservative treatment for segmental instabilities in the lumbar section (20) as sitting on a moving horse has specificity for the exercise producing 100–120 walk-like movements per minute for the person sitting astride (21). Equine-facilitated therapy is more known as a treatment for balance (22), kinematics of walking (2), symmetry (23) and gross motor function (24) for neurological disorders. The treatment has been recognized for its psychological effects like the quality of life (25), a reduction in the amount of pain in LBP patients (26) also utilizing mechanical horse (27).

Companion animals (28) and connectedness to nature (29) have been found to affect human psychological, behavioral, physiological, and social wellbeing. Hypotheses about the psychological benefits of horses (30) have been published, as well as the effects on cognitive and psychological factors (31), and post-traumatic stress symptoms (32, 33). Finally, EFT treatment for anxiety disorders has been used for adults (32, 34) and youth (35).

Positive relationships between the service provider /therapist and horse, and systematic training of horses for working situations are crucial for successful equine-facilitated services. In addition to impacting the horse's welfare, these interactions based on positive contact seeking with humans can affect the safety of work and the horse's contact-seeking with humans (36). For the horse to become a reliable and safe companion curiously seeking contact with the patient in the rehabilitation process the equine training needs to be based on continuous positive interactions and applying equine learning theory (37, 38). Negative affective states, inability to understand equine behavior and equine suboptimal living conditions not only play a great role in horse-related injuries and fear but can also hinder the horse's willingness to make contact with people (39).

The aim of this study is to evaluate the effect of a 12-weeks Equine-Facilitated Therapy intervention on chronic LBP patients' self-assessed functional impairments, wellbeing and pain. The hypothesis is that a 12-weeks intervention of EFT can relieve the amount of perceived pain and increase wellbeing and functional abilities of a chronic low back pain patient.

2. Materials and methods

The mixed methods design of the study was kept as close as possible to everyday clinical practice for LBP patients in EFT to ensure the replicability of the study. Quantitative and qualitative data were collected from the participants, who serve as their own controls. Measurements were taken before, during and after 12-weeks intervention. Final data collection, consisting of participant interviews and hospital data repository documentation, was completed 6 months after the treatment.

2.1. Participants

Twenty-seven subjects (4 male, 23 female), with a long history of clinical treatments for pain and decreased ability of daily functioning and working, were recruited by collaborating public hospital units. Participants that received a payment plan were pre-screened for any condition that might affect attending the intervention. The inclusion criteria were chronic low back pain within diagnosis groups ICD-10; M51.1-M54.5, and the exclusion criteria were acute spinal cord inflammation. One participant with primary diagnosis of multiple sclerosis was not included in the study, though did receive rehabilitation according to the payment plan. One participant did not show up and two participants withdrew during the intervention. The participants were informed of the study and signed a consent form. The study has ethical approval to perform a multiple center study (Dnro658/130100/16) from the Northern Ostrobothnia Hospital district and complies with the declaration of Helsinki.

2.2. Horse

Even though the horses already had experience working with humans and being ridden, a preparation to ensure the safety of the participants and the welfare of the horses was completed over 2014–2015. The horses were trained by applying learning theory into practice (40) (i.e., by gradually habituating to the equipment, humans and study place): shaping the responses to leading aids through negative (pressure and release) and positive reinforcement (e.g., food and scratching). The horses involved in the intervention were selected (41) according to the type of work they perform with the service provider. For this study, they were trained to work in a physical therapy setting, for example, to being accustomed to the patient's muscular imbalance. Additionally, the horses were accustomed to people entering and exiting the arena by opening revolving doors, filming and another horse (both familiar with each other) moving in different directions or staying in one place in the indoor arena.

2.3. Intervention

The intervention and outcome measurements were completed in two EFT centers in 2016–2017. Phone interviews were conducted on 22 (4 male and 18 female) participants and hospital patient data collected on visits to the rehabilitation or pain clinic.

The intervention consisted of 12 weekly EFT sessions. Given a delicate consideration of pain and its prolonged state, the exercise load (sitting on a moving horse) was increased systematically from 10 to 30 min: The first four times consisted of 10 min, next four times 20 min and last four times 30 min. During the first session, the patients were allowed to choose between two horses and equipment, both of which were pre-selected by the session leading therapist as the most suitable for them. The participants came to each allocated therapy session in pairs to encourage the social support of a "group". The intervention was led by two physical therapists with a certificate in EFT and a long history in rehabilitation work. The indoor arena session consisted of two units: two participants, two therapists, two horses and two therapy assistants. Direct communication stayed within each unit, though all parties were aware of the other unit working in the same area. Although the session consisted of two units, they both worked independently.

Every participant had five humans and two horses to be attentive to and each horse had six humans and another horse to observe. Each unit had 12 lateral, horizontal or diagonal verbal and non-verbal communication lines, as shown in Figure 1. The communication from the horses toward humans was non-verbal. Psychoeducation was completed in the form of multimodal feedback. The therapist used visual, vocal, kinesthetic and tactile feedback to interpret her analysis of the patients embodied understanding of the movement dialogue between the horse and the rider (42). The therapists filmed participants at the beginning and end of the intervention and interpreted from the together viewed video their walk and sitting posture on the horse. The indoor arena also had mirrors at the end and sides of the arena to view one's own posture during the exercise.

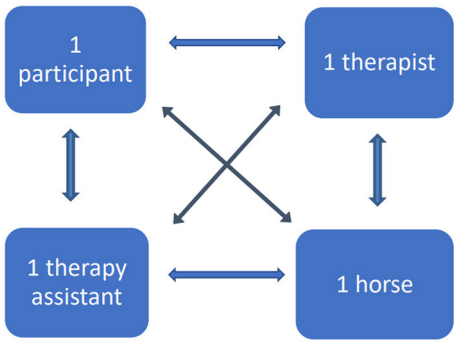

FIGURE 1
Single unit dialogue directions: The verbal and non-verbal communication lines. In the figure horses uses only non-verbal communications whereas all other are able to use both verbal and non-verbal communication simultaneously.

2.4. Data collection

The perspective of a patient is a core component of evidence-based practice (43). Questionnaires were completed pre- and post-intervention, an interview as well as the patient data repository visit were compiled at the end and a numeric rating of the amount of pain was collected twice every session to measure the possible effect.

2.4.1. Questionnaires

The participants answered the questionnaires at home before they came to the first session of the intervention and after the last one. Questionnaires containing prefilled envelope and stamp with return address for the researcher were sent to the participants by mail. Performance rating with the help of an occupational therapist was completed on site at the stables.

Canadian Occupational Performance Measure (COPM) (44) helped participants to recognize and rate self-selected items (2–5) of daily functioning and satisfaction with functioning with numbers from zero to ten (0–10) (items that the participant wanted to do, those they needed, or were expected to do but could not do, and those they did not do or were not happy with how they did them). The bigger the number given, the higher the participants rated their functioning and satisfaction with functioning.

The quality of life - questionnaire (SF-36) was self-administered by the participants. The 36 -item pre-coded survey assesses the following eight health concepts: (1) limitations in physical activities because of health problems; (2) limitations in social activities because of physical or emotional problems; (3) limitations in usual role activities because of physical health problems; (4) bodily pain; (5) general mental health (psychological distress and wellbeing); (6) limitations in usual role activities because of emotional problems; (7) vitality (energy and fatigue); and (8) general health perceptions (45). SF-36 results are significant when at least one of the subdomain scores reports a statistically significant result in favor of the experimental intervention (46).

Similarly, the short version of Beck's depression questionnaire (R-BDI) (47) is a self-reported test consisting of 21 items on physical, behavioral and cognitive symptoms of depression from

mild to severe (0–63 scores). The form is internationally validated to indicate depression. The questionnaire contains one question of anxiety that is not used to calculate the depression index. Scores between 0 and 13 indicate no or minimal depression, 14 – 19 mild depression, 20 – 28 moderate depression and 29 – 63 severe depression (48).

Chronic Pain Acceptance Questionnaire (CPAQ) (49) evaluated self-reported chronic pain acceptance with two subscales and is valid and reliable to detect rehabilitation outcomes. The survey reflects on "Activity Engagement", or the pursuit of life despite pain (scale 0 – 66) and "Pain Willingness", a lack of effort to prevent or control pain (scale 0 – 54) (48).

2.4.2. Unidimensional measure

The numeric rating scale (NRS) was used to verbally indicate the amount of pain experienced by each participant at the arrival to each session and shortly after descending from the horse. On the 11-point numeric scale, 0 represents "no pain" and 10 "worst pain imaginable" (50).

2.4.3. Interviews

A semi-structured follow-up interview was implemented six months after the intervention to supplement the patient data repositories and record patient experiences of the intervention (51). The follow-up interview was voluntary and conducted by the researcher who was not steering the practical sessions of the intervention to remain neutral. Answers were collected on 1 day and the phone call lasted between two and 15 min depending on the individual's verbal expression. The interviews were written records of a completed oral discussion. The questions included, "*How have you been since the intervention?"; "Have you visited the pain clinic since the intervention?" and "What would you like to say about the intervention?".*

2.4.4. Patient data repository

Access to the hospital patient data repository was granted to the sending hospitals with a contract. The researcher secured an identity card with limited access to rehabilitation and pain clinic patient data repositories. The search was limited to the relevant ICD-10 diagnosis or pain symptom in the lumbar area that prompted the participant to join the intervention. The findings were documented at the hospital archives room in the presence of an archivist. A code of visit for each patient data was reported as "for the research intentions" with a date and a timestamp. Patient data repositories were visited within a week of the interview.

2.5. Statistical analysis

Paired *t*-tests were estimated using IBM SPSS 27.0 (IBM, Armonk, USA) to analyze the difference between the beginning and end measurements of the intervention and to show the outcome results of the rehabilitation. *P*-values < 0.05 were considered significant. The effect size was measured with Cohen's *d* also reporting the lower and upper confidence interval (52). A value of 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and above a large effect size. Pearson's correlation and Kendall's tau was performed on COPMs. A value >0 indicate a positive association between two variables.

2.6. Qualitative analysis

The analysis of interviews is qualitative and the content of the interview was independently reviewed by the first and last author of this article. The themes were analyzed and thematized into groups. Two sets of analysis were united into one convergent result highlighting the main themes and conditions that generated these themes at the individual and group level (53). Visits to the rehabilitation or pain clinic were counted of 22 participants patient data repository entries and compared to the data received from interviews.

2.6.1. Final analysis

The final analysis of the results was completed by uniting qualitative and quantitative data together to validate different sources of collected information.

3. Results

The results are listed below according to the method used to detect the outcomes of the intervention. These first lists (4.1–4.5) the results of measured and statistically analyzed questionnaires and second reports the (4.6–4.7) analyzed data.

3.1. COPM

Canadian Occupational Performance Measure was used to measure those performances (d1) of daily life the participants wanted or needed to do but couldn't to their satisfaction (d2). The 22 participants selected altogether 106 important performances (2 - 5 self-selected items/participant). The most identified (20 times) within the group of participants were "sleep and sleep-related items", like falling asleep and continuous sleeping without waking up ($p = 0.037$, d1 = 0.96 and d2 = 0.55). Tasks that require "reaching and bending forward" (d1 = 1.92) like vacuuming and lifting objects from the floor were identified second most (18 times). "Sitting for a long time", for example in the car or at work, was identified 15 times, and satisfaction with sitting related functions was found significant ($p = 0.037$, d1 = 2.13 and d2 = 2.02). "Standing for a long period of time" in various everyday work and home situations was identified 10 times, and satisfaction with standing related functions was found significant ($p = 0.039$, d1 = 0.58 and d2 = 0.54). The rest of the identified items were selected under 10 times and were: performances needing "walking" (walking with a dog or to a shop) (d21 = 0.75); "Carrying, lifting and moving heavy objects needing power/strength", for example carrying a bag from a shop and shoveling snow or working in the garden; "other exercise" like walking, running or skiing; "participation in free time activities" like hunting, dancing, concerts and reading; "taking part in social events" like hiking and meeting relatives, and "starting

TABLE 1 Canadian Occupational Performance Measure (COPM) $n = 22$.

Domains of performance selected	p-value	Effect size, Cohen's d	Confidence interval	
			Lower	Upper
Sleeping related functions ($n = 20$)	0.237	0.96	−0.22	0.90
Satisfaction with sleeping rel. func.	0.037	0.5	0.04	1.24
Bowing and reaching functions	0.058	1.92	−0.02	1.11
Satisfaction with bow and reac. function	0.119	0.45	−0.11	0.99
Sitting related functions	0.062	2.13	−0.30	1.20
Satisfaction with sitt. rel. func.	0.037	2.02	0.04	1.31
Standing related functions	0.373	0.58	−0.92	0.35
Satisfaction with stand. rel. func.	0.039	0.54	0.04	1.46
Walking related functions	0.838	0.28	−0.56	0.69
Satisfaction with walk rel. func.	0.138	1.75	−0.16	1.12

Significant at the 0.05 level. Effect size value 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and larger a large effect size.

movement having been static" like sitting or lying down. The results are presented at Table 1.

The findings indicate that a positive change in self-selected items of performance and satisfaction with performance have a strong correlation (Pearson, $r = 0.900$, $p < 0.001$). The COPM measurements was tested again with Kendall's Tau τb. A strong association ($\tau b = 0.677$, $p < 0.001$) between COPM performance and satisfaction with performance was detected with Kendall's Tau.

3.2. SF-36

From the 36-item health survey, an increase was detected at a group level in general health (from 44 to 48%), physical functioning (from 55 to 57%), physical role functioning (from 39 to 52%), emotional role functioning (from 56 to 65%), vitality (from 48 to 51%), social functioning (from 66 to 71%) and bodily pain (from 39 to 41%). Mental health scores (MCS) indicated significant increase in mental health ($p = 0.001$) (Table 2).

3.3. RBDI

In the beginning, eight participants indicated no or minimal depression; this number increased to eleven (from 38 to 53%) by the end. The number of participants with mild depression changes were noted from six to four participants (from 29 to 19%), moderate depression changed from five to four (from 24 to 19%) and the number of severe depression participants stayed at two (9%). The sum of group-level points decreased from 150/1323 to 121/1323. Anxiety in the group level decreased from 15/63 to 12/63. The total scores detected significant change ($p = 0.014$) (Table 3).

3.4. CPAQ

Physical functioning increased in the group level from 54 to 58 points, however the mental functioning indicated pain acceptance decreased from 40 to 35. The total score for chronic pain acceptance increased from 46 to 48. The chronic pain acceptance questionnaire showed no statistical significance (Table 4).

3.5. NRS

A numeric rating scale for the amount of pain was analyzed considering the exercise length of time (from 10 to 30 min). The amount of pain decreased with the increase of the load and progression of the intervention. The decrease in the amount of pain during the intervention was found significant ($p = 0.050$, $d = 0.74$). Exercise response was found most significant following 30 min on horseback (Table 5 and Figure 2).

3.6. Interviews

The participants answers revealed that they experienced a decrease in pain during the intervention with elevated levels of performance. The support of the units during the sessions had built a safe space and trust for rehabilitation. They also felt more self- confident adding daily physical performance and grew more satisfied with performance. The participants were not diagnosed with mental health problems, but answers reveal that the intervention helped their mental health. Three main themes were detected in line with research question: physical (Figure 3), psychological (Figure 4) and social themes (Figure 5).

3.7. The patient data repository

Reviewing the patient data repositories revealed that only two of the 22 participants had visited the health care center, with the same problem for which they were sent to the EFT intervention for during the 6 months after the intervention had ended.

TABLE 2 Quality of life questionnaire SF-36, $n = 22$.

Domains of questionnaires	*p*-value	Effect size, Cohen's *d*	Confidence interval	
			Lower	Upper
Physical Change Scores (PCS)	0.131	0.23	−0.10	0.76
Mental Change Scores (MCS)	**0.001**	0.36	0.30	1.26

Significant at the 0.05 level, marked bold. Effect size value 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and larger a large effect size.

TABLE 3 RBDI: Short version of Beck's depression inventory by Raitasalo, $n = 22$.

Domains of questionnaires	*p*-value	Effect size, Cohen's d	Confidence interval	
			Lower	Upper
Depression	0.056	0.27	−0.87	0.01
Anxiety	0.329	0.16	−0.63	0.21
Total Score	**0.014**	0.22	−1.02	−0.11

Significant at the 0.05 level, marked bold. Effect size value 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and larger a large effect size.

TABLE 4 Chronic pain acceptance questionnaire, CPAQ, $n = 22$.

Domains of questionnaires	*p*-value	Effect size, Cohen's d	Confidence interval	
			Lower	Upper
Physical functioning	0.07	0.16	−0.40	0.81
Mental functioning	0.738	0.06	−0.35	0.49
Total Score	0.113	0.13	−0.08	0.78

Significant at the 0.05 level. Effect size value 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and larger a large effect size.

TABLE 5 Numeric rating scale (NRS) exercise response vs. amount of perceived pain, $n = 22$.

Exercise Time on Horseback	*p*-value	Effect size, Cohen's d	Confidence interval	
			Lower	Upper
10 min	0.712	0.08	−0.34	0.50
20 min	0.381	0.08	−0.61	0.23
30 min	**0.032**	0.74	−0.93	−0.04
Total	0.050	0.63	−0.67	0.18

Significant at the 0.05 level. Effect size value 0.2 represents a small effect size, 0.5 a medium effect size and 0.8 and larger a large effect size.

4. Discussion

The aim of this study was to evaluate the effect of 12 weeks Equine-Facilitated Therapy intervention for chronic LBP patients' self-assessed functional impairments, wellbeing and pain. The participants served as their own controls in the 12 weeks intervention. The material was collected pre- and post-intervention added with a control in the form of interviews and archive search 6 months after the intervention. The results indicate the primary outcome was a strong correlation between performance and satisfaction with performance. Secondarily, the mental health scores and quality of life improved. Thirdly, the total score of depression inventory decreased. In the study completed by Ojala et al. (54) participants indicated pain to be "the phenomenon that affects the whole person". Health-related follow-up information from the interviews, which came directly from the patient, were found to contain themes that the participants had started to process during the intervention. The comments of patient interview are written in italic and tied to the measured results and previous research in this field.

4.1. Physical themes

4.1.1. Amount of pain

The International Association for the study of pain has revised the definition of pain to be multifactorial: biological, psychological and social factors that contribute to the pain syndrome (55). In this study, the amount of pain was reported twice during every session (24 times), and pain acceptance using the CPAQ and bodily pain using the SF-36 were collected before and after the intervention.

The follow-up interviews revealed a long-lasting effect on the patients; *"I have had no symptoms of low back pain after the intervention"*. The patient data repositories complimented this finding: only two of the 22 had returned to the rehabilitation or pain clinic after the intervention. From the socioeconomical and

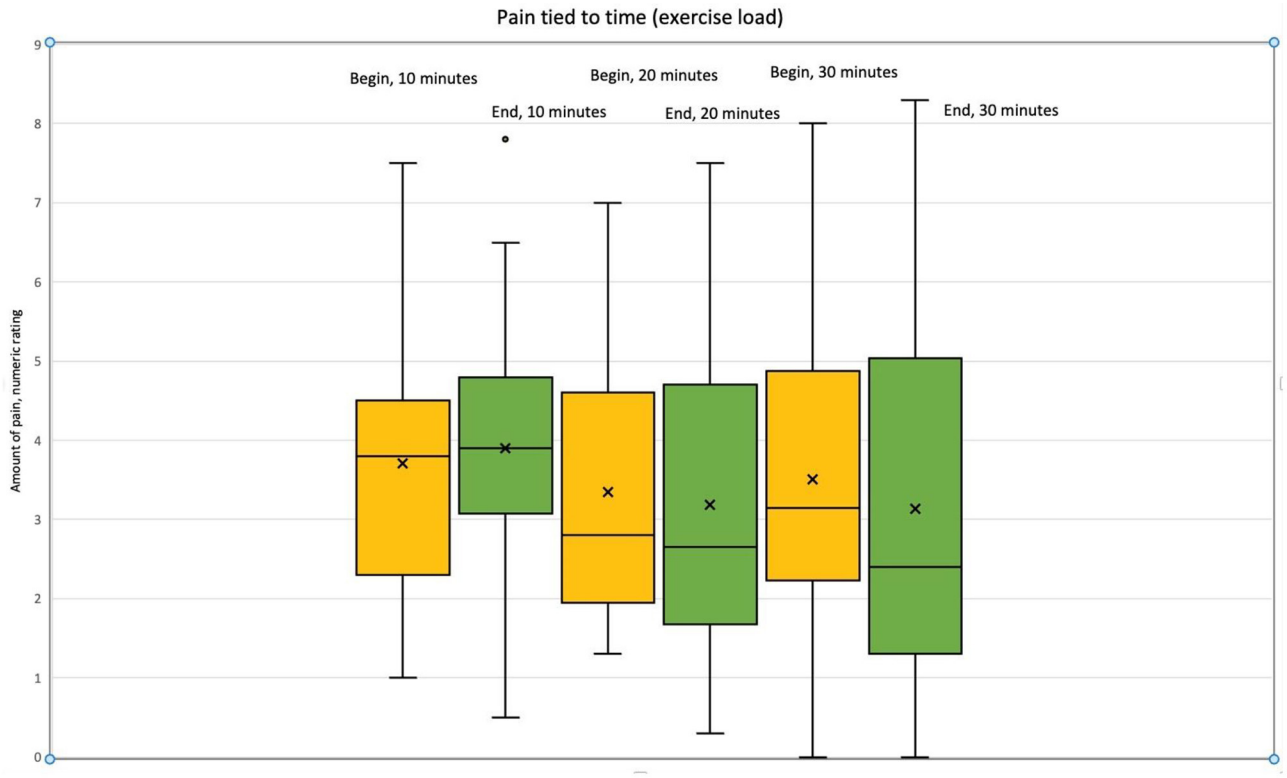

FIGURE 2
Exercise vs. pain chart.

individual level, managing life and pain (7) is important, and the findings of the study corroborate this: "*Because of the therapy intervention, I have started to move more, and that's why I have more pain*".

A change in the finding of prolonged use of generic medication (6); "*I use less painkillers*" is individual, although the group level finding suggests that the increase in exercise load from 10 to 30 min was decreasing the amount of perceived pain and intake of medication. Even if the optimal time was found to be 30 min, the exercise load for the LBP patients must grow gradually. The turning point for average pain intensity seemed to be 20 min on the horseback and 5–8 weeks of intervention. This needs further research.

4.1.2. Physical performance

External stimulus, like moving a body part that is painful, is generally avoided (4). Although, sitting on a moving horse and receiving 100-120 walk-like movements (21) was endorsed: "The movement felt good - the horse moved me correctly" and "There is no other way that exercises me like this". The participants accepted one horse's walking phases correlating to own body movement (56) better than the other; "One horse felt good and other made my pain worse." The ability to connect professional's and patient's expertise in the selection of the horse and equipment seems to be important in pain - related rehabilitation. The "Warmth of the horse" has been found to be 1.5 degrees higher than in humans and affects muscular tone (57). It may have influenced a COPM measured stationary performance, Sleeping related functions, selected considerably frequently 20/22 amongst the participants. Sleeping quality is not an indicator for decreased amount of pain, however having an association between sleep quality, low back pain and disability (58) and an association between sleeping problems and the intensity of chronic pain (59) has already been found.

A movement dialogue between the patient and the horse is the primary interest in EFT from physical therapy perspective. Psychoeducation for the participants through video gave visual feedback of bodily movements (60)in walk and sitting on the horseback. Especially the movement that the horse produced for the LBP patient; "*I didn't know my back could move that much*" seemed to be important psychoeducation to overcome the fear of movement.

EFT is reported to increase postural balance and to improve everyday performance (61). "*Increased balance*" was supported at the patient interview with the increase of COPM daily performances: bowing and reaching, sitting, standing and walking. Kinesiophobia, irrational fear of movement motivates defensive and avoiding behavior toward exercise and everyday performances with elevated levels of pain (3);"*I have been afraid of pain getting worse*". The results suggest small increase to physical functioning according to SF-36 Physical Change Scores and CPAQ. An interest toward interventions is increasing where one's awareness, acceptance, internal experiences, and physical sensations are enhanced (12).

FIGURE 3
Physical themes.

4.2. Psychological themes

People with elevated pain-related anxiety and fear avoid activities that may be important to recovering (1). *"Feeling successful"* reveal the developing emotional self-competency. Emerged sentences; *"Content with life"* and: *"Positive experience"* might be indicators of emotional awareness and comply with Lumley et al. (12) research of emotion producing (12) and are supported by elevated RBDI depression and SF-36 Mental Change Scores indicating better mental health. Nevertheless, RBDI anxiety and CPAQ mental functioning address the opposite. The satisfaction with performance measured with COPM was evidenced more often significant than the performance tied to the satisfaction.

Positive emotional states generally reduce pain (62). The EFT intervention seems to have started emotional processes and created *"Safety"*(17) and *"Helped me mentally"* for the recovery. The interview reveals that the presence of the horse in the rehabilitation made the difference (63) for bonding *"At first I was scared but I learned to trust my horse"*, *"Mentally calm feeling and a feeling that the horse is listening"; "Being one with a horse is important to self-image"* (64) *"Me relaxing- horse relaxing"* (64) that are connected to the descriptions of human-animal attachment theories.

4.3. Social themes

With the horse and in the context of EFT as a form of physical therapy, assistant is utilized to provide best practice for the rehabilitation. This setting formed a unit of four (participant, horse, therapy assistant and therapist) living creatures where communication, verbal and non-verbal, was one of the key elements in the patient's experience of rehabilitation. As two same working units were present in the indoor arena; *"The created group effect was a positive experience"* and *"I miss riding and the group"*. The communication flew into 12 different directions allowing:*"Environment and social contact for the staff and horses"*. As the pain affects social interaction (2) and the patients feel isolated from normal daily activities and helpless because of the lack of physical performance;*"Always someone to help me"* supported the rehabilitation. These interview findings are supported by the results of SF-36 "limitations in social activities because of physical or emotional problems". The intervention also added knowledge to the participants of themselves and their bodily movements, giving them confidence to perform physical activities and be satisfied with them enough to take part in social activities.

During the intervention the patients got to know the horses they had chosen as their therapy horses. A bonding and trust between the participant and the horse in therapy (65, 66) and *"I miss*

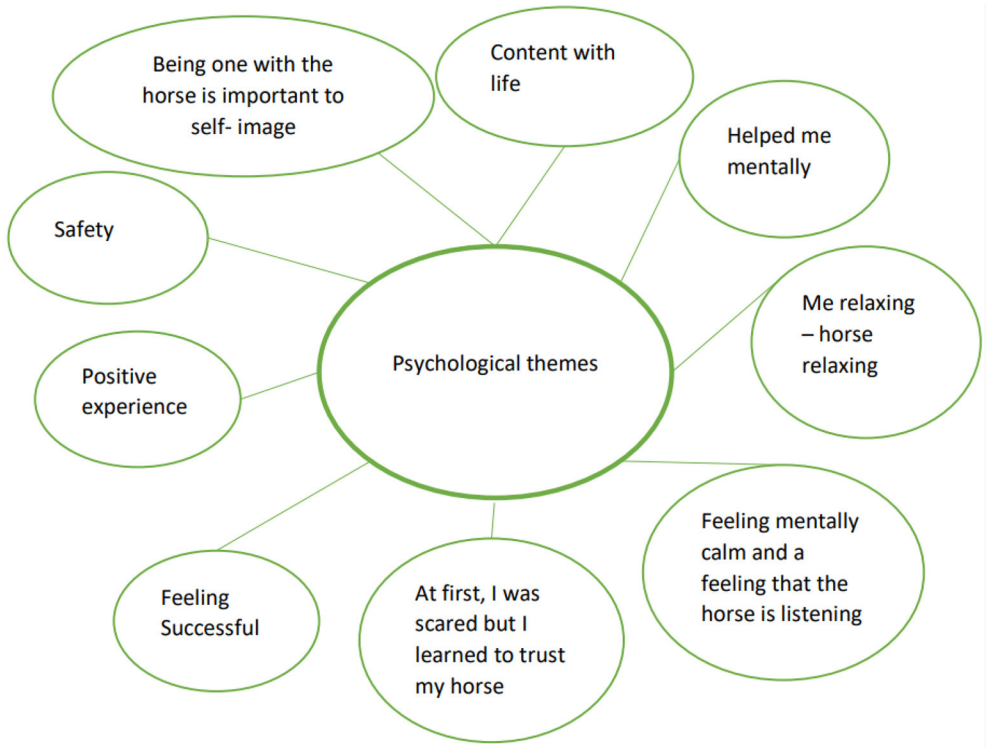

FIGURE 4
Psychological themes.

FIGURE 5
Social themes.

Allu (name of the horse)" was recognized through the participant interveiw. Vice versa, as the horses became accustomed to the work, trusted the therapy assistant and the therapist, working was made predictable and safe, building a collective trust within the session (67).

4.4. The horse

We wanted to express the timely discussion of equine welfare in Equine - Assisted Interventions. If the welfare of the horse is not considered at the rehabilitation process, the justification of

the use of the horse is not possible. Through careful selection of the horse (41) to be trained, and a proper training (40), EFT as a rehabilitation method can be beneficial reciprocally (68). The movement of the horse (21) added with the contact (36) between the patient and a horse, as well as the social support of the units during the sessions was found important for the participants during their recovery process. Some results, obtained with solely having the living creature, horse, present at the rehabilitation process might have been unattainable using electronic device as a substitute. The nature, natural bonding and equine environment have been found advantageous during the procedure (69).

As the field of Equine - Facilitated Interventions (EFI) has been growing rapidly not only terminology (70) but also variability in the levels, content and access to education bring complexity for service buyers, customers, service providers and horses affecting the brand. Recently ended EU-project: "Equine - Facilitated Interventions - Education" brought together five partners sharing the key elements of their education curricula which formulated the base of the results of the project leading to uniformity in EFI education. Another EU-project concentrating in equine training for different EFI disciplines will be completed with results of training consensus.

4.5. Strengths and weaknesses of the study

The strength of this study is that two of the authors work providing EFT, and one has been training therapy horses. Using several variables, both objective quantitative and subjective qualitative methods enable versatile interpretation of the 12 weeks intervention outcomes. The recruitment through public health care made the participants equal from medical and economical view. All collected and analyzed data point to the same direction of outcome and is connected to formulate a broader understanding of the rehabilitating effect of the horse.

Even though CPAQ did not detect acceptance to pain on the group level, it revealed differences in individual level, seen in the range of confidence interval. The COPM measurements helped the participants to identify the performances and satisfaction with performances of daily living that correlated in the statistical analysis. As the occupational therapist that had training for the COPM measurement, we believe objectivity within the data collection.

The study has limitations which should be considered when interpreting the results. Small sample size and lack of a control group are weaknesses. Other instruments could have been more relevant to use and midterm measurements could have provided us with more data. Repeated questions of pain twice every session may have led to unintended focus on pain and contradictory to the participants acceptance. Deeper interviews would have provided more qualitative data. This will be considered in future studies.

An important factor in considering strengths and weaknesses in this study is that the researcher assumed the intervention to produce mainly physical outcomes for the chronic low back pain patients. However, the byproduct caused by the interview 6 months after the intervention turned out to be core element of the study. The importance of human-animal interaction with meaningful experiences in physical, psychological and social domains became visible in the interview, shown in Figures 3–5.

In the future, a study where multi-professional team: Equine Facilitated therapists with mental and physical competence, with the horse and assistant is recommended. A longer intervention, repeated re-evaluated measures, psychoeducation and better prepared interview with control group receiving standard care, would produce more information for EFT as a rehabilitation and support recovery of the LBP patients.

5. Conclusions

The objective of this article is to evaluate the impact of EFT on perceived physical performance, pain and psychological wellbeing for 22 chronic LBP patients. Given the prolonged nature of the pain in the patient group the rehabilitation process of 12-weeks is considerably short. However, this study presents a mixed methods study where triangulation of data demonstrates how results from many sources, with only few significant changes give evidence for a successful treatment modality. The unique contributions from horses are presented from the data obtained.

The communication flow within the unit in the sessions, both verbal and non-verbal encouraged learning in performing physical daily activities, understanding bodily movement and self – confidence in the chronic LBP patients. Additionally, these participants have added knowledge to their ability to take part in social activities.

"*I would recommend it to other low back pain patients*" highlights a feeling of a participant for nature based active rehabilitation (69). Our suggestion is to continue with these chronic pain patients' themes, which would include psychotherapeutic exercises and elements that target pain management, mindfulness and self-compassion together with movement training.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Northern Ostrobothnia Hospital district. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

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

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Publisher's note

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Mixed-reality-based human-animal interaction can relieve mental stress

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Introduction: Interacting with animals has been demonstrated to possess the healing benefits to humans. However, there are limitations in physical interaction due to COVID-19 and safety issues. Therefore, as an alternative, we created mixed-reality (MR)-based human-animal interaction (HAI) content and experimentally verified its effect on mental stress reduction.

Methods: We created three types of interactive content: observing the movement of a non-reactive virtual cat, interacting with a virtual cat whose responses can be seen, and interacting with a virtual cat whose responses can be both seen and heard. The experiment was performed by 30 healthy young women, and a mental arithmetic task was used to induce mild mental stress before experiencing each content. During the experiment, the subject's electrocardiogram was continuously recorded, and the psychological state was evaluated through a questionnaire.

Results: The results showed that MR-based virtual cat content significantly reduces mental stress and induces positive emotions after stressful situations. In particular, when the virtual cat provided audiovisual feedback, the activation amount of the parasympathetic nervous system and the increase of positive emotions were the greatest.

Discussion: Based on this encouraging research result, this method should be further investigated to see if it can replace real HAI for human mental health management.

KEYWORDS

human-animal interaction, mixed reality, virtual animal, mental healthcare, stress relief

1. Introduction

Human-animal interactions (HAI) have been studied over the past two decades to assess their therapeutic value. Since there is a strong bond between humans and animals, interactions with animals are widely believed to reduce human anxiety, loneliness, and depression, thereby reduce severity of diseases and relieve stress (1). The Animal Visitation Program (AVP) is a program on nearly 1,000 U.S. university campuses that aims to reduce university students' stress caused by other factors providing them with the opportunity to interact with real animals such as cats and dogs (2). In the previous studies, the AVP has demonstrated its effect of relieving the perceived stress momentarily (3, 4), increasing the level of positive emotions, and decreasing the level of negative emotions (5).

However, one study highlighted that real HAIs can cause animal welfare problems. Some dogs participating in AVP exhibited stress behaviors such as lip licking and yawning (6). So while HAIs may provide healing effects in humans, they may also increase stress in animals. In addition, there are several limitations to supporting HAI in universities, such as allergies to animals, safety issues, and a lack of space. In addition, face-to-face activity has been greatly reduced due to COVID-19, and HAI has become more difficult due to the risk of contagiousness from contact with the same animal. To overcome these limitations, interactions with virtual animals can be considered an alternative to interacting with real ones.

Our previous study first investigated whether a stress-relieving effect could be observed even by replacing a real animal with a virtual one. To this end, the physiological and psychological responses of participants were compared after interaction with a virtual cat and after viewing photos of real cats. Surveys and electrocardiograms (ECGs) showed that interactions with virtual cats can reduce negative emotions and induce positive emotions in users in stressful situations (7). However, it was not clear whether the resulting effect was directly due to the interaction. Since many participants were unfamiliar with the experience in a mixed environment, proposed MR content may have had a greater effect compared to viewing static images. This study aims to understand how the stress-relieving effects of virtual cats are caused by diversifying the interaction types. MR content without interaction was set as a virtual cat moving alone, while MR content with interaction was set as a virtual cat interacting with the user and reacting in various ways according to the user's commands. Moreover, unlike the previous study, the virtual cat's auditory feedback was added for a more realistic interaction, and the virtual cat's reaction in the interaction condition was divided into visual-only and audiovisual. The stress-relieving effect was observed by the survey and heart-rate variability (HRV) from ECGs. HRV analysis specifically focused on the mean HR (Heart Rate; average heart rate). We hypothesize that this approach will lead to a more detailed understanding of which aspects of interactions with virtual animals cause stress-reducing effects.

2. Related works

Lin et al. reported that pet games can provide emotional support through interaction with virtual pets, without involving animal-related issues such as allergies (8). It was also noted that interactions with virtual pets can have the effect of promoting collaboration, and empathy for users. Norouzi's study found that walking with an AR dog affects a user's walking speed, passing distance, and head rotation. In particular, it was found that if an AR dog reacted to a collision with another person, it increased the user's co-presence and had a positive effect on the user's behavior (9). Furthermore, some other studies have shown that interactions with virtual animals can improve the academic performance of students and have positive effects on their physical activities. One study designed and built a mixed reality system for children to train and play with virtual pets (10). Interactions with virtual pets have succeeded in motivating the treatment groups for physical activity, demonstrating the real potential of mixed reality to influence motor behavior in children. Another study linked a user's daily steps to the growth of a virtual fish in a fishbowl to encourage more physical activity (11). They also succeeded in improving their physical activity through collaboration and competition with other users. Finally, there was a study that showed that animals play various educational roles in a digital environment, helping children to motivate, reflect, and interact with members (12).

Unlike the existing entertainment platforms, augmented reality (AR) and mixed reality (MR) techniques will allow virtual animals to coexist with humans in the real world. MR glasses allow users to interact with virtual animals in the real world. Additionally, the graphical representation of virtual animals can provide users with more advanced graphics and an appearance that resembles real animals compared to robots and desktops used so far (13). The presence or absence of an animal reaction to the user's actions may also have an effect. In one study, to solve a mathematical fraction problem, an interactive virtual reality learning activity was compared with learning by observing the learning of a robot without interaction. The average number of correct answers was slightly higher for interactive learning activities (14). Also, a user's emotions may vary depending on whether an auditory sound is included. One study demonstrated that the effects of sounds from nature and footsteps induced by user movement have statistically significant effects on presence and the feeling of "being there" (15).

3. Program design and implementation

3.1. Platform overview

Microsoft HoloLens[1] is a pair of 3D holographic glasses that can recognize and utilize the surrounding environment through spatial feature point extraction methods with a central processing unit (CPU), graphics processing unit (GPU), and holographic processing unit (HPU) (16). Its superior features over traditional AR devices include a stereoscopic 3D display, gaze control, gesture control, spatial sound development, and spatial mapping (17). In order to create content for HoloLens, it is necessary to use the Universal Windows Platform (UWP). Unity is a platform that supports the UWP and integrates and links component assets used within a project, such as 3D objects, and audio (18). Furthermore, Microsoft recently restructured the Mixed Reality Toolkit (MRTK), a powerful SDK useful for developing applications for HoloLens (19). In this study, MRTK v2.4.0 was used to develop MR content. Virtual animals were animated and controlled within Unity through the use of C# using Visual Studio 2019.

3.2. Animations

Schwind et al. noted that if the virtual cat model was more natural, of higher quality, and had a less intimidating appearance, users could feel more comfortable with the virtual cat model and interact better with it (20). Considering this aspect, this study used the "Kitten (short)" asset[2] from the Unity Asset Store. Developers could manipulate the cat's behavior by animating its actions such as sitting, running, and jumping, based on various conditions. In this study, nine behaviors were constructed: idle, eating, walking, jumping, sitting, sleeping, running, lying down, and showing affection. The idle is a default state as shown in Figure 1. For each animation, a bool-type parameter was connected with the idle state that will control the transition. The virtual cat slept when the content started, went idle as soon as the user woke it up, and remained idle whenever the user isn't interacting with it. The parameter value was initialized to false which means to maintain idle. An animation was activated when its parameter becomes

1 https://www.microsoft.com/en-us/hololens

2 https://assetstore.unity.com/packages/3d/characters/animals/mammals/kitten-short-132026

FIGURE 1
The idle state of virtual cat.

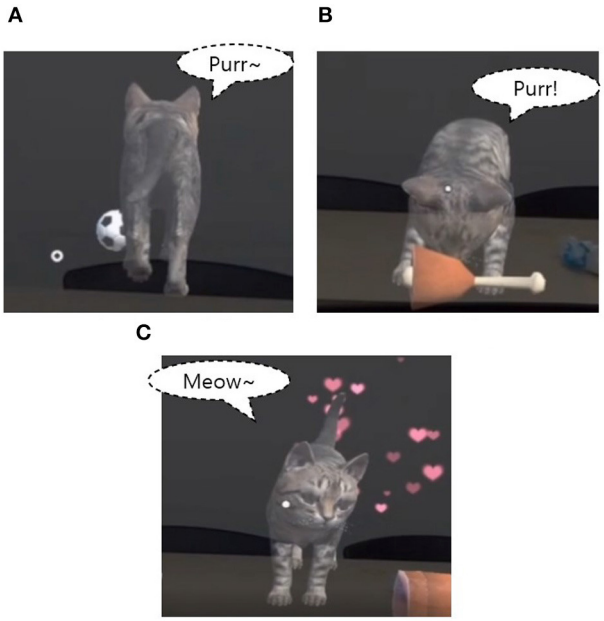

FIGURE 2
Examples of interaction with gestures. **(A)** Catching a ball, **(B)** feeding, and **(C)** petting.

true under the user's control. After the animation was finished, its parameter returned to false and the cat's state returned to idle. To ensure that the movement of the virtual cat was not interrupted, transitions connected in the direction of entering an idle state had a fixed end time.

3.3. Gestures

An MRTK profile for the HoloLens 1 version was created and the input action handler was used to recognize user gestures. In HoloLens, the air-tap is a gesture of gently bending the index finger as if tapping the air while clenching a fist with the back of the user's right hand facing upward. The MRTK input action handler recognizes this gesture as "Select." Interaction through gestures consisted of catching, feeding, and stroking the ball as shown in Figure 2. Additionally, in the audiovisual condition, cat sounds were added for a more realistic interaction. The sounds of the cat were not added for all gestures or voice commands, but sounds were added only in situations where the cat mainly made sounds by referring to actual cat videos. The cat sounds were selected from Free Cat Sound Effects.[3]

First, as shown in Figure 2A, when the user air-taps the ball, the cat follows the ball, bites it, and brings it back to the user. At this time, the sound of a cat excited while chasing the ball is played. Afterward, when the virtual cat bites the ball, the sound stops and the virtual cat runs to the user. For this animation, we implemented the code in C# to control the position, movement speed, and rotation of the ball and set it to be activated when the air tap is performed. The virtual cat rotates in the direction of the ball as it rolls and a "run" animation is activated to move along the ball's position. When the cat's position reaches the ball, the cat bites the ball and approaches the user's position. Also, when the cat returns to its original position, the ball is deactivated.

Next, when the user air-taps the fish or ham, the virtual cat is set to eat it gradually (Figure 2B). The fish and ham consist of four parts, time is allocated through the IEnumerator, and each part is sequentially deactivated to express the cat's gradual eating of ham and fish. When food is placed in front of the virtual cat, the virtual cat makes a hungry sound and starts eating, and returns to idle again when only the bones of the ham and fish are left. Also, the star-shaped particle effect spreads after the cat has finished eating, indicating that the cat likes the food.

Finally, the user can pet the cat. When the virtual cat is idle, users can air-tap the cat to make it feel good and cute. At this time, to express the cat's satisfaction, a heart-shaped particle effect is added and a cute meow sound is added (Figure 2C).

3.4. Voice commands

The game voice control plugin [4] is used to recognize the user's voice. In this study, four types of voice commands and interactions are constructed as shown in Figure 3. GameVoiceControl is loaded into the Hierarchy, English is chosen as a command language, and Commands are registered with the Textlog so the four words "ump," "Lie down," "Come here," and "Sit down" are recognized. A voice command is displayed and recognized in the Text object, and an animation is triggered when it matches one of the four commands. In the case of "Come here," the cat makes a happy sound as it approaches the user. When the motion is complete, the animation is disabled again and goes back to idle.

3 https://mixkit.co/free-sound-effects/cat/

4 https://assetstore.unity.com/packages/tools/audio/game-voice-control-offline-speech-recognition-178047

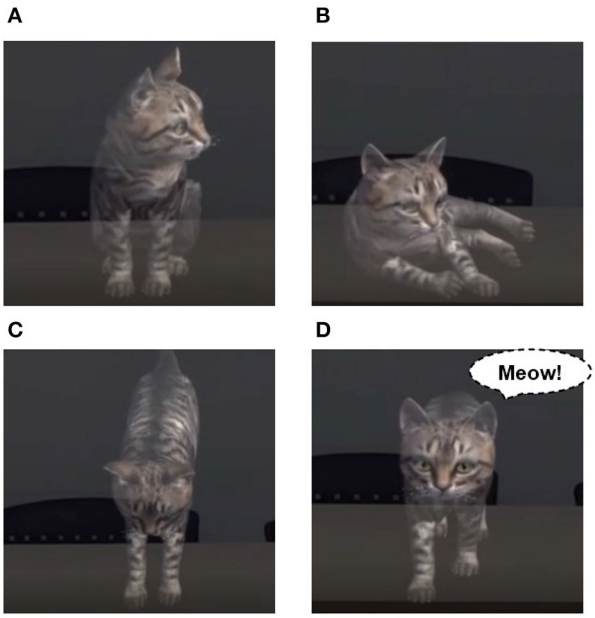

FIGURE 3
Examples of interaction with voice commands. **(A)** Sit down, **(B)** lie down, **(C)** jump, and **(D)** come here.

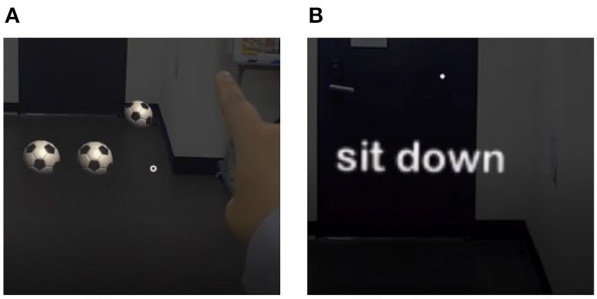

FIGURE 4
Scene examples of the tutorial phase. **(A)** Gestures and **(B)** voice command.

4. Experiment

4.1. Subjects

The experiment involved 30 healthy female adults in their twenties (mean (M) ± standard deviation (SD) age 22.07 ± 2.29). Subjects with a history of heart disease and neuropsychiatric disorders, those currently taking medications, pregnant women, or women about to become pregnant were excluded from the study. Additionally, subjects who normally wear glasses were asked to wear contact lenses in order to use HoloLens during the experiment. All experimental procedures involving human subjects were approved by the affiliated institutional review board (SMWU-2008-HR-073). The entire experimental procedure was introduced orally to the participants and written consent was obtained. All participants who took part in the experiment were given a monetary reward after the experiment was over. In addition, the experiment was conducted 1:1 with the experimenter and the subject in an independent room.

4.2. Experimental design

The experiment was conducted in the order of "Preparation—Tutorial—Baseline— Experiment 1—Rest—Experiment 2—Rest—Experiment 3," and the total time required was approximately 60 min. For convenience, subjects wore the HoloLens only when experiencing Tutorial and MR contents, and took it off for the rest of the experiment. Each phase of the experiments will be explained in detail.

4.2.1. Preparation

At the beginning of the experiment, a preparatory phase gave the subject the details of attaching the ECG sensor to their chest on their own. Also, the first survey was conducted to measure the baseline psychological states of the subjects. The surveys were conducted 7 times in total to measure psychological changes, first time after the Baseline and two times per Experiment phase.

4.2.2. Tutorial

After wearing the HoloLens, a tutorial was conducted so that the user can become familiar with the MR environment, gestures, and voice commands. As shown in Figure 4, the subject went through an acclimatization process by speaking into a microphone and rolling a ball using the air tap gesture to confirm the operation of the speech recognition system. The tutorial was repeated until the subject determined that they were sufficiently familiar with speech recognition and gestures.

4.2.3. Baseline

The subject was then asked to sit still for 3 min to measure the baseline states by recording ECGs and responding the surveys. The survey was conducted after 3-min ECG recording is completed.

4.2.4. Experiment and rest

Three Experiment phases consist of "Mental arithmetic (MA) task—Survey—Interaction task—Survey." MA task is well-known to induce mild stress (21). In this study, subjects were asked to guess the correct answer by looking at a randomly generated 4-digit number in the center of a screen and subtracting a constant 2-digit number appearing above the 4-digit number as shown in the Figure 5. After subjects said aloud their answer, they could see whether their answer was correct or not by looking at the 4-digit number that followed. The four- and two-digit numbers used for subtraction were renewed every 30 mental arithmetic problems.

As per the hypothesis, Interaction task presents one among three types of MR content: observing the movement of a non-reactive virtual cat (referred to as "Observation"), interacting with a virtual cat whose responses can be seen ("Visual"), and both

FIGURE 5
Examples of mental arithmetic task. Background color changes when the initial 4-digit number changed.

seen and heard ("Audiovisual"). The duration of each Interaction task was set to 3 min, the average time for all defined commands to be repeated up to two times through the pilot test. To compare the effect of adding or reducing the virtual cat's response, the Interaction task presents three MR contents in two orders: "Observation—Visual—Audiovisual" and "Audiovisual—Visual—Observation."

After each Experiment phase is completed, the 5-min Rest is followed. As a result of several pilot tests, the overall HRV values returned to the baseline when a 5-min period was given. In order to remove the influence of the previous tasks, subjects were allowed to take a rest and sit comfortably for 5 min.

4.3. Electrocardiogram recording

At the Preparation phase, a wireless ECG sensor was attached to record ECG continuously until the end of the experiment. All subjects had to wear a patch-type electrocardiogram sensor (T-REX, Taewoong Medical, Korea) on the proper location to measure lead II ECG. The sensor is rectangular-shaped with removable patch that can non-invasively assess the electrical activity of the heart.

After the recording, mean HR was calculated. In this study, We specifically focused on the HR, which can intuitively understand that the value changes according to the state of tension and rest. An increase in HR suggests a state of tension, i.e., being under stress, whereas HR decreases during recovery (22).

4.4. Survey

The PANAS (Positive Affect and Negative Affect Schedule) is a clinically used questionnaire that evaluates positive and negative emotions in humans. Using a total of 20 items, including 10 items of positive emotion and 10 items of negative emotion, it has been widely used to diagnose one's emotion and mood (23). Subjects were asked to respond on a 5-point Likert scale. The higher the score, the higher the corresponding emotion. In order to prevent the subjects from knowing the purpose of this study and answering intentionally while doing MR content after the MA task, the order of negative and positive questions in the PANAS questionnaire used in the experiment was jumbled, and the survey was quick to respond as soon as each task was completed.

In addition, a question was added to the subjects to choose their current stress level from a number between 0 and 4. The higher the number, the higher the stress level.

5. Results

5.1. Average heart rate

To quantitatively evaluate the physiological response of the subject to stress during this experiment, the mean HR was analyzed. In this experiment, 30 samples were used, and the Friedman Test was performed on seven task scores, along with a post-test, since the normality was not satisfied. For comparisons between many groups over multiple data sets, Friedman test with *post-hoc* Nemenyi test was recommended in a previous study (24). Therefore, in this study, the Nemenyi *post-hoc* test was performed if Friedman's test was significant. Firstly, as shown in Figure 6, the mean HR of the three types of MR content was significantly lower compared to the mean HR of the previous MA. Also, the mean HR of MR content was significantly lower than baseline. In particular, the mean HR of "Audiovisual" was the lowest, and the statistical significance of "Audiovisual" compared to MA and baseline were also the greatest compared to those of the rest Interaction tasks, i.e., "Observation" and "Visual."

5.2. Survey

The mood status was evaluated by scoring two sub-areas of the PANAS questionnaire immediately after each task. Friedman and Nemenyi post-tests were included in the psychological evaluation for each of seven scores. In the case of negative emotions, after the three MR contents, the negative emotions scores were significantly reduced compared to those of MA. Also, they were all significantly lower than the baseline negative scores (Figure 7A). In particular, "Audiovisual" had the lowest negative emotional score, and the greatest statistical significance with baseline and MA. Next, in the case of positive emotions, the scores of the three MR contents were significantly higher than the MA scores performed immediately before, and were higher in the order of "Audiovisual," "Visual," and "Observation" (Figure 7B). Lastly, in the case of stress index, similar to the negative emotion score of PANAS, the three MR contents had significantly lower stress index than baseline and MA (Figure 7C). Also, "Audiovisual" had the greatest statistical significance with baseline and MA. There were no significant differences in the correction rates among three MA tasks.

5.3. Comparison by personal experience of MR and companion animals

To investigate the effect of personal experience with companion animals and a virtual environment, prior questions were asked to each subject before the experiment. Based on their answers, we divided subjects into two groups for each experience. The

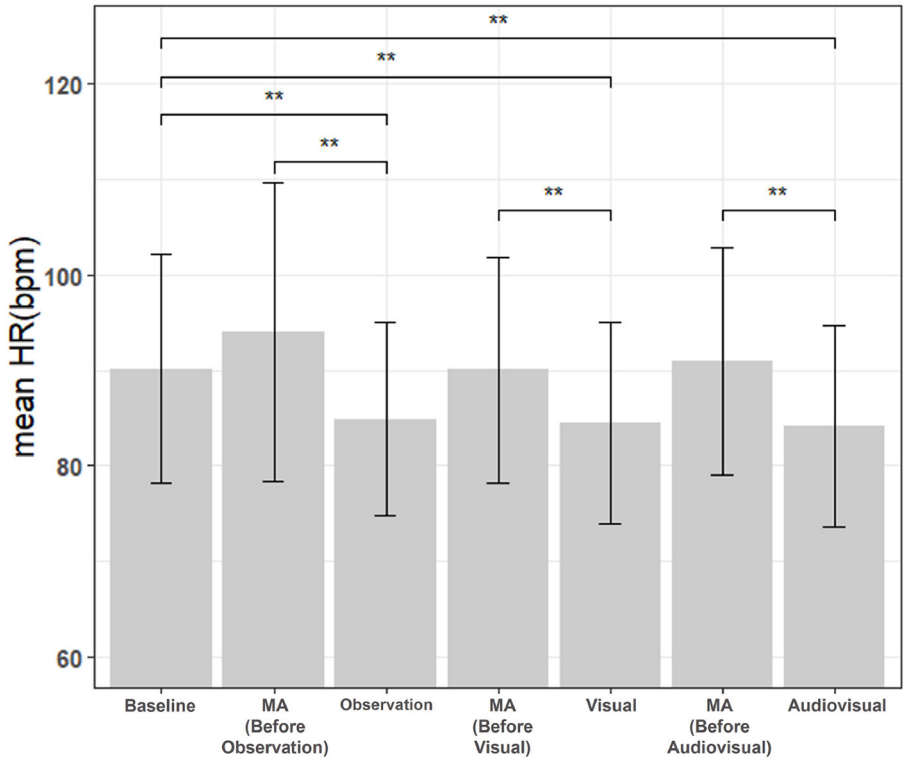

FIGURE 6
Comparison of mean HR between baseline, MA, and interaction tasks (observation, visual, and audiovisual). $N = 30$, mean±standard error, $^{**}p < 0.01$.

experiment was conducted by adjusting the number of assignments to each group evenly. A significant difference in mean HR was not found between groups, but it was confirmed that the mean HR of the group with prior experience of MR was lower. The subject group that had companion animals had a lower mean HR than the group that did not. This means that the subjects who have experienced MR content or have had companion animals experienced a more relaxed state on average. In the case of PANAS, the positive affect score was higher and the negative affect score was lower in the group without prior experience of MR and the group with experience raising companion animals. This result may imply that positive emotions have arisen under the influence of the novelty of experiencing MR content and familiarity with animals. Finally, in the case of stress index, the group that had companion animals was significantly lower than the group that did not. To sum up, the more you have experience raising companion animals, the greater the effect of relieving mental stress by MR content. In addition, tension was relieved more when having prior experience of the virtual environment, and positive emotions increased more when there was no prior experience of the virtual environment.

6. Discussion

This study aims to investigate the effect of stress relief using the MR-based human and virtual cat interaction. A total of 30 healthy female college students participated in the experiment. Experimentally, subjects were asked to do a mental arithmetic task to induce their mental stress. Subsequently, three types of MR content were compared corresponding to stress reduction: observation of the movement of the virtual cat (Observation), visual interaction with the virtual cat (Visual), and audiovisual interaction with the virtual cat (Audiovisual). For quantitative evaluation of the stress-reduction effect, a single-lead ECG and a questionnaire survey were used.

Firstly, mean HR showed significant changes due to stress and recovery. Mean HR was significantly decreased in all three types of MR when compared to MA. These results are consistent with the general findings of low HR during recovery in the ECG study (25). Moreover, mean HRs of the three types of MR contents were significantly decreased even when compared to baseline, indicating effective stress relief. In particular, "Audiovisual" had the lowest mean HR compared to two other MR contents, "Observation," and "Visual," and had the greatest statistical significance with baseline and MA. In addition, it was investigated whether there was an effect on the order of the MR content. The mean HR was compared by dividing the group into a sequential group (Observation—Visual—Audiovisual) and a reverse group (Audiovisual—Visual—Observation), but the order of the MR contents did not significantly affect the effect of stress relief. Consequently, MR content employing a virtual cat can effectively relieve tension by reducing heart rate in stressful situations, and audiovisual interactions have been observed to further decrease heart rate.

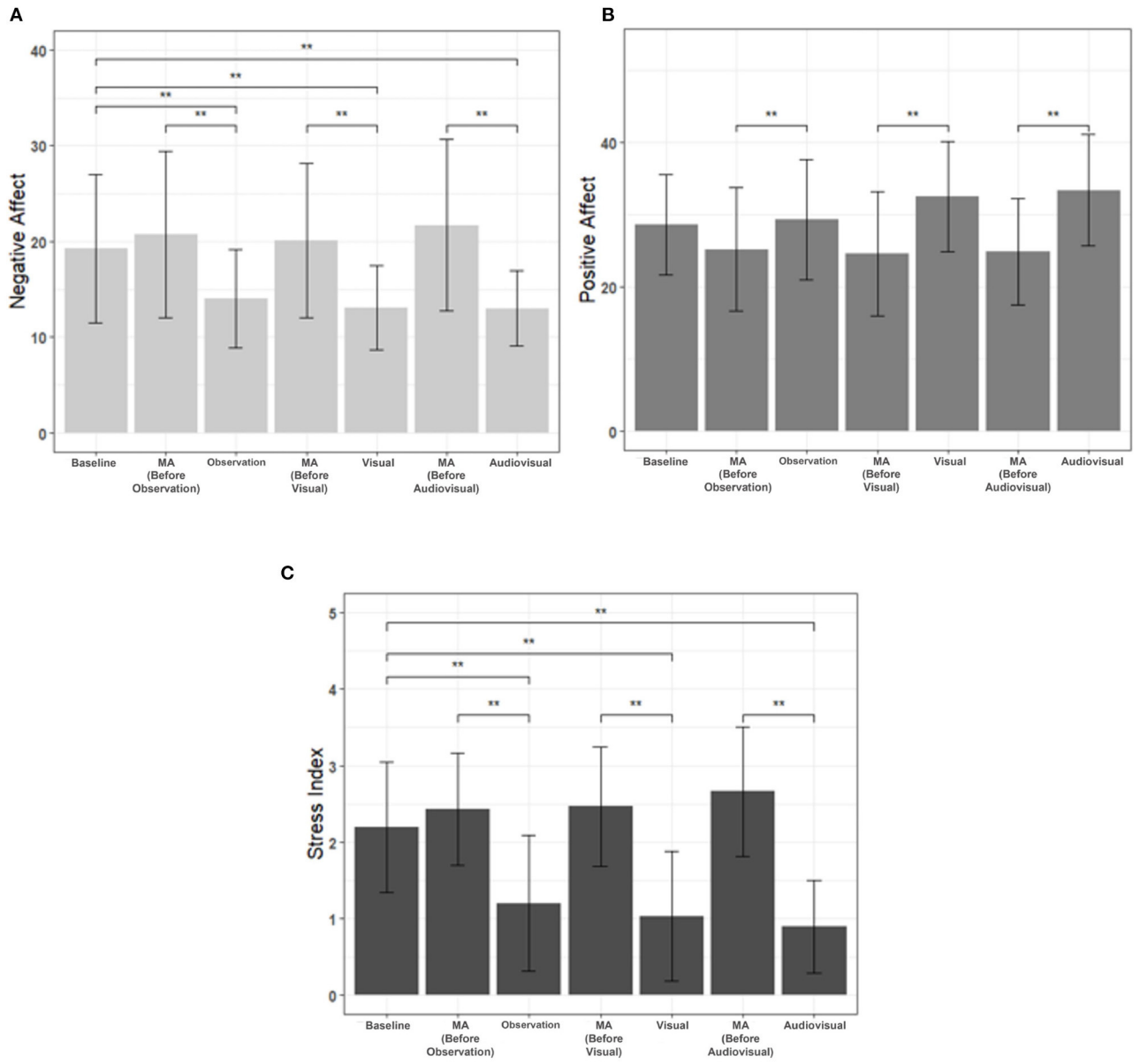

FIGURE 7
Comparison of survey results between baseline, MA, and interaction tasks (observation, visual, and audiovisual). $N = 30$, mean±standard error, $*p < 0.05$ and $**p < 0.01$. **(A)** Negative affect, **(B)** positive affect, and **(C)** stress index.

Next, positive and negative affect values were compared through PANAS. Negative affect and stress index, which indicate negative emotions, were significantly decreased in all three types of MR contents compared to MA, which is the baseline and stressful situation. This suggests that MR-based HAI can help to relieve negative emotions. The positive affect was significantly higher in MR contents than in the MA, suggesting that MR-based HAI can help to induce positive emotions to the subjects. In addition, in the case of "Audiovisual," which had an audiovisual interaction with a virtual cat, it was significantly higher than that of MA. Also, MR contents with interactions (Visual and Audiovisual) had lower negative emotional scores and higher positive emotional scores than just observing the virtual cat (Observation). Consequently, MR-based animal contents can be used to reduce mental stress and induce positive emotions, and the effect can be even greater if interaction is included.

Mental stress and relief can be influenced by a number of factors, including gender, age, occupation, personal experiences with pets, and personal experiences in virtual environments. This study has limitations in that it only targeted female university students in their 20s to control for the effects of gender, age, and occupation. Also, the order of Interaction tasks has been investigated only two sequences, ascending and descending of interactions. In order to further emphasize the effect of visual and auditory interaction, future research will need to further develop content for various age groups and genders and prove it in a more

specific way. In this study, we tried to find the most natural and high-quality model to make our users more comfortable and more interactive, so we decided that the cat model we used was the best fit. However, we plan to add another animal model such as a dog, which is the most familiar and friendly companion animal to many people, in future studies. In addition, compared to robots or mobile apps, AR and MR clearly have the advantage of sharing real physical space with virtual animals, giving a greater sense of reality, but the critical problem is that people do not generally own AR headsets. In order to be widely applied to regular treatment of mental healthcare or AVP activities in the future, further research will be essential.

7. Conclusion

In this study, as an alternative to interaction with real animals, interaction content was developed between humans and virtual animals using MR, a core technology of the 4th industrial revolution. Through gestures or voice commands, users can easily interact with virtual animals. In order to intensively verify the effect of interaction with virtual animals, three types of MR contents were created: content without interaction, content with interaction using visual feedback, and content with interaction using audiovisual feedback. The effect of relieving mental stress was evaluated using physiological indicators and psychological questionnaires. As a result, all three types of MR contents had the effect of reducing mental stress regardless of the presence or absence of interaction with the virtual cat and the type of interaction. However, when both visual and auditory feedback were provided, the effect on physiological response and psychological state was the greatest. The results of this study show that interaction with virtual animals can reduce the stress of the younger generation, who are most familiar with virtual environments than other generations. We expect this study can contribute to the wider application of MR in the field of mental healthcare.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board of Sookmyung Women's University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

HN designed the methods, performed the experiments, analyzed the results, and wrote the manuscript. S-YD designed the methods, discussed the results, and extensive revisions to the paper. Both authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Age modifies the association between pet ownership and cardiovascular disease

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Introduction: Studies examining associations between pet ownership and cardiovascular disease have yielded inconsistent results. These discrepancies may be partially explained by variations in age and sex across study populations. Our study included 6,632 American Gut Project participants who are US residents ≥40 years.

Methods: We first estimated the association of pet ownership with cardiovascular disease risk using multivariable-adjusted logistic regression, and further investigated effect modifications of age and sex.

Results: Cat but not dog ownership was significantly associated with lower cardiovascular disease risk (OR: 0.56 [0.42, 0.73] and OR: 1.17 [0.88, 1.39], respectively). Cat and dog ownership significantly interacted with age but not sex, indicating that cardiovascular risk varies by the age-by-pet ownership combination. Compared to the reference group (40–64 years, no cat or dog), participants 40–64 years with only a cat had the lowest cardiovascular disease risk (OR: 0.40 [0.26, 0.61]). Those ≥65 years with no pets had the highest risk (OR: 3.85 [2.85, 5.24]).

Discussion: This study supports the importance of pets in human cardiovascular health, suggesting optimal pet choice is age-dependent. Having both a cat and dog can be advantageous to people ≥65 years, while having only a cat may benefit those 40–64 years. Further studies are needed to assess causality.

KEYWORDS

human animal bond, cardiovascular disease, pet ownership, one health, age, aging

Introduction

Despite recent advances in medical and pharmaceutical treatments, cardiovascular disease (CVD) remains the leading cause of mortality in the US and worldwide (1, 2). CVD is responsible for 37% of deaths attributable to noninfectious causes of individuals under 70 years of age worldwide (3), and approximately one in four deaths in the US (4). In 2018, the prevalence of CVD excluding hypertension was 11.8% among adults over 18 years of age in the US (2). The prevalence also increases by age and was 28.5% among those age ≥ 65 years (2).

A large, multinational cohort study found that approximately 70% of CVD cases are attributable to modifiable risk factors (5). Thus, non-medical interventions that can reduce CVD and its underlying risk factors, such as management of anxiety and social isolation, exercise, and a healthy diet, are critical. There is also considerable interest in the beneficial role that companion animals play in human health, including the potentially protective effect of pet ownership on CVD. In 2020, 45 and 26% of US households had a dog or a cat, respectively (6). Thus, a positive

association between pet ownership and CVD could provide a strong basis for implementation of a population-based prevention strategy.

Several hypotheses have been proposed that may explain the potential relationship between pet ownership and CVD. First, it is hypothesized that the pet ownership-CVD association is mediated by psychological and physiological changes that occur when a pet is present (7–12). For example, Allen et al. (7) found that the increase of heart rate and blood pressure while performing challenging math problems was significantly smaller among people who had their pet present than those without their pet present. In 1993, Patronek and Glickman (10) coined the term "pet preventable fraction" as the percent of myocardial infarctions and death that pet ownership could prevent. However, this fraction has not been firmly established for CVD. Second, it is hypothesized that the protective benefit of pet ownership is partly mediated by increased exercise (13, 14), particularly in the case of dog ownership. Some studies have found that dog owners have higher levels of physical activity than non-dog owners (15–18). In contrast, cat ownership has not been found to be associated with physical activity (15, 18). Thus, reduced CVD risk among pet owners may not be merely mediated by increased physical activity.

However, existing studies regarding the association between pet ownership and CVD have not yielded consistent results, showing either positive, negative, mixed, or no associations. Several meta-analyses have attempted to clarify the relationship, but their findings have also differed. For instance, one meta-analysis found modestly lower cardiovascular mortality among cat owners and pet owners compared to non-cat and non-pet owners, respectively, but the differences were not statistically significant (19). Another meta-analysis found that dog owners had a reduced risk of cardiovascular mortality compared to non-dog owners, but the study did not adjust for potential confounding factors (20). In a meta-analysis by Yeh et al. (21), pet ownership was associated with a lower adjusted cardiovascular mortality in the general population compared with CVD patients.

These discrepancies may result from several methodological differences across the studies. First, as discussed in a systematic review, the CVD risk factors considered in these studies differed (22). One of the meta-analyses excluded covariates from their analysis (20), while others included them (19, 21). Second, the studies considered populations with varying age groups. For instance, Chowdhury et al. (23) evaluated the association between pet ownership and survival among hypertensive adults between 65 and 84 years of age, while Maugeri et al. (24) evaluated the association between dog ownership and CVD among adults between 25 and 44 years. A few existing meta-analyses were also conducted by integrating results from studies with participants of various age groups. For example, Kramer et al. included a study with participants between 33 and 85 (25), a study with participants between 65 and 84 (23), and an earlier study with participants who were "adults" with unspecified age (12). El-Qushayri et al. also included studies with participants of varying age from 5 to 17 years (26) to 50–95 years (27). Yeh et al. included studies whose participants were 44.5–72.6 years.

The association between pet ownership and CVD may differ between age groups due to changes in the relationship between the pet and owner across the lifespan. Pets may be sole companions for some senior people, particularly women who are more likely to live alone than age-matched men (3). Pets may also mitigate feelings of loneliness and social isolation among senior people who live alone leading to a reduced risk of CVD.

In this study, we aim to evaluate the association between pet ownership and CVD risk while considering a comprehensive list of risk factors and confounders. We hypothesize that the effect of pet ownership on CVD risk may differ by sex and age groups. Therefore, we further evaluate potential effect modification due to age and sex, which has not been well understood in the literature. The varying effect of pet ownership across subgroups of participants may explain the inconsistent results from previous studies.

Methods

Study population

Our study population included 6,632 individuals who were participants of the American Gut Project (AGP) between 2012 and 2020. The AGP employed a cross-sectional study design with voluntary response sampling. Participants enrolled in the project through either the Indiegogo or FundRazr crowdsourcing websites and completed a demographics, health, and lifestyle survey. Our study was limited to participants ≥40 years of age who resided in the US and answered multiple choice survey questions about pet ownership, cardiovascular disease, and age (28) (see Supplementary Survey). The lower age limit in this study was chosen as individuals ≥40 years are significantly more likely to have age-related forms of CVD compared with those <40 years who are more likely to have hereditary forms (29).

Ethical considerations

Participants' consent for the AGP was obtained under Institutional Review Board human research subject protocols from University of Colorado, Boulder (Protocol 12-0582, 12/2012-03/2015) or University of California, San Diego (Protocol 141853, 02/2015-present). All data were deidentified and publicly available. Raw data were obtained using redbiom, a utility that allows for accessing and processing of publicly available data stored in Qiita (30). The protocol of this study was reviewed by the Institutional Review Board at Indiana University and was determined to be non-human subjects research (Protocol 1910657990).

Exposure—pet ownership

The main exposures of interest were cat ownership and/or dog ownership. Cat ownership was defined as having a cat(s) and dog ownership as having a dog(s).

Outcome—CVD

The outcome of interest was history of CVD. The answer to the survey question, "Have you ever been diagnosed with coronary artery disease, heart disease, heart attack, or stroke?" determined the history of CVD. Cases were defined as participants who were diagnosed with CVD by a medical professional. CVD controls were defined by those participants who answered "No" to this question.

Covariates

The AGP collected a comprehensive list of covariates that may impact the association between CVD and pet ownership. Demographic factors included age group (40–64 years and ≥ 65 years), sex (female or male), and the highest level of education attained (up to some high school, high school graduate to undergraduate, some graduate school or graduate degree). We dichotomized age into two age groups using the cut point of ≥65 years as previous studies have suggested that the rate of increased CVD risk is relatively stable up to age 65, then increases significantly after age 65 (31). We conducted sensitivity analysis using alternative cut off values (i.e., 60 years) to evaluate the robustness of our analysis. Race or ethnicity was self-reported by participants as Caucasian, Asian or Pacific Islander, African American, Hispanic, or "other." As more than 90% of participants self-identified as Caucasian, race or ethnicity was collapsed into two levels, Caucasian and non-Caucasian. Height and weight were self-reported by participants and used to calculate body mass index (BMI).

Statistical analysis

Data analysis was conducted using RStudio, Version 4.1.4 (32). The univariate comparisons of covariates between cases and controls were conducted by Pearson's Chi-square test and two-sample *t*-test for categorial and continuous variables, respectively (Table 1). The association between pet ownership on CVD (odds ratio, or OR) was estimated *via* multivariable-adjusted logistic regression models. Potential confounders were included as covariates in the logistic regression models.

We further tested the secondary hypotheses that there are interactions among cat ownership, dog ownership, age, and sex. We considered five additional logistic regression models with various combinations of interaction terms representing potential effect modification among these factors (Table 2). We first evaluated the effect of cat ownership and dog ownership on CVD risk using a multivariate logistic regression model without considering any potential interactions (i.e., Model 1). We adjusted for age, sex, race, BMI, sleep, alcohol use, smoking, exercise, and education. Model 2 included a cat-by-dog interaction term. Model 3 included an age-by-cat ownership interaction term. Model 4 included an age-by-dog ownership interaction term. Model 5 included both age-by-cat and age-by-dog ownership interaction terms. Model 6 included interaction terms for sex-by-cat ownership and sex-by-dog ownership. All models adjusted for the same covariates other than pet ownership, age, and sex. We conducted stepwise model selection using likelihood ratio tests to determine the optimal model based on the data (33). The likelihood ratio test is calculated as the ratio of the log likelihood of the simpler model relative to the more complex model, with the test statistic approximating a chi-square distribution. When comparing two models, a nested model that was more parsimonious was preferred unless an extended model significantly improved the model fit ($p < 0.05$).

Results

Participant characteristics

The participants' characteristics and univariate comparisons between cases and controls are shown in Table 1. Our study population included 405 CVD cases (6.1%) and 6,227 controls (93.9%). Cat owners comprised 27.6% of the population and showed significantly lower proportion in cases than in controls (17.5% vs. 28.2%; $p < 0.01$). Dog owners comprised 36.2% of the population and had comparable proportions between cases and controls (35.1% vs. 36.2%, $p = 0.61$). For dichotomized covariates, a higher proportion of the population was 40–64 years (56.2%), female (53.3%), Caucasian (90.7%), sleep over 7 h/day (56.9%), and current non-smokers (96.1%). Significant differences were found between cases and controls for most of these covariates, including ≥65 years (55.1% vs. 27.6%), female (33.6% vs. 54.6%), Caucasian (94.6% vs. 90.4%), and sleep over 7 h/day (50.1% vs. 57.3%). The proportion of non-smokers did not show significant difference between cases and controls (95.5% vs. 96.1%). A few covariates (BMI, alcohol use, exercise, education) had three or more levels. The levels with the highest proportion were normal BMI (49.5%), rarely alcohol use (27.3%), exercise regularly (39.0%), and some graduate school or graduate degree (61.8%). The distributions of all these covariates were significantly different between cases and controls. For example, the cases were less likely to have normal BMI than controls (34.8% vs. 51.1%).

The association between pet ownership and CVD

The results of the adjusted model without interaction terms are summarized in Table 3. Cat owners had significantly lower risk of CVD compared with non-cat owners (OR: 0.56 [0.42, 0.73]). There was no significant difference in the risk of CVD between dog owners and non-dog owners ($p = 0.17$). The risk of CVD was approximately 3.5 times higher among participants aged ≥65 years than among those age 40–64 (OR: 3.51 [2.80, 4.40]) and approximately 2 times higher among men than women (OR: 2.07 [1.65, 2.61]). Both obese and overweight had significantly increased risk over normal BMI, while underweight did not show any significant difference. Exercise, alcohol use and education were all significantly associated with CVD risk, while smoking was not.

Interactions between pet ownership and age or sex

Results of the likelihood ratio tests are shown in Table 4. Model 5 performed significantly better than the other models and was selected as the final model. We followed the principle of parsimony during model selection, wherein an extended model is only selected if it fits the data significantly better than a reduced model ($p < 0.05$). Sex-by-pet ownership interactions did not improve the data fitting over the non-interaction model (Model 6 vs. Model 1) so were not considered further in additional models. The results of Model 5, which included interaction terms for age-by-cat ownership and age-by-dog ownership, are shown in Table 5. Adjusted ORs, 95% confidence intervals, and value of *p*s for the final model are shown in Table 5. As a result of the interactions, each participant falls into one of eight groups depending

TABLE 1 Study population characteristics.

Characteristic	All (*n*=6,632)	CVD (*n*=405, 6.1%)	No CVD (*n*=6,227, 93.9%)	*p* value
Pet ownership (exposure)				
Cat ownership	1,829 (27.6%)	71 (17.5%)	1,758 (28.2%)	<0.01
Dog ownership	2,398 (36.2%)	142 (35.1%)	2,256 (36.2%)	0.61
Age (years)				<0.01
40–64	3,729 (56.2%)	182 (44.9%)	4,507 (72.4%)	
≥ 65	2,903 (43.8%)	223 (55.1%)	1,720 (27.6%)	
Sex				<0.01
Female	3,535 (53.3%)	136 (33.6%)	3,399 (54.6%)	
Male	3,053 (46.0%)	268 (66.2%)	2,785 (44.7%)	
Race				<0.01
Caucasian	6,013 (90.7%)	383 (94.6%)	5,630 (90.4%)	
Non-Caucasian	604 (9.1%)	22 (5.4%)	582 (9.4%)	
Sleep				<0.01
≥7-h	3,771 (56.9%)	203 (50.1%)	3,568 (57.3%)	
<7-h	2,844 (42.9%)	200 (49.4%)	2,644 (42.5%)	
BMI				<0.01
Underweight	175 (2.6%)	8 (2.0%)	167 (2.6%)	
Normal	3,286 (49.5%)	141 (34.8%)	3,185 (51.1%)	
Overweight	2,108 (31.8%)	178 (44.0%)	1930 (31.0%)	
Obese	1,006 (15.2%)	78 (19.3%)	928 (14.9%)	
Alcohol use				<0.01
Daily	1,109 (16.7%)	63 (15.6%)	1,046 (16.8%)	
Regularly (12–20 times/month)	1,203 (18.1%)	109 (26.9%)	1,094 (17.6%)	
Occasionally (4–11 times/month)	1,214 (18.3%)	53 (13.1%)	1,161 (18.6%)	
Rarely (1–3 times/month)	1813 (27.3%)	90 (22.2%)	1723 (27.7%)	
Never	1,303 (19.6%)	109 (26.9%)	1,194 (19.2%)	
Smoking				0.63
Smoker	241 (3.6%)	17 (4.2%)	224 (3.6%)	
Non-smoker	6,374 (96.1%)	387 (95.5%)	5,987 (96.1%)	
Exercise				<0.01
Daily	1,420 (21.4%)	90 (22.2%)	1,330 (21.4%)	
Regularly (12–20 times/month)	2,585 (39.0%)	179 (44.2%)	2,406 (38.6%)	
Occasionally (4–11 times/month)	1712 (25.8%)	75 (18.5%)	1,637 (26.3%)	
Rarely (1–3 times/month)	705 (10.6%)	42 (10.4%)	663 (10.6%)	
Never	199 (3.0%)	18 (4.4%)	181 (0.3%)	
Education				<0.01
Up to high school graduate	142 (2.1%)	14 (3.5%)	128 (2.1%)	
Associate's to bachelor's degree	2,367 (35.7%)	171 (42.2%)	2,196 (35.3%)	
Graduate school or graduate degree	4,101 (61.8%)	219 (54.1%)	3,882 (62.3%)	
Unspecified	22 (0.3%)	1 (0.2%)	21 (0.3%)	

on their level of cat ownership, dog ownership, and age group. Each of these eight groups has a different CVD risk (Table 5).Participants who were 40–64 years, non-cat owners, and non-dog owners were considered the reference group. Compared to the reference group, all other groups had a significantly different risk of CVD.

Participants who were 40–64 years who owned a cat had lower risk of CVD than age-matched participants without a cat, regardless of whether they also owned a dog. Cat-owning Participants who were 40–64 years who did not own a dog had the lowest risk of CVD (OR: 0.40 [0.26, 0.61]) compared to the reference group. Participants aged

TABLE 2 Logistic regression models for estimating effect of pet ownership with or without interactions.

Model 1	CVD ~ age + cat ownership + dog ownership + sex + other covariates*
Model 2	CVD ~ age + cat ownership + dog ownership + sex + other covariates* + (cat ownership x dog ownership)
Model 3	CVD ~ age + cat ownership + dog ownership + sex + other covariates* + (age x cat ownership)
Model 4	CVD ~ age + cat ownership + dog ownership + sex + other covariates* + (age x dog ownership)
Model 5	CVD ~ age + cat ownership + dog ownership + sex + other covariates* + (age x cat ownership) + (age x dog ownership)
Model 6	CVD ~ age + cat ownership + dog ownership + sex + other covariates* + (sex x cat ownership) + (sex x dog ownership)

*Other covariates include amount of sleep, BMI category, sex, race, smoking status, exercise frequency, alcohol use frequency, education.

40–64 years who owned both a cat and dog had the second lowest risk (OR: 0.60 [0.35, 1.03]) compared to the reference group.

For participants ≥65 years, those who owned both a cat and dog had the lowest CVD risk (OR: 2.42 [1.50, 3.91]). On the other hand, participants ≥65 years who did not own a cat or a dog had the highest risk (OR: 3.85 [2.84, 5.24]). The other participants ≥65 years had varying levels of CVD risk based on the profiles of cat and dog ownership with odds ratios ranging from 2.97 to 3.85. The risk of CVD for all age and pet ownership groups was significantly different from the reference group at $p < 0.05$ significance level. The risks of CVD for these groups are summarized in Table 5 and depicted in Figure 1.

To illustrate this relationship due to the complex interactions, we further described the effect modification of age on pet ownership in Figure 2. In this figure, we estimated participants' risk of CVD for the most common covariate profile of participants in the study. For all participants, the estimated risk of CVD increases with age, but at a varying rate by the pet ownership status. For ≥65-year participants, owning no pets was associated with the highest risk of CVD. In contrast, for 40-64-year participants, owning a dog but no cat was associated with the highest CVD risk. Owning both a cat and a dog was associated with the lowest CVD risk among participants ≥65 years, while owning a cat but no dog was associated with the lowest risk among those 40–64 years.

We further repeated all analyses using an alternative cut-off value for age groups (i.e., 40–59 years and ≥60 years) as a sensitivity analysis. There were no appreciable difference from these results; thus, the conclusion remains the same.

Discussion

We found a significant association between pet ownership and CVD risk in our study population. In addition, we found that age group was an effect modifier of this association. For those ≥65 years, owning both a cat and dog was associated with the lowest risk of CVD, while owning no cat or dog was associated with the highest risk of CVD. Further, for those 40–64 years, the lowest risk of CVD was associated with having a cat but no dog, while those with a dog but no cat had the highest CVD risk. A participant's sex did not significantly modify the associations between pet ownership and CVD. While some prior studies have shown that owning a pet may be associated with reduced risk of CVD, others showed no association. Our findings may help explain the discrepancies in prior studies. Our results suggest that it could be especially beneficial for people ≥65 years to have both cat and dog with respect to cardiovascular health. However, for people aged 40–64 years, having a cat may have sufficient benefit, while having a dog will increase rather than decrease the risk of CVD.

Owning both a cat and dog may be associated with the lowest risk of CVD among ≥65-year participants due to reduced feelings of loneliness and social isolation. This is consistent with existing literature (34). Feelings of loneliness are lowest in middle-aged adults and highest in late adulthood (35). For adults 65–84 years, one study found that feelings of loneliness or social isolation were significantly lower among current or past dog owners than never dog owners (36). In a study of adults ≥60 years, pet owners were 36% less likely to report a feeling of loneliness compared with non-pet owners (37).

Our findings also suggest that owning a dog may increase the risk of CVD among those who are 40–64 years and cat owners. One potential reason is that dog ownership adds responsibilities to life, such as providing food, water, and exercise and managing veterinary care. While cat owners also provide daily food and water, they may not spend time as much time exercising their animals. Cat owners also visit the veterinarian less frequently than dog owners. A 2016 American Veterinary Medical Association survey found 54% of cat owners and 83% of dog owners visited the veterinarian at least once in 2016 (38). Adding these at a time in life when many people are already busy with work and family demands may be a source of stress. Further, dog owners aged 40–64 years may tend to own breeds that confer more stress or other demands.

Another reason the association between pet ownership and cardiovascular disease might differ depending on age may be that cardiovascular reactivity tends to be higher in older than younger individuals. For example, blood vessel responses to stress are impaired as people age due to vascular aging (39). Several experimental studies have found an association between pet ownership and cardiovascular parameters among adults, especially blood pressure and heart rate (7, 40, 41). Maintaining a healthy blood pressure can reduce the rate of vascular aging (42, 44). As pet ownership was associated with blood pressure reductions in several studies, pets may help reduce the rate of vascular aging in people as they age.

Our findings should be viewed considering a few limitations. For example, future studies may benefit from adjusting for pet breed and for pet care demands, such as time spent feeding or walking pets. In addition, further investigation of the association between pet ownership and the adult gut microbiome, contrasting people with and without CVD, may also elucidate the mechanism by which pet ownership is associated with CVD.

Another limitation is that the cases and controls were significantly different, as shown in Table 1. Compared to cases, controls tended to be younger, female and Caucasian, in the normal BMI category, more likely to have attended graduate school and be occasional exercisers, and more likely to be regular alcohol users.

TABLE 3 Estimated effects of covariates without consideration of potential interactions (i.e., Model 1).

Covariate		Odds ratio	Confidence interval (95%)	*p* value
Cat owner	Yes	0.56	0.42, 0.73	<0.01
	No	Ref	Ref	Ref
Dog owner	Yes	1.17	0.88, 1.39	0.17
	No	Ref	Ref	Ref
Age	40–64 years	Ref	Ref	Ref
	≥65 years	3.51	2.80, 4.40	<0.01
Race	Non-Caucasian	0.64	0.64, 0.97	0.04
	Caucasian	Ref	Ref	Ref
Sex	Male	2.07	1.65, 2.61	<0.01
	Female	Ref	Ref	Ref
BMI (kg/m^2)	Obese	1.95	1.41, 2.66	<0.01
	Overweight	2.07	1.61, 2.66	<0.01
	Normal	Ref	Ref	Ref
	Underweight	1.22	0.54, 2.43	0.60
Sleep	<7-h	1.45	1.16, 1.81	<0.01
	≥7-h	Ref	Ref	Ref
Smoking status	Smoker	1.32	0.75, 2.19	0.31
	Non-smoker	Ref	Ref	Ref
Exercise frequency	Never	0.83	0.46, 1.42	0.52
	Rarely (1–3 times/month)	0.81	0.55, 1.17	0.28
	Occasionally (4–11 times/month)	0.49	0.31, 0.66	<0.01
	Regularly (12–20 times/month)	Ref	Ref	Ref
	Daily	0.93	0.70, 1.23	0.63
Alcohol use frequency	Never	Ref	Ref	Ref
	Rarely (1–3 times/month)	0.55	0.40, 0.74	<0.01
	Occasionally (4–11 times/month)	0.45	0.31, 0.65	<0.01
	Regularly (12–20 times/month)	0.77	0.55, 1.06	0.10
Highest education attained	Daily	0.41	0.29, 0.59	0.01
	Up to high school graduate	1.50	0.77, 2.71	0.21
	Associate's to bachelor's degree	1.50	1.20, 1.88	<0.01
	Some graduate school or graduate degree	Ref	Ref	Ref

TABLE 4 Results of likelihood ratio tests for model selection.

Models compared (reduced vs. extended)	Likelihood ratio test	Value of *p*	df
1 vs. 2	0.49	0.48	1
1 vs. 3	5.62	0.02	1
1 vs. 4	6.91	<0.01	1
3 vs. 5	6.94	<0.01	1
4 vs. 5	5.65	0.02	1
1 vs. 5	12.56	<0.01	2
1 vs. 6	2.98	0.23	2

Likelihood ratio test = chi-square test statistic for the likelihood-ratio test: $-2(\text{LogL}_{\text{nested model}} - \text{LogL}_{\text{complex model}})$. df = degrees of freedom for the χ^2 test statistic defined as the number of covariances fitted for the two models.

TABLE 5 Estimated effects of covariates with pet ownership-by-age interactions (i.e. Model 5).

Covariate		Odds ratio	Confidence interval (95%)	Prob(>|z|) value of *p*
Age × pet ownership interaction	≥65 years, cat owner, not dog owner (*N* = 306)	2.97	1.98, 4.47	<0.01
	40–64 years, cat owner, not dog owner (*N* = 876)	0.40	0.26, 0.61	<0.01
	≥65 years, cat owner, and dog owner (*N* = 109)	2.42	1.50, 3.91	<0.01
	40–64 years, not cat owner, not dog owner (*N* = 1,850)	Ref	Ref	Ref
	≥65 years, not cat owner, and dog owner (*N* = 326)	3.14	2.09, 4.72	<0.01
	40–64 years, not cat owner, and dog owner (*N* = 1,425)	1.53	1.12, 2.08	0.01
	≥65 years, not cat owner, and not dog owner (*N* = 1,202)	3.85	2.84, 5.24	<0.01
	40–64 years, cat owner, and dog owner (*N* = 538)	0.60	0.35, 1.03	0.03
Sleep	<7 h	1.43	1.15, 1.78	<0.01
	≥7 h	Ref	Ref	Ref
BMI (kg/m^2)	Obese	1.90	1.39, 2.59	<0.01
	Overweight	2.03	1.58, 2.62	<0.01
	Normal	Ref	Ref	Ref
	Underweight	1.21	0.53, 2.40	0.62
Sex	Male	2.08	1.65, 2.62	<0.01
	Female	Ref	Ref	Ref
Race	Non-Caucasian	0.64	0.40, 0.97	0.04
	Caucasian	Ref	Ref	Ref
Smoking status	Smoker	1.37	0.78, 2.29	0.25
	Non-smoker	Ref	Ref	Ref
Exercise frequency	Never	0.88	0.49, 1.50	0.65
	Rarely (1–3 times/month)	0.83	0.56, 1.19	0.32
	Occasionally (4–11 times/month)	0.46	0.32, 0.66	<0.01
	Regularly (12–20 times/month)	Ref	Ref	Ref
	Daily	0.96	0.72, 1.26	0.75
Alcohol use frequency	Never	Ref	Ref	Ref
	Rarely (1–3 times/month)	0.54	0.40, 0.74	<0.01
	Occasionally (4–11 times/month)	0.46	0.32, 0.66	<0.01
	Regularly (12–20 times/month)	0.76	0.55, 1.05	0.10
	Daily	0.41	0.28, 0.59	<0.01
Highest education attained	Up to high school graduate	1.51	0.77, 2.73	0.20
	Associate's to bachelor's degree	1.49	1.19, 1.87	<0.01
	Some graduate school or graduate degree	Ref	Ref	Ref

While these variables were controlled covariates in the logistic regression models, it is possible that there could be unmeasured confounding of some of the variables, such as BMI. It is possible that residual differences between cases and controls could confound results. It is also likely that the imbalance with respect to other unmeasured factors may contribute to the observed association. Future studies could resolve this with propensity scores.

A shortcoming of this dataset is that, while there was a race and ethnicity question on the questionnaire, the response encoders ultimately classified participants by race (i.e., Caucasian, Asian or Pacific Islander, African American, Hispanic, or "other"). Thus, information about ethnicity was missing in this analysis.

There are also public health measures that could be implemented based on these findings. In particular, the benefit of pet ownership to the cardiovascular health of those ≥65 years suggests that people of this age group should not give up their pets, including people who reside in retirement or assisted living centers. However, not all retirement or assisted living centers accept pets. In 2019, approximately 75% of for-profit retirement living residences accepted pets and the proportion of non-profit residences accepting pets is much lower (43). This is contrary to the US Department of Housing and Urban Development requirement that all properties designated for "elderly or handicapped persons" may not discriminate against individuals with a "common household pet" (45).

Finally, as this study is cross-sectional, a cause-and-effect relationship between pet ownership, some covariates (exercise, sleep, alcohol use, and exercise frequency), and CVD cannot be drawn. Reverse causation can

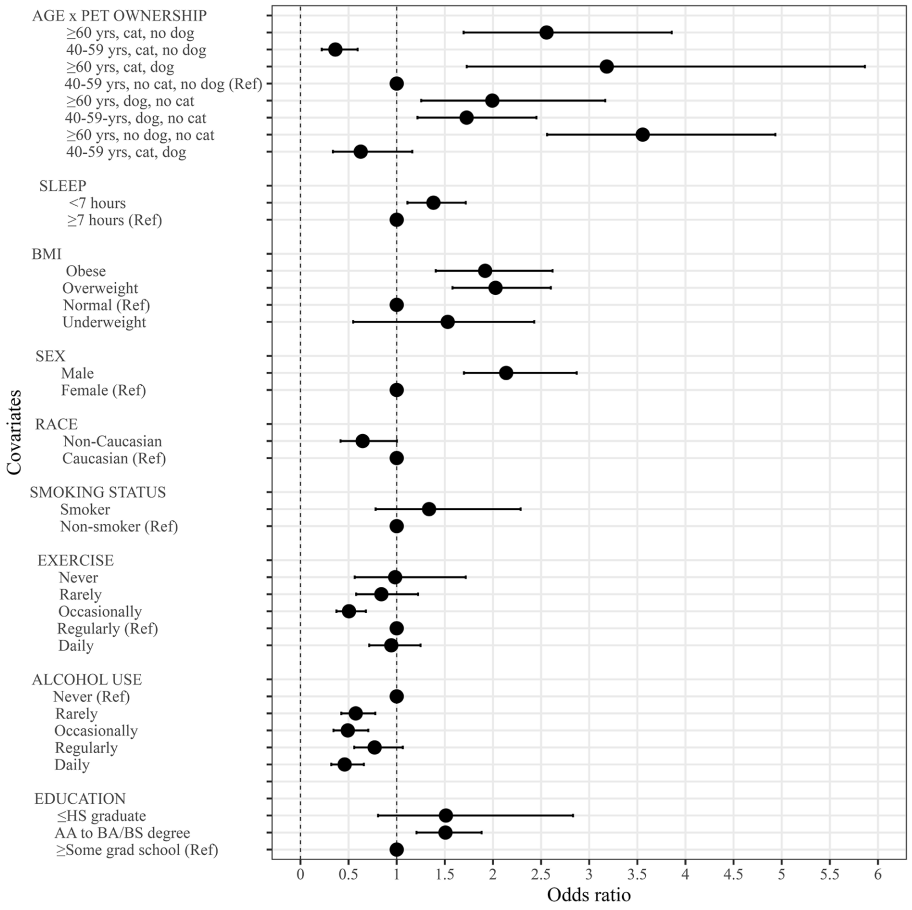

FIGURE 1
Association between covariates and CVD risk based on the final model (i.e., Model 5).

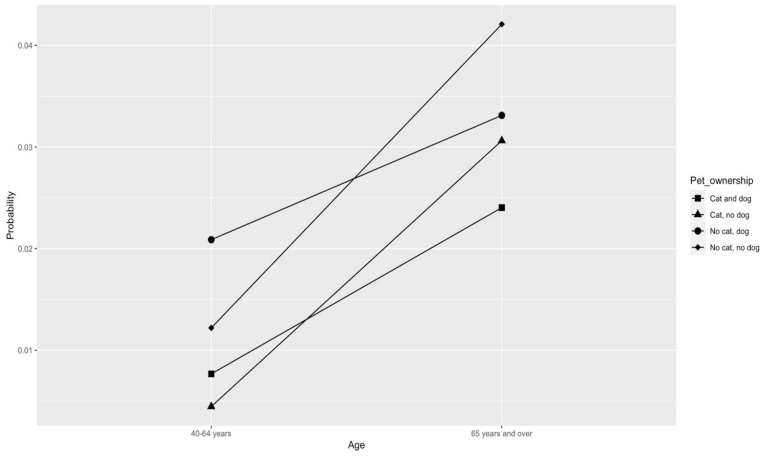

FIGURE 2
Estimated probability of CVD as a function of pet ownership and age, assuming an individual with a fixed covariate profile (i.e., >7h sleep, normal BMI, female, white, non-smoker, regular exerciser, rare drinker, and some grad school; i.e. the most common people in our study).

not be ruled out with this study as the order of events is unknown. For instance, a participant may have been advised to obtain a pet after being diagnosed with CVD. However, the finding of effect modification of the pet ownership by age by CVD relationship suggests that future prospective studies, or propensity score analyses, where cause and effect may more easily be interpreted, are indicated.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://www.ebi.ac.uk/ena/browser/view/PRJEB11419.

Author contributions

KW conceived and designed the study, performed the statistical analysis, and wrote the first manuscript draft. ML and KK provided study design guidance. ML contributed to the statistical analysis. TS edited the final manuscript and assisted with data visualization. All authors contributed to the manuscript revisions, read, and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fvets.2023.1168629/full#supplementary-material

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Optimizing palliative care and support for pets –perspectives of the pet-parent and the veterinarian

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As animals benefit from improved chronic disease care, more pet-parents and veterinarians face issues of late life and terminal care. Management of life limiting disease commonly considers the timing of euthanasia, often overlooking the role of supportive palliative care. Necessary communications between vet and pet-parents are rarely emphasized. However, as in human palliative care, the central role of good communications is critical. In particular, three communication elements are primary, namely: empathic communication and shared decision-making; managing progressive symptoms, and; advanced directives. Moreover, focusing only on euthanasia can easily discount the profound emotional legacy of bereavement. This Perspective illustrates how communications policies derived from human palliative care are exemplified in the management of a case of canine lung cancer, to the wider practice benefits of pets, pet-parents and veterinary practice staff.

KEYWORDS

palliative care, communication, supportive care, end of life care, psycho-oncological care

1. Methods

This single-case study derives from participant observation data-gathering from the first and second author's own pet-parent experience of managing the terminal illness of their toy Poodle, Joe, who died from a primary pulmonary adenocarcinoma. All authors were approached and verbal and written informed consent was sought, and confirmed by their willingness to write this paper. The pet's verbal consent was sought by proxy, from the pet-parents. Clinical case data was extracted from the patient's medical record by a qualified veterinarian, the main care provider.

2. Introduction

Advances in veterinary diagnostics and treatments have increased geriatric companion animal numbers and management decisions around end-of-life issues. Organ failure is the main incurable life-limiting condition of older dogs and cats, many suffering the same diseases as their humans. Cancer rates however, are lower. U.S. insurance industry data indicate overall rates of cancers in pedigree dogs around <3%, but in some breeds may be considerably higher (1, 2) though such data are only indicative. Soft tissue, skin, bone and hematological cancers predominate (2, 3). As such, pet-parents increasingly face the challenges of caring for aging pets with life-limiting disease. As with human

patients, personalized palliative care plays an essential role to minimize suffering in pets with incurable and progressive disease. Most animal palliative care literature focuses on managing the pet near the end-of-life and on euthanasia (4). For people, palliative care, by definition, is care that aims to maximize quality of life during life-limiting disease by effective symptom management, establishing clear care goals, maximizing independence and offering psychosocial support (5). We believe this definition is also applicable in veterinary care. This Perspective examines palliative care, integrating pet-parent and veterinarian views on the process of optimizing palliative care for companion animals.

3. Case

Joe, a neutered male brown toy poodle, was blind, overweight with Inflammatory bowel disease and only a few teeth when "rescued" aged 10-years (2015). Fiercely independent, he quickly navigated complex daily walks, needing guidance only on steps. Over time, Joe's Vet (LYC) managed his Calcium Oxalate urolithiasis (cystotomy, 2017), hip subluxation (osteotomy, 2018), and heart murmur (Grade IV/VI). A carefully-balanced home-cooked diet helped renormalized his weight. Bi-annual blood profiles indicated persistent borderline/high $Calcium^{+}$ and ALKP (2017), unmodified by restricting Oxalate intake, remaining enigmatic despite exhaustive investigations. In Spring, 2020 a mild persistent cough and hesitancy/panting during walks emerged. Echo and X-ray (May 2020) revealed mild diffuse interstitial patterns in caudal lung fields. By early March 2021, caudal lung field crackles were apparent and a thoracic x-ray was suggestive of lung consolidation/dysplasia. Referral to a palliative care Internist for small animals, for FNA, CT and Ultrasound investigation confirmed a right caudal lung mass ($7.4 \times 5.9 \times 5.3$ cm), probably primary Pulmonary Adenocarcinoma, displacing both the bronchus and Aorta. After a surgical consult, the Internist suggested pneumonectomy, which, if successful, offered potential life expectancy of up to 12 months.

Given Joe's age, tumor mass, and likely operative trauma, the pet-parents chose palliative care under his usual Vet. Joe survived comfortably until early August 2021 when he was euthanized at home, age 16, due to rapidly-escalating respiratory distress, using intravenous infusion of Sodium Pentabarbital 200 mg/ml at a dose of 200 mg/kg.

4. The pet-parent perspective

This personal experience emphasized three important aspects in optimizing palliative care for pets and companion animals, namely empathic communication and shared decision-making, managing progressive symptoms, and advanced directive.

4.1. Empathic communications and shared decision-making

Empathic communications underpin all good health care for humans and animals. Providing the opportunity to discuss with the pet-parent the diagnosis and prognosis *in a compassionate manner*, 1. builds a good, trusting relationship between the pet-parent and veterinarian, thereby 2. facilitating decision-making for effective management by the veterinarian. Empathic communication includes delivering the diagnosis in a sensitive manner, acknowledging the likely emotional impact this has by using empathic statements.

4.1.1. Breaking bad news

An old dog inevitably prompts end-of-life awareness, but it remains a shock for the pet-parent to be told that time is imminent. Joe's Vet titrated diagnostic information in response to Joe's pet-parents' emotional reactions, pausing frequently to allow assimilation, before moving on to management options. A strategy for this is as follows: First, ask how much pet-parents want to know about the diagnosis and prognosis and inform accordingly. Break bad news using an Assess; Disclose; Assimilate (ADA) approach (6): *Assess* pet-parent understanding. This reveals what they need to be told. *Disclose* sensitively, pausing to allow questions and emotional adjustment. Then help the pet-parent *Assimilate* the information. Use of lay terms and encouragement helped Joe's pet-parent's accept both diagnosis and prognosis. ADA is not a one-off exercise, but a tool for repeated use across the illness (6).

4.1.2. Clarifying goals

During the diagnostic consultation, available treatment options and associated risks and benefits were outlined, including mentioning possible positive outcomes, to allow retention of some realistic hope. We shared our goals for Joe: to maximize his comfort and independence at home for as long as possible. Pet-parents' preference for life-sustaining treatments are likely influenced by expectations of treatment outcomes, so ask pet-parents about their outcome priorities and expectations. These often depend on how different outcomes are framed. Recommending surgery required emphasizing survival duration, but QoL (and financial!) costs likely dictate many pet-parents' choices. Pneumonectomy is traumatic, painful, and would have severely impaired Joe's independence, if he survived the operation and hospitalization stress. Without surgery, Joe's expected prognosis was 6 months. Palliative care would provide at least equivalent good QoL duration. For many pet-parents, underemphasizing surgical downsides when recommending treatment could skew decision-making. Clear information about the probabilities of both positive and negative health outcomes, with an unbiased professional recommendation for survival duration vs. QoL, best guides pet-parents to optimal decision-making. Be honest about downsides early on. Ask about the pet-parent's preferences and ability for involvement in future care.

4.2. Managing progressive symptoms

A second key aspect in palliative care is effective management of progressive symptoms. Disease progression is inevitable in life-limiting disease.

4.2.1. Preparation

Preparing pet-parents by explaining what to look out for and how to manage disease progression is essential to avoid unnecessary emergency visits and hospitalizations. From the beginning, the veterinarian outlined the potential scenarios for Joe's condition. This was helpful both in helping avoid unnecessary emergency visits and maintaining a sense of control. For instance, respiratory distress is a significant risk in advanced lung cancer. To avoid unnecessary (and expensive) hospitalizations, Joe's pet-parents were advised to rent an oxygen concentrator and box in case oxygen support was needed (which it wasn't, until Joe's final week). With that, Joe was looked after at home throughout the illness journey without a single hospitalization. In Joe's case, managing cough and pneumonia were the biggest challenges. Certain anti-tussive medications (e.g., Butorphanol) induce drowsiness, whereas antibiotics for managing pneumonia impair appetite, an issue when maintaining nutrition intake became challenging. With the ongoing and timely support from Joe's veterinarian and the nurses, each of the challenges were handled and the pet-parents were able to maximize Joe's comfort as symptoms emerged.

4.2.2. When?

Another common question is "When?" will the disease progress to the stage that pet-parents have to consider the hardest decision to let go? (6) By June, when the X-ray showed the tumor compressing the bronchi, Joe's veterinarian was asked, "what will happen to Joe as the tumor continues to grow, further compressing the bronchi?" She replied "That would be the time to let go". The thought of letting him go was devastating, but that conversation was certainly helpful, and also raised the topic of advanced directive.

4.3. Advanced directives

Decide beforehand about euthanasia. Why? First, acute illness crises are distressing, decision-making becomes emotive and sub-optimal, and may be regretted later. Second, knowing in advance the plan of action enables practical and emotional preparation for death. Emotional preparation allows pet and parents to share quality time before symptom distress intrudes, which facilitates pet-parent bereavement adjustment. Third, Von Clauswitz's adage "no plan survives first contact with the enemy" applies. Disease trajectories vary and, in Joe's case, he thankfully remained independently active until the last afternoon of his life. Despite anticipating and planning for breathlessness, pain and pneumonia, the pet-parents instead frequently faced nocturnal fever spikes requiring ice packs, and appetite loss. In his last week, Joe's love of eating gradually faded. Finding something he enjoyed was helped by daily variation of his diet. But some days he would not eat, so the Vet nurses called Joe to the clinic, hand-feeding him tinned dogfood, which he always relished! The first weekend of August saw him increasingly dyspnoeic and, despite the Oxygen concentrator, Joe was progressively uncomfortable. After a Sunday night that saw him largely sedated it was clear on Monday morning that he was struggling to breathe. He went outside to pee on awakening and stood sniffing the air between panting. When taken back to his bed he unusually ignored the sounds of breakfast time, and just laid there. Joe almost never barked, but at that moment, he made one clear and loud bark. The pet-parents felt this was his request to go. The Vet team was contacted and made a home visit over their lunchbreak that day. Before the euthanasia infusion syringe was even half empty Joe was still. He chose his time, staying independent to the end.

Accompanying the vet were all the clinic nurses who had helped care for Joe over the years and who had come to say goodbye. To know he was such a widely-loved old boy meant so much to us.

The bereavement was long, and 18 months later we have found a way to both accept Joe is gone while keeping his memory alive. It hasn't always been easy.

Joe enjoyed 22 weeks of good quality, stress-free life, independence and indulgence from when his diagnosis was confirmed. We were pleased to have been able to care for him, spoil him a little, and enjoy his remaining time. This wouldn't have been possible to anything like the same extent without the support of a great veterinary team.

5. The vet perspective

Within daily veterinary practice, the need to manage pets with life-limiting disease is a growing problem that all vets face on a regular basis. In particular how do we best support pet-parents to care for elderly and terminally ill pets? Good communication is key. Communication enables planning and predictability, which in turn enhances a sense of control over what can feel like a helpless situation to the owner. As Joe's case exemplifies, five main elements helped ensure both the pet's physical comfort as well as the pet-parents' mental comfort:

5.1. Empathy and decision-making.

5.1.1. Empathy

Empathy is something easier said than done. Often, we see so many sick patients that we forget to show sincere compassion to every owner. This is especially difficult on a busy day rushing between patients. When I disclosed an open diagnosis of Joe possibly suffering from pulmonary neoplasia or lung consolidation, the owners were shocked and tearful. Sometimes a pat on the shoulder better shows one's empathy over words (6).

5.2. Take time with client communication

Especially in terminal/incurable disease, schedule the owners for the last morning or evening consult enabling extra time and privacy if needed. In Joe's case, with the radiographs suggestive of probable neoplasia, a pre-lunch appointment was allocated, when no other clients are waiting, instead of breaking the news immediately over the phone (never!) or between other consults. Deliver news in digestible pieces, allowing owners time to accept

and digest the situation. Check that they are emotionally ready before presenting more information and options to them. This is the ADA approach in practice (6).

5.3. Deliver information in Layman's terms using a gentle tone

Joe's owners have medical backgrounds, making it easier to explain Joe's condition without too much confusion. But for most owners, jargon can confuse. So, lay terms, for example, "lung cancer" instead of "pulmonary neoplasia" should be used wherever possible. Check understanding is correct. After owners have understood the diagnosis, the usual illness trajectory in dogs with lung cancer can then be explained, along with localized vs. metastatic disease, and likely signs the animal may show as the disease progress. This increased predictability benefits owners' sense of control, which helps to reduce their stress and anxiety (6). Recognize cancer is a scary thing to most people, vets included.

5.4. Advanced directives: provide options and hope

Engage them in the decision-making process after you have presented them with all the information. Giving realistic hope may sound very contradictory when dealing with an incurable disease, but hope is what keeps us all going. Normally when dealing with cancer or other chronic disease, the owner's first question is: Is it curable? If not, what could be done to slow down the progress and relieve any discomfort? In Joe's case, despite facing Pulmonary Adenocarcinoma, there were options to managing his illness and quality of life: surgery and/or palliative treatment. As veterinarians we have the medical knowledge to inform the owners of different treatment methods and their likely survival times but our most important goal is to present this information with the pros and cons to allow the owner to make an informed decision with all the facts. It is important to let the owners make their own decision informed by your guidance and experience. Avoid forcing your ideals onto them, though, as in human cancer treatment decision-making, a clinician's recommendation can be a helpful proxy for a client's lack of technical knowledge. There is no absolute right or wrong decision.

In Joe's case, Primary Pulmonary Adenocarcinoma, diagnosed by CT scan and histopathology, was displacing the bronchus and Aorta. Surgery was feasible, but significantly invasive with its own risks and complications. Medical treatment including curative and palliative chemotherapy would only retard disease progress and relieve symptoms temporarily, but with significant impact on QoL. After explaining the pros and cons of all the options, the clients were asked what they thought was best for Joe: maximum survival time, or comfort with minimal aggressive treatment? It is very important to listen to what the owners want for their pet and guide them through options that best fit their expectations. Joe's owners chose palliative treatment comprising a combination of symptomatic treatment with conventional medicine, supplemented by traditional Chinese Medicine for coughing and delaying the disease progress.

5.5. Continuity of care

Lastly, and most importantly, regular follow-ups support owners emotionally and clinically, and provide peace of mind. In Joe's case, phone call follow-ups (either by me personally or clinic nurses) every 2–3 weeks checked if the owners needed any help or guidance. Once every 1-to-2 months Joe came for a check-up. This involved repeat radiographs to check the size of the carcinoma and a basic blood profile to check for significant leucocytosis suggestive of inflammatory process or secondary infection warranting anti-inflammatories or antibiotics. As the disease approached end stage, guidance of how to gauge quality of life was given to the owners and the topic of when was the time to let go was gently brought in. Information about cremation and other options for managing the body was given in case of sudden death. The owners achieved a clear idea of when to let go and had prepared well for Joe's departure. After Joe passed away, the clinic prepared a sympathy card to show our care, love and sorrow.

To conclude, although our experience and medical knowledge is imperative in keeping the patient comfortable, for me, to successfully handle a case well also involves genuine empathic care for the pet and ensuring good open communication is maintained with the owners.

6. Summary

Good communications care facilitates physical care, which in turn, can enhance quality of life for both animal and their humans. While we were lucky with Joe in terms of his illness trajectory, and our own professional backgrounds undoubtedly helped, for most companion animal-human families, potentially different scenarios are not uncommon. Even so, the growing recognition of the need for, and emphasis on clinical communications skills training in medical doctors, show the recognition good communications and careful communications planning facilitates decision-making around difficult topics such as breaking bad news, handling questions, and end-of-life care planning, including advanced directives (6). These have consistently shown to benefit quality of life in patients and their families before, and importantly, after death. There is no reason to think that this will not be the case in veterinary care also.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study of animal participants in accordance with the local legislation and institutional requirements. Written informed consent was obtained from the owners for the participation of their animals in this study.

Author contributions

WL contributed in conception, drafting, and editing the manuscript. RF and LC contributed in drafting and editing the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

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

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The efficacy of Equine Assisted Therapy intervention in gross motor function, performance, and spasticity in children with Cerebral Palsy

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Purpose: To evaluate the efficacy of Equine Assisted Therapy in children with Cerebral Palsy, in terms of gross motor function, performance, and spasticity as well as whether this improvement can be maintained for 2 months after the end of the intervention.

Methods: Children with Cerebral Palsy participated in this prospective cohort study. The study lasted for 28 weeks, of which the equine assisted therapy lasted 12 weeks taking place once a week for 30 min. Repeated measures within the subject design were used for the evaluation of each child's physical performance and mental capacity consisting of six measurements: Gross Motor Function Measure-88 (GMFM-88), Gross Motor Performance Measure (GMPM), Gross Motor Function Classification System (GMFCS), Modified Ashworth Scale (MAS) and Wechsler Intelligence Scale for Children (WISC III).

Results: Statistically significant improvements were achieved for 31 children in Gross Motor Function Measure and all its subcategories ($p < 0.005$), also in total Gross Motor Performance Measure and all subcategories ($p < 0.005$). These Gross Motor Function Measure results remained consistent for 2 months after the last session of the intervention. Regarding spasticity, although an improving trend was seen, this was not found to be statistically significant.

Conclusion and implications: Equine Assisted Therapy improves motor ability (qualitatively and quantitatively) in children with Cerebral Palsy, with clinical significance in gross motor function.

KEYWORDS

Cerebral Palsy, equine assisted therapies, gross motor function, gross motor performance, spasticity

1. Introduction

Cerebral Palsy (CP) is a permanent, non-progressive encephalopathy that occurs in the brain during its development, before, during the birth, and up to 2 years after the birth (1–3). Children with CP have atypical posture and gait patterns due to abnormal muscle tone, reduced control of their muscles, static and dynamic imbalance, incoordination and asymmetry between agonist and antagonist muscles and poor equilibrium reflexes (4, 5). The main target of any therapeutic intervention is to enable patients to carry out daily activities and participation as independently as possible (International Classification of Functioning d230) (6–8).

In equine assisted therapy (EAT) the movement of the horse is utilized to improve functional and sensory limitations of individuals with movement disorders (9, 10). During EAT the muscles strengthen and the range of motion of joints is improved. Also, their stability, the coordination of the movement, the synergy of muscles, the displacement of weight shift and the control of the balance (11, 12) are improved while the oscillation of the patient is reduced due to its effort to maintain posture on the horseback (13–15). EAT also enhances the stability of the hip and trunk with hip and pelvic flexibility (16, 17).

Studies have shown that EAT is beneficial for children with CP for motor function abilities (13, 18–22), standing (13, 20, 23, 24) and sitting balance (25–27), gait parameters (13, 19, 28), the reduction of spasticity (23, 29–31), the symmetry of muscle activity (32), the joint range of motion (29) as well as in psychosocial domains and quality of life (18, 19, 21, 33, 34). The common outcome measures in the above studies were the Gross Motor Function Measure (GMFM) and Pediatric Balance Scale (PBS).

Furthermore, the duration of the positive effect of the EAT after its termination is questionable, having not been extensively investigated. In the literature, only two studies (35, 36) using GMFM found that participants had positive results in their gross motor function that was maintained from seven to 10 weeks, following the completion of the intervention.

This study aimed to investigate the effect of EAT on gross motor function, performance, and spasticity in children with CP in terms of GMFM, Gross Motor Performance Measure (GMPM) and Modified Ashworth Scale (MAS). This study also aims to investigate whether these improvements continue to exist after a two-month follow-up from the completion of the intervention.

2. Materials and methods

This prospective cohort study was registered in the clinical trials database (NCT01621984 Unique Protocol ID: 274/21-9-2011) and was approved by the Scientific Committee [12/24-8-2011 (θ.17)] and Administration Board (38/3–102,011 θ.33) of the University Hospital of Ioannina. All procedures performed in studies involving human or animal participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

2.1. Data collection

2.1.1. Participants

Participants were sought within the registry of the Department of Physical Medicine and Rehabilitation and the Pediatrics Department of the General University Hospital of Ioannina, as well as through the non-profit organization "MERIMNA." Informed consent was signed by the parents or caregivers after informing the purposes of the study and were assured the confidentiality of the personal data. Assessment and selection of children who met the inclusion criteria followed as outlined below. This study conforms to all CONSORT and STROBE guidelines and reports the required information accordingly.

2.1.2. Inclusion criteria

The Inclusion criteria included: (1) children aged from 3 to 18 years old with CP; (2) written parental consent; (3) children with adequate range of motion to sit astride on the horse (participants should also have at least partial head control).

2.1.3. Exclusion criteria

Exclusion criteria included: (1) unregulated epileptic seizures; (2) any musculo-skeletal disorder which could be aggravated by the motion of the horse; (3) allergy to the dust of the riding arena; (4) previous experience in EAT (5) botulinum toxin injections in any muscle during the last six months and (6) any surgery within a year prior to the study.

2.2. Instruments

2.2.1. GMFM-88

The Gross Motor Function Measure is the most common quantitative outcome measure used for children with CP (37, 38) to evaluate a change occurring over time in gross motor ability after various clinical interventions (37, 38). It quantitatively measures gross motor function, an activity a child can do (GMFM-88) or a level of motor ability achieved (GMFM-66) (38). GMFM-88, which was used for the present study, includes 88-point assessment criteria, being distributed across 5 categories: (A) lying and rolling, (B) sitting, (C) crawling and kneeling, (D) standing and (E) walking, running & jumping. Each category is comprised of several elements graded from 0 to 3 units (0 = the child is not able to start an activity and 3 = the child is able to fully complete the activity). It has been studied for its reliability and validity (37–39).

2.2.2. GMPM

The Gross Motor Performance Measure assessed the quality of movement, which means how well an activity is completed. It has been designed to be used in combination with GMFM (40, 41). It is a criterion-based observational measure evaluating five different aspects of quality of movement: alignment, stability, coordination, weight shift and dissociation over 20 GMFM items (40, 41). It additionally has been studied for its reliability and validity (41, 42).

Abbreviations: CP, Cerebral Palsy; EAT, Equine Assisted Therapy; GMFCS, Gross Motor Function Classification System; GMFM, Gross Motor Function Measure; GMPM, Gross Motor Performance Measure; MAS, Modified Ashworth Scale; Wisc III, Wechsler Intelligence Scale for Children, 3rd edition.

2.2.3. MAS

The Modified Ashworth Scale is a measure of resistance to passive stretch which has been studied for its reliability and validity. A six-point numerical scale (0, 1, 1+, 2, 3, 4) grade spasticity from zero to four, with zero being no resistance and four being a joint rigid in flexion or extension (43, 44). While resistance and passive movement from the hip joint were both measured from five repetitions.

2.2.4. Measuring procedure

Gross motor function and performance, as well as spasticity of all participants who were included in the study, were assessed. All participants were categorized cognitively, with Wisc III, and motorically, with the GMFCS. The total number of children was subdivided into two subgroups, the first included children with severe deficits and the second included children with mild and moderate deficits, according to their cognitive or/and functional capacity. This was completed to identify changes in cognitive and gross motor capacity (progress of the functionality) within these two groups of children.

For each patient, six measurements took place using the GMFM scale and the MAS. The GMPM scale was measured at two different time points, before and after the intervention (Table 1). Successive assessments of the children were carried out by two independent researchers (AP, DV) who were experienced in the use of the assessments and were blinded to the results of previous assessments. The evaluators of Wisc III were child psychiatrists who were blinded to the study and this assessment took place in State Pediatrics Educational Center in Ioannina.

TABLE 1 Time points for the assessment of GMFM, GMPM and MAS.

Time points for GMFM and MAS	
Assessments	**Time point**
*Assessment 1	8 weeks before the start of the intervention
	4 weeks before the intervention
	Just before the planned intervention
Assessment 2	6 weeks after the start of the intervention
Assessment 3	12 weeks after the start of the intervention (at the end of the intervention)
Assessment 4	8 weeks after the end of the intervention
Timepoints for GMPM	
Assessment 1	Just before the planned intervention
Assessment 2	12 weeks after the start of the intervention (at the end of the intervention)

*Assessment 1 calculated as the average value of the 3 measurements performed before the intervention.
GMFM, gross motor function measure.
GMPM, gross motor performance measure.
MAS, modified Ashworth scale.

2.3. Intervention

The equine assisted therapy lasted for 3 months (12 weeks) each session consisting of 30 min of exercise on the horseback taking place every week at the Ioannina Therapeutic Riding Center, Greece. Participants continued to receive their conventional rehabilitation program throughout the pre-and post-intervention as well as during the intervention.

Three horses, trained for therapy purposes, of varying sizes were used to match the sizes of the participants. Two qualified professionals in EAT carried out the intervention which was individualized to the needs of every child. Trained side-walkers ensured the safety of the mounted child and horse leaders followed the instructions from the EAT practitioner for the individualized walking rhythm of the horse. A soft saddle pad with a vaulting girdle was used for the children to be able to perceive the horse's temperature and transmitted movement more easily (13, 45). Adjustable stirrups in the vaulting girdle were used for performing exercises, such as sitting and standing up (45).

All children wore protective riding helmets. Children according to their ability mounted the horse from a mounting ramp with assistance, independently or were passively placed on the horseback by the professional leading the session. The EAT sessions were carried out depending on the children's classification of performance ability according to GMFCS and mental capacity according to Wisc III.

The horse was being led in straight lines, in circles, or a "figure of eight" between cones and serpentines and the child was sitting on the horseback with the eyes open or closed. The horse's gait also varied (moderate to fast walking and trotting) (45, 46). One goal for the participant was to be able to sit independently, with good alignment and symmetry (47).

The ones that were able to follow directions, either because their mental capacity (Wisc III) allowed them to do so or because of their functional capacity (GMFCS I, II, III) or as an outcome of a combination of the above, played a more active role in their therapy and performed more complicated activities.

Each child, depending on motor ability, actively or passively changed position while on the horse (i.e., sitting astride or laying back or in front on the neck of the horse or sitting sideways on the horse) (48, 49). Different body positions on the moving horse ensured that the child would receive multiple vestibular stimuli (46, 48, 49) Stirrups were used (50) so that the child would be able to lift himself and sit back again (48, 51) to strengthen the lower limbs and to improve in shifting the centre of gravity and balance (48).

In order to attain the objectives, set for the EAT intervention, a series of exercises were performed. Exercises that were masked to a form of play were easier to perform. The exercises performed consisted of catching and tossing a ball, throwing rings on the cones, throwing bean bags on the basket, and searching for hidden objects on the horse by catching and tossing a ball to a basket from a moving horse the eye-hand coordination, planning, timing and needed force to perform the task were trained. Hiding objects underneath a saddle pad was aimed to train body orientation and problem-solving.

Children of classification IV and V in GMFCS in combination with respective Wisc III classification, children presenting serious and severe mental disabilities, received passive mobilization of their body on the horseback, directional changes, gradually building up the stimuli depending on their needs and limitations.

To enable active participation with performance wherever possible, a passive or active-assisted approach was applied for exercises of the trunk and extremities (reaching, weight shifting), while on the horse, to increase the range of motion. An effort was made for their active participation wherever this was possible.

2.4. Statistical analysis

Statistical analyses were conducted using Stata 14.1 (StataCorp, College Station, TX, United States). A longitudinal analysis was performed for the GMFM. Univariate and multivariate mixed-effects linear regression models were used (time series analysis was used based on single and multiple linear mixed-effects models with individuals as random effects). In the univariate models, the time of measurement was the primary variable. The comparison for the subgroup was done with paired t-test. The results were considered significant at the level 0.05.

The comparison of the GMPM scale values was done in a univariate manner with paired *t*-tests and in a multivariate way using longitudinal analysis methods.

To compare the values of the MAS at different time points, Fisher's exact test was used. In the multivariate models, the results were adjusted for possible confounding variables, such as gender, age, and assessment based on Wisc III and the GMFCS level for the aforementioned three types of assessment tools. Data on MAS, GMFM and its subcategories were available for six-time points. The first three took place before the intervention. For increased accuracy with respect to the initial measurement of MAS and GMFM, the mean of the three GMFM measurements prior to intervention was used.

3. Results

Thirty-five children fulfilled the initial inclusion criteria and were included in the study. One child withdrew immediately after the first assessment; another one after the second; and two others after the third assessment, all prior to the start of the intervention because the caregiver did not see a benefit to the intervention. Finally, 31 children participated in the EAT intervention (Table 2).

From the 31 children, two subgroups were divided according to their mental or/and functional capacity. Eleven children with severe deficits, and 20 children with mild and moderate deficits. The term severe impairment referred to children with a low score in WISC III (profound and severe, that usually are not able to follow rules and communicate) or/and are classified as Level III, IV, V in GMFCS. Children with severe deficits needed more assistance from the therapist in contrast with children with mild and moderate impairments that they could be more active in the intervention due to their higher cognitive and motor function level (Table 2).

TABLE 2 Demographic data as a whole and per GMFCS level.

Characteristic	Total		GMFCS I		GMFCS II		GMFCS III		GMFCS IV		GMFCS V	
	N (31)	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Sex												
Male	18	58.06	4	50	3	37.5	4	66.67	3	75	4	80
Female	13	41.94	4	50	5	62.5	2	33.33	1	25	1	20
WISC III												
Normal	10	32.26	6	75	2	25	2	33.33	0	0	0	0
Low average	1	3.23	1	12.5	0	0	0	0	0	0	0	0
Mild	1	3.23	0	0	0	0	1	16.67	0	0	0	0
Moderate	3	9.68	1	12.5	1	12.5	0	0	1	25	0	0
Sever	9	29.03	0	0	2	25	0	0	2	50	5	100
Profound	7	22.58	0	0	3	37.5	3	50	1	25	0	0
Type of CP												
Hemiplegia	2	6,45	2	25								
Diplegia	12	38,71	5	62,5	6	75	1	16,67	1	25		
Quadriplegia	17	54,84	1	12,5	2	25	5	83,33	3	75	5	100

	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Age	31	10.39 (5.07)	8	7.13 (3.72)	8	11.75 (5.7)	6	11.17 (5.31)	4	12 (5.89)	5	11.2 (4.6)
Weight	31	35.16 (17.51)	8	27.5 (13.09)	8	47 (20.3)	6	35.67 (18.73)	4	37.25 (17.8)	5	26.2 (9.98)
Height	31	1.29 (0.27)	8	1.23 (0.22)	8	1.4 (0.35)	6	1.29 (0.18)	4	1.26 (0.35)	5	1.21 (0.27)

GMFCS, gross motor function classification system.
WISC, Wechsler intelligence scale for children.

TABLE 3 Comparison of the GMFM and dimensions (A, B, C, D, E) between the different time points (assessments 2, 3, 4) and the initial measurement (assessment 1).

Characteristic	N	Total ($N = 31$)		Value of p	
		Mean (SD)	Mean difference (SE*)	Univariate model	Multivariate model**
GMFM, A					
Assessment 1	31	81.54 (22.19)	0	–	–
Assessment 2	31	86.4 (19.36)	4.86 (1.02)	<0.0001	<0.0001
Assessment 3	31	89.41 (18.22)	7.87 (1.02)	<0.0001	<0.0001
Assessment 4	29	88.03 (19.93)	6.31 (1.06)	<0.0001	<0.0001
GMFM, B					
Assessment 1	31	74.68 (29.84)	0	–	–
Assessment 2	31	78.92 (28.95)	4.25 (1.17)	0.0003	0.0003
Assessment 3	31	82.15 (28.91)	7.47 (1.17)	<0.0001	<0.0001
Assessment 4	29	81.73 (28.19)	5.27 (1.21)	<0.0001	<0.0001
GMFM, C					
Assessment 1	31	61.93 (39.42)	0	–	–
Assessment 2	31	67.28 (38.42)	5.35 (1.06)	<0.0001	<0.0001
Assessment 3	31	69.12 (38.23)	7.19 (1.06)	<0.0001	<0.0001
Assessment 4	29	69.05 (37.26)	5.79 (1.10)	<0.0001	<0.0001
GMFM, D					
Assessment 1	31	53.27 (36.78)	0	–	–
Assessment 2	31	58.23 (37.78)	4.96 (1.30)	0.0001	0.0001
Assessment 3	31	62.61 (37.74)	9.35 (1.30)	<0.0001	<0.0001
Assessment 4	29	60.68 (36.85)	7.03 (1.35)	<0.0001	<0.0001
GMFM, E					
Assessment 1	31	44.01 (34.88)	0	–	–
Assessment 2	31	48.16 (36.36)	4.15 (0.99)	<0.0001	<0.0001
Assessment 3	31	51.48 (37.47)	7.47 (0.99)	<0.0001	<0.0001
Assessment 4	29	50.2 (36.81)	6.26 (1.02)	<0.0001	<0.0001
GMFM, Total					
Assessment 1	31	62.88 (30.83)	0	–	–
Assessment 2	31	67.8 (30.44)	4.92 (0.71)	<0.0001	<0.0001
Assessment 3	31	70.94 (30.24)	8.05 (0.71)	<0.0001	<0.0001
Assessment 4	29	69.98 (30.08)	6.38 (0.73)	<0.0001	<0.0001

*Compared to the pre-intervention value.
**The multivariate model has been weighted for gender, age, level of WISC III and GMFCS level. GMFM, gross motor function measure.

3.1. GMFM-88

Of 31 children, 29 participated in the last assessment (assessment no 4) that took place 2 months after the end of the intervention. The total score of GMFM increased significantly ($p < 0.0001$) after 6 weeks (assessment no 2) (mean difference = 4.92) as well as after 12 weeks (assessment no 3) of the intervention (mean difference = 8.05) (Table 3; Figure 1). Nevertheless, a statistically significant decrease ($p = 0.0217$) in the total GMFM score was observed between the 3rd third (at the 12th week, the end of the intervention) and the fourth 4th assessment (2 months after the end of the intervention). However, the total GMFM in the 4th assessment was still significantly better ($p < 0.005$) than the 1st assessment and about the same as the 2nd assessment (mean difference = 2.18). Statistically significant improvements were also observed in all subcategories of GMFM (A-D) but not in subcategory E (walking running and jumping) of non-ambulatory children (level V of GMFCS) ($p > 0.005$). A greater improvement of the total score was found for children classified as GMFCS III (13.65), then IV (10.61), then II (9.98), V (4.26) and lastly I (3.03) (differences between assessments 1st and 3rd).

3.2. GMPM

Gross motor performance measure was measured of 29 participants. Distribution across the GMPM scale and its subcategories, for two

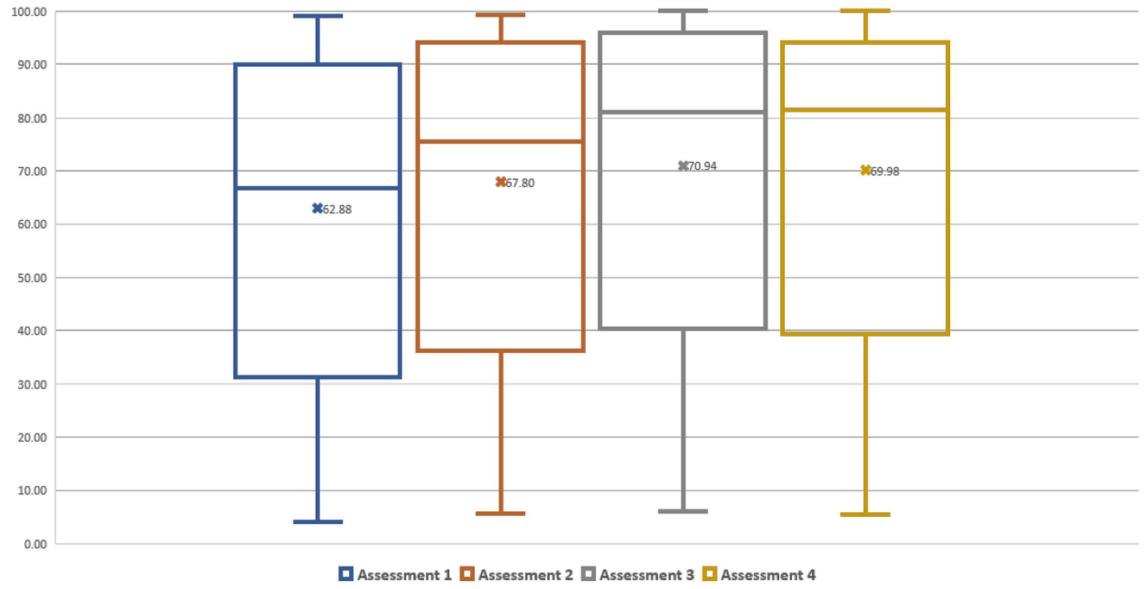

FIGURE 1
Diagram of mean GMFM of the 4 assessments.

TABLE 4 Comparison of the GMPM and its subcategories, before and after the intervention.

Scale	Before the intervention $N = 29$ Mean (SD)	After the intervention $N = 29$ Mean (SD)	Mean difference (SE)	Paired t-test p	Multivariate model*
Dissociated movement	51.69 (30.38)	56.4 (28.38)	4.71 (1.55)	0.005	0.0019
Coordination	52.82 (22.51)	60.56 (24.45)	7.74 (1.93)	0.0004	<0.0001
Alignment	52.46 (18.05)	57.24 (21.75)	4.78 (1.73)	0.0101	0.005
Weight shift	42.87 (18.64)	49.93 (21.9)	7.06 (1.50)	0.0001	<0.0001
Stability	56.39 (21.73)	64.81 (21.21)	8.42 (1.85)	0.0001	<0.0001
Total	51.25 (21.25)	57.66 (22.39)	6.42 (1.12)	<0.0001	<0.0001

*The multivariate model has been weighted for gender, age, level of WISC III and GMFCS level.

different time points is presented in Table 4. A statistically significant increase in GMPM and all its subcategories was achieved (Table 4). Children classified as level I (8.17) on the GMFCS showed greater improvement in the total score, followed by levels V (6.66), IV (6.25), III (5.58) and lastly, II (4.93) (differences between assessments 1st and 3rd).

3.3. MAS

Nineteen of the participants had spasticity and three of them did not participate at the last assessment 2 months after the end of the intervention. Ashworth scale values of the different time points are presented in Table 5. A decrease in spasticity is seen over the time points, but it was not found to be statistically significant per Fisher's exact test criterion ($p = 0.350$).

3.4. Results of subgroups

All participants, regardless of mild–severe deficits, demonstrated statistically significant improvement in the GMFM (mean difference = 7.16 and 9.67 respectively) and GMPM (mean difference 6.53 and 6.19 respectively) ($p < 0.05$) (Table 6). No statistical significance was observed between the two groups.

3.5. Minimal clinically important differences (MCID)

According to the literature (52), clinically important improvement was observed (average low-value differential >1.29 and high value >3.99) in all GMFM analyses between the initial assessment (assessment no 1) and the 12th-week assessment (assessment no 3), regarding the total number of the children (8.06), but also in the subgroups of children with mild and moderate deficits (7.16) and children with severe deficits (9.67). The same was observed between the initial and the final assessment. This is a high-power study (100.00 and 95.86%, respectively, for average low differential and average high differential MCID) according to the post-hoc power estimation for Minimal Clinically Important Differences.

TABLE 5 Modified Ashworth scale results.

Grades of MAS	Assessment 1	Assessment 2	Assessment 3	Assessment 4
	N (%)	*N* (%)	*N* (%)	*N* (%)
Missing	0 (0)	0 (0)	0 (0)	3 (9.86)
0	12 (38.71)	12 (38.71)	13 (41.94)	12 (38.71)
1	1 (3.23)	1 (3.23)	2 (6.45)	1 (3.23)
1+	4 (12.9)	6 (19.35)	4 (12.9)	7 (22.58)
2	6 (19.35)	4 (12.9)	10 (32.26)	3 (9.68)
3	7 (22.58)	7 (22.58)	1 (3.23)	4 (12.9)
4	1 (3.23)	1 (3.23)	1 (3.23)	1 (3.23)
Total	31 (100)	31 (100)	31 (100)	31 (100)

Fisher's exact test, p-value = 0.350.
MAS - modified Ashworth scale.

TABLE 6 Mean (SD) total GMFM and GMPM in subcategories of children with 1. mild and moderate deficits and 2. severe deficits.

Subgroups	Mild and moderate deficits $N = 20$			Severe deficits $N = 11$			Difference between groups		
	Difference before-after	Standard Error	value of p	Difference before-after	Standard error	value of *p*	Difference	Standard error	*p*-value
GMFM total	7.16	1.21	<0.001	9.67	2.02	0.007	2.51	2.02	0.260
GMPM total	6.53	1.54	0.0005	6.19	1.51	0.0027	0.34	2.40	0.887

GMFM, gross motor function measure.
GMPM, gross motor performance measure.

3.6. Adverse events

There were no adverse events related to the intervention. None of the participants suffered any injury or had any other complication during the study.

4. Discussion

This prospective study aimed to assess the effectiveness of EAT intervention in children with CP. The aforementioned results state, that the participants demonstrated improved GMFM scores that met the criteria of MCID at the last follow-up. All groups show statistical significance ($p < 0.005$) between the assessments (Table 4). An important note is that the results of the intervention show, that there is no statistical difference in the outcomes between the CP subgroups (mild and moderate vs. severe). As it is not correct to compare unsimilar groups we can see significant improvement in both subgroups, stating that the objectives for the rehabilitation were achieved regardless of the level of CP. The results for spasticity showed improvement but were not statistically significant.

In the literature, many studies have shown statistically significant improvement in some subcategories of GMFM and total score of GMFM-66 and GMFM-88 depending on the classification (level I to IV in GMFCS) (13, 20, 35, 47, 49, 50, 53). In our study, statistically significant improvement was observed in all subcategories and the total score of GMFM-88, but, as was expected, there was no statistically significant improvement in subcategory E (walking, running and jumping) of non-ambulatory children (level V of GMFCS).

In two other studies (35, 36), GMFM measurements took place at 7 and 10 weeks following the completion of the intervention, respectively, and found that positive results of GMFM were maintained (no statistically significant difference was noticed from the termination of intervention to the last follow-up). Similarly, in our study, the significant improvement of GMFM was maintained 8 weeks after the completion of the intervention, which was also clinically significant (according to MCID). This means that the increase of GMFM of patients being rehabilitated with EAT (following equine assisted exercises) was leading to better functional abilities.

Regarding GMPM, the current study showed that EAT intervention improved the quality of movement of children with motor dysfunctions. Similar studies in the international literature using GMPM, investigate the benefits of different types of therapeutic exercise with heterogeneous results (54–56).

In the study of MacKinnon et al. (21) children who were able to cooperate better (due to their mental capacity and functional skills) showed increased motor development. Based on our results using GMFM and GMPM and according to GMFCS level, it was observed that in quantitative measurement of motion (GMFM) children classified as II and III improved more compared to other subcategories, while children classified as I and V improved less. The opposite happens concerning the quality of movement (GMPM). A possible theory could be that EAT intervention benefits more children with mild and moderate functional deficits in gross motor function, while children with independent functionality or severe motor disorders are mainly benefited in terms of the quality of movement. Probably children with independent functionality (level I) as well as with severe motor disorders (V) cannot give statistically significant results in

contrast to mild and moderate motor deficits (II, III) where the intervention seems to give statistically significant results.

While statistically significant differences were found in our measures, this does not necessarily translate to clinically important differences. Minimal Clinically Important Differences (MCID) provide the threshold for determining if clinically important differences take place before and after an intervention (57). Our study has shown the clinical significance of the change in gross motor function of children by the equine assisted therapy intervention. In the study of Davis et al. (33) both the statistical and clinical significance of gross motor function changes were not proven results, while in a review study by Little et al. (58), the clinically meaningful effect of hippotherapy on gross motor function in the short term was small.

Regarding spasticity and MAS, one randomized trial (59) and one meta-analysis (60) showed a statistically significant improvement in adductor spasticity (32, 59) and generally in the muscles of the pelvis and lower limbs (29, 61, 62). Nevertheless, in another study (63), results were similar to ours, since no statistically significant improvement had been observed concerning adductor spasticity. Antunes et al. (64) noticed an improvement in adductor spasticity when horse walking and trotting were included. It is worth mentioning that the benefits of this intervention were short-term (32, 59–62, 64). This is shown by the fact that measurements in these studies were made just before and after the treatment was completed (32, 61, 64), in contrast to our study, where spasticity was measured at a pre-determined appointment after the intervention. The above studies are possibly based on the fact that prolonged muscle stretching for a period of 10–30 min is effective in reducing spasticity and may last up to 35 min after exercise completion (65). It has also been mentioned that spasticity improvement has been maintained up to at least 4 days (62). The fact that in our study final assessments for each patient took place in a period of 1–5 days after the end of the intervention, may hide the possible beneficial immediate effect of EAT on spasticity.

4.1. Strengths and limitations

The strength of the study is the relatively large number of participants in comparison to other studies (10, 11, 17, 60, 66–68), as well as the participation of children of various functional levels and with a diversity of motor dysfunctions. It also categorized the results in children with different functional levels. The intervention was led by different professionals than those conducting the assessments and were blinded. Another strength was, that the horses with staff stayed the same for the children throughout the intervention.

A disadvantage of our study was that children varied greatly in functional classification in all subcategories according to GMFCS and Wisc III. So, in children of lower classification in Wisc III, communication and cooperation were difficult. We may have had more significant improvement with an intervention, which would have lasted several months longer or the conditions were designed for the children to participate more frequently in the therapy. This research, as others (47, 49, 50), uses the same children as a control group before and after the intervention, instead of other participants who would not have gone through any EAT as in a typical control group. This may be initially seen as a study limitation, but in reality, it may also be a sensitive way of detecting even the slightest therapeutic changes (49), since the development of each child with CP may vary. The children continued to receive their conventional therapies throughout the intervention period and follow-up. Even though the strength of the statistical analysis for the modified Ashworth scale changes is low, the results are valid for our sample.

5. Conclusion

The findings of this study support that EAT may improve gross motor function and performance in children with CP, even 2 months after the end of the intervention. These findings should be reinforced with more research, as many clinically significant results were found.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving human participants were reviewed and approved by the Scientific Committee [12/24-8-2011 (θ.17)] and Administration Board (38/3–102,011 θ.33) of the University Hospital of Ioannina. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

AS: conceptualization, formal analysis, investigation, methodology, visualization, and roles and writing – original draft. SM-R: data curation, methodology, software, and writing – review and editing. DV: conceptualization, investigation, resources, software, visualization, roles and writing – original draft, and writing – review and editing. MT: conceptualization, investigation, project administration, and supervision. PP: data curation, investigation, and resources. AB: formal analysis, software, supervision, and writing – review and editing AP: conceptualization, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, and writing – review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Ownership of dogs and cats leads to higher levels of well-being and general trust through family involvement in late adolescence

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Introduction: Late adolescence is a crucial period during which individuals connect with new communities. Furthermore, their mental health has lasting effects on their overall well-being. Involvement with family and the local community plays a significant role in shaping adolescents' personalities and well-being. Additionally, pets, such as dogs and cats, function as social catalysts and increase interactions with family and the local community. We hypothesized that pet ownership would increase involvement with family and the local community and thereby impact adolescents' personalities and well-being.

Methods: Therefore, this study investigated whether owning dogs or cats was related to well-being through increased involvement with family and local community members in late adolescence. Data were collected via a questionnaire administered to high school and university students. The questionnaire included questions on basic information about adolescents and their families, pet ownership experience, family and local community involvement, well-being, cultural estrangement inventory, and general trust.

Results: Structural equation modeling revealed that adolescent women who owned dogs or cats had higher well-being and general trust through their involvement with their families. Although previous research reported that men who had experienced pet ownership in childhood were more sociable in old age, the effect of pet ownership on men was not observed in this study.

Discussion: During late adolescence, when individuals experience many connections with new communities, the effects of pets may temporarily decrease. Therefore, future cohort studies should examine the effects of pets on each age group.

KEYWORDS

dog, cat, adolescent, family, well-being, general trust

1. Introduction

During the transition from late adolescence to early adulthood, individuals often encounter several risks and opportunities (1). Health and mental issues that arise during this period can have a lasting impact on an individual's overall well-being (2). Patton et al. (3) found that mental health disorders during adolescence were the strongest predictors of the same in young adulthood. Additionally, the values and beliefs during adolescence influenced their well-being in older age (4). These findings suggested that an individual's personality and health status had long-term effects on their overall well-being. Japan's mental health ranks 37th out of the 38 developed countries (5). The percentage of adolescents who feel comfortable making friends is

low at 68%, which ranks also 37th (5). Low mental health among adolescents is a serious concern in Japan. Elucidating the factors that influence their well-being and personality could help address this issue.

During late adolescence, individuals form relationships extending beyond familial connections and thus develop their personalities. Environmental factors such as social relationships are relatively stable constituents that influence personality (6). In Japan, a notable personality characteristic is the low level of general trust (7). General trust is a personality of belief in the benevolence of human nature in general and thus is not confined to specific relations. A study has shown that the Japanese are more likely to distrust others than Americans and have fewer opportunities to establish new relationships (7). Conflicts arising from personality and value differences are not exclusive to family members but also occur among friends and others. Individuals who perceive themselves as misaligned with community values may experience self-discrepancy, potentially leading to life dissatisfaction, depression, low self-esteem, and interpersonal anxiety (8).

As adolescents expand their social connections beyond the family unit, the social environment that influences well-being shifts. Maintaining strong ties with family members, particularly parents, is crucial for adolescent well-being (9). Studies have consistently shown, across diverse cultures, that adolescents who are highly engaged with their families experience greater life satisfaction and reduced psychological distress (10). As these individuals progress into late adolescence and spend more time interacting with friends and non-family members, the influence of these relationships on their well-being becomes increasingly evident. Adolescents who maintain higher levels of involvement with friends and neighbors also demonstrate high well-being (11). Thus, during adolescence, interactions with family members, friends, and neighbors are pivotal factors contributing to an individual's well-being.

Pets function as social catalysts that facilitate people-to-people relationships. Walsh (12) suggests that pets can serve as a significant factor in unifying families and mitigating family conflicts. Studies have demonstrated that the presence of a pet enhances interpersonal interactions (13, 14). Beyond the context of familial relationships, pets also contribute to the development of social bonds within local communities. It has been observed that pet owners are more likely to be acquainted with their neighbors compared to non-pet owners, with 40% of pet owners reporting receiving social support from relationships made through their pets (15, 16). Specifically, dog owners were found to be five times more likely to establish new social connections compared to owners of other types of pets (15). In addition, children who had recently acquired a pet dog were reported to have visited more friends during a one-month follow-up compared to children without a dog (17). Through dog walking, dogs can facilitate interactions and help individuals form new relationships (18, 19). People with dogs are often perceived as amiable (20), and dogs serve as effective icebreakers in social situations (15, 21–23). Owing to the necessity of outdoor activities, such as walking, dogs exert a broad impact on interpersonal relationships. In contrast, there are few reports on the social relationships of cat owners. Notably, cat owners who demonstrate a high level of attachment to their pets report lower levels of social support, although the causal direction of this relationship remains unclear (24). Pets, particularly dogs, can potentially facilitate the establishment of connections with others, thereby contributing to enhanced well-being.

Recently, extensive research has been conducted on the relationship between pet ownership (e.g., dogs and cats) and well-being. Many studies have reported that pets are beneficial to people, including adolescents (25). Studies have also reported that owning pets has a positive impact on well-being, regardless of species (26–29). However, other findings suggest that pet species, such as dogs and cats, have different effects on well-being (15, 28, 30, 31). A cohort study in Japan found that adolescents who owned dogs had a consistently high level of well-being from the ages of 10–12 years (31). Conversely, adolescents who owned cats experienced a significant decrease in well-being compared to those who owned dogs or had no pets (31).

Based on these findings, we hypothesized that the ownership of a dog or cat forms a late adolescent's personality, such as general trust, and boosts well-being in late adolescence through the involvement of family and local communities (Figure 1). This study aimed to examine the above-stated hypotheses via structural equation modeling (SEM) using questionnaire survey.

2. Materials and methods

The survey included questions regarding the participants' basic attributes, family composition, pet ownership, involvements with family members and the local community, as well as indicators of cultural estrangement inventory, general trust, and well-being measured using the World Health Organization-Five Well-Being Index. Questions regarding animal attitudes and attachment to pets were also included; however, these were not analyzed.

2.1. Subjects

An online survey was conducted via Cross Marketing Inc. (Tokyo, Japan). Data screening was conducted by the survey company. This screening process targeted only high school and university students and excluded careless responses. We used 2,845 data points for the analysis.

2.2. Participants' basic attributes

The participants answered questions regarding their sex, age, prefecture of residence, occupation (high school or university student), type of residence (apartment or house), and annual household income.

2.3. Family composition

The survey included questions regarding the participants' family composition, such as the age of family members and participants' parents' jobs.

2.4. Pet ownership

The participants' past and current pet ownership experiences were also recorded. This included the type of pet owned (dog, cat, or other),

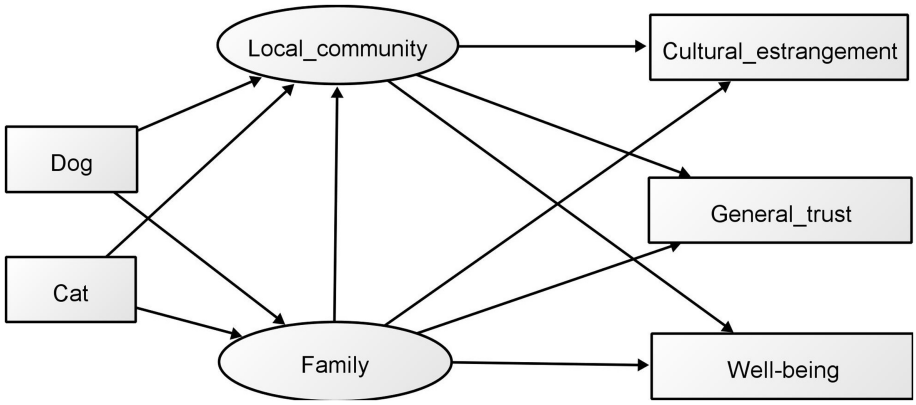

FIGURE 1
Hypothetical model. "Dog" and "Cat" indicate the experience of owning dogs and cats.

where the pet was kept, and the amount of time they spent interacting with the pet when they were in elementary, middle, and high school, as well as university.

2.5. Cultural estrangement inventory

To assess the degree of alignment between one's own values and those of one's family and surroundings, the Japanese version of the Cultural Estrangement Inventory (CEI) developed by Cozzarelli and Karafa (8) was used. The CEI was primarily designed to measure cultural estrangement tendencies in the American culture and consisted of five items each related to culturally atypical and misfit constructs. In this study, the questions were adapted to replace "Japanese people" or "people in this country" with "family," "friends/neighbors," and "community members" (e.g., "I strongly identify with my family's values"). All questions were answered on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The Cronbach's alpha coefficient, indicating the reliability between items, was 0.904 for atypical and 0.883 for misfit, and the total of the atypical and misfit constructs was 0.821. In this study, the total of atypical and misfit was used for the present study's analysis.

2.6. World Health Organization-five well-being index

The World Health Organization developed the Five Well-Being Index (WHO-5) as a simple indicator of mental health. The Japanese version of the WHO-5 was developed by Awata et al. (32, 33) after its equivalence with the original version was confirmed and its procedures were standardized. The WHO-5 consists of five questions that enquire about an individual's moods, such as "during the past two weeks, how often have you been in good spirits?" It has the advantage of being able to measure mental health status within a short period. Responses were rated on a 5-point Likert scale ranging from 1 (all of the time) to 5 (none of the time). The scores were summed across the five questions. The raw scores ranged from 0 to 25 points, with 0 and 25 indicating the poorest and best well-being status, respectively. The Cronbach's alpha coefficient was 0.910.

2.7. General trust

General trust was measured using items developed by Yamagishi (7, 34, 35). The participants were asked to rate their agreement with statements, such as "most people can be trusted," "people who are trusted tend to trust others," "most people are trustworthy," "most people are fundamentally honest," "I tend to trust people," and "most people are basically kind and helpful" on a 7-point Likert scale that ranged from 1 (strongly disagree) to 7 (strongly agree). The Cronbach's alpha coefficient was 0.905.

2.8. Involvement with family

The participants answered three questions regarding their relationships with their families: the amount of time they spent talking with their family (F1), the frequency of conversations regarding themselves with their family (F2), and the amount of time they spent together in a family gathering place (F3) such as a living room. The responses were rated on a 4-point scale. The Cronbach's alpha coefficient was 0.807.

2.9. Involvement with local community

The participants answered questions regarding their frequency of community activities in the neighborhood (LC1); activities that involved interaction with others, such as sports, hobbies, and lessons (LC2); volunteering (LC3); and meeting with classmates outside of school (LC4). Regarding the frequency of meeting with classmates, they answered on a 5-point Likert scale ranging from 1 (never) to 5 (daily). For the other questions, the responses were rated on a 7-point Likert scale ranging from 1 (not participating) to 7 (more than four times a week). The Cronbach's alpha coefficient was 0.572.

2.10. Statistical analysis

Pet ownership was coded as follows: owning a dog was coded as 1, not owning a dog was coded as 0; owning a cat was coded as

1, not owning a cat was coded as 0. This coding was applied for both current and past pet ownership. These were treated as four separate variables. T-tests were performed to evaluate the presence of differences between individuals in well-being, general trust, and CEI across several categories, including: gender (male vs. female), sibling status (presence vs. absence of siblings), type of residence (house vs. apartment), current or past dog ownership (groups with vs. without dogs), and current or past cat ownership (groups with vs. without cats). If adolescents owned both dogs and cats, due to the potential that they were influenced by owning both types of pets, the data were overlapped in the analysis. Pearson's correlation coefficients were used to investigate the relationship between well-being, general trust, and CEI and age, income, and involvement with family and the local community. The significance level was set at 5%. These analyses were performed using JMP® (ver. 14.2.0). Subsequently, we performed SEM using the WLSMV method with the lavaan package in R (ver. 4.2.1). The relatively low Cronbach's alpha coefficients for family and community involvement were speculated to be because they comprised only three and four items, respectively. Consequently, for SEM, we used the individual item values, rather than the aggregate scores, for both family and community involvement. Sex was an important risk factor for mental health disorders. Females were diagnosed with depression and anxiety disorders at much higher rates than males in early adolescence (36) and had lower well-being (37, 38). Therefore, we conducted separate analyses based on sex because different developmental processes could result in different processes related to pet ownership, family relationships, community involvement, and well-being. To control for socioeconomic status, additional analysis was conducted with the model including income. As more than 50% of the respondents did not know their family income and the fit index of the model was low [comparative fit index (CFI): 0.823–0.859, Tucker–Lewis index (TLI): 0.754–0.803, root mean square error of approximation (RMSEA): 0.058–0.067, and standardized root mean squared residual (SRMR): 0.063–0.074], the model was adopted without income. For the observed variables of family relationships and community involvement, we added covariance relationships with modification indices greater than five and adopted the final model to improve statistical validity without losing logical validity.

3. Results

3.1. Descriptive statistics

Among the respondents, 753 were men and 2092 were women. There were 1,033 high school students and 1812 university students. Furthermore, 2,110 people had siblings. Regarding residence type, 1,625 and 1,220 people lived in houses and apartments, respectively. Regarding pet ownership, 773, 592, and 1,480 people currently owned pets, previously owned pets, and never owned pets, respectively. Of those who currently owned pets, 396 owned dogs, 230 owned cats, and 230 owned other pet types. In addition, 415 participants owned dogs, 245 owned cats, and 634 owned other types of pets (some reported ownership of multiple pets). Other descriptive statistics are shown in the Supplementary material.

3.2. Correlation analysis

3.2.1. Well-being

Significant sex differences were observed, with males scoring higher than females [t (2843) = −2.285, p = 0.024]. Current dog ownership was negatively associated with well-being, and those who currently owned dogs scored lower than those who did not [t (2843) = −2.280, p = 0.023]. Similarly, individuals who had previously owned a dog scored lower than those who had never owned one [t (2843) = −2.052, p = 0.040]. Additionally, annual income, local community involvement, and family involvement were significantly correlated with well-being. Higher income was positively associated with well-being (rs = 0.132, p < 0.001), as were greater levels of community involvement (community: rs = 0.108, p < 0.001, rs = 0.155, p < 0.001, rs = 0.119, p < 0.001, rs = 0.211, p < 0.001, rs = 0.226, p < 0.001) and family involvement (family: rs = 0.162, p < 0.001, rs = 0.193, p < 0.001, rs = 0.140, p < 0.001, rs = 0.196, p < 0.001). These results are included in the Supplementary material.

3.2.2. General trust

We examined the effects of having siblings, current dog ownership, and previous dog ownership. Those with siblings scored higher than those without them [t (2843) = 2.617, p = 0.009]. Furthermore, those who currently owned dogs had lower scores than those who did not [t (2843) = −2.629, p = 0.009], as did those who had owned dogs in the past compared to those who had never owned them [t (2843) = −2.190, p = 0.028]. Furthermore, there was a positive correlation between general trust and age (r = 0.062, p < 0.001). There were significant positive correlations among general trust, community involvement, and family involvement (community, LC1: rs = 0.038, p = 0.040; LC2: rs = 0.120, p < 0.001; LC3: rs = 0.057, p = 0.002; LC4: rs = 0.161, p < 0.001; family, F1: rs = 0.081, p < 0.001; F2: rs = 0.130, p < 0.001; F3: rs = 0.073, p = 0.004). These results are included in Supplementary material.

3.2.3. Cultural estrangement inventory

The CEI score was higher for males than for females [t (2843) = −3.352, p = 0.022], and for high school students than for university students [t (2843) = −2.295, p < 0.001]. In addition, significant negative correlations were found with age (rs = −0.061, p = 0.001) and income (rs = −0.084, p = 0.004). Negative correlations were also found with family (talk time: rs = −0.071, p < 0.001; talk about oneself: rs = −0.126, p < 0.001; sharing space: rs = −0.065, p < 0.001) and community involvement (hobby: rs = −0.078, p < 0.001; classmate: rs = −0.164, p < 0.001). These results are included in the Supplementary material.

3.2.4. Family and local community involvement

Regarding family involvement, sex, residence type, current dog or cat ownership, age, and income were significantly related. Women were more involved with their families than men [t (2843) = 10.395, p < 0.001]. Furthermore, those living in houses had higher involvement than those living in apartments [t (2843) = −9.494, p < 0.001]. People who owned dogs and cats had a higher level of involvement than those who did not [t (2843) = 2.379, p = 0.017; t (2843) = 2.532, p = 0.011]. Furthermore, a negative correlation was observed between age and

involvement (rs = −0.138, $p < 0.001$), while, a positive correlation was observed between income and involvement (rs = 0.218, $p < 0.001$).

Local community involvement was significantly related with sex, presence of siblings, past dog ownership, age, and income. Community involvement was higher among men than among women [t (2843) = −1.999, $p = 0.046$], and among those with siblings compared to those without [t (2843) = 2.130, $p = 0.033$]. Those who previously owned dogs were also more likely to have a relationship with the local community [t (2843) = 2.915, $p = 0.004$]. In addition, there was a negative correlation between age and relationship with the local community (rs = −0.117, $p < 0.001$), while, there was a positive correlation between income and the relationship with the local community (rs = 0.096, $p < 0.001$).

A positive correlation was observed between family and community involvement (rs = 0.146, $p < 0.001$).

Considering the connections between these factors, it was possible to explain the hypothesis that owning a dog or cat led to greater involvement with the family and community, which resulted in increased well-being, general trust, and CEI. However, when the direct relationship between owning dogs or cats and well-being, general trust, and CEI was examined, a negative effect was observed for dog ownership, whereas no effect was observed for cat ownership. Additionally, the correlation coefficients were low for items that showed correlations. Well-being, general trust, and CEI could not be explained by a single factor, as each factor was complexly intertwined and generated; this possibility was also considered in the correlation analysis. Therefore, SEM was undertaken based on the hypothesis model.

3.3. SEM

The effects of the current and past ownership of dogs and cats were also examined. All models showed a good fit with the following indices: CFI > 0.95, TLI > 0.92, RMSEA<0.05, and SRMR <0.04. The goodness of fit for each model is shown in Table 1.

3.3.1. Effects of current ownership of dogs and cats

The results for males and females are shown in Figures 2, 3, respectively. The standardized regression coefficients and factor loadings between the components are also shown in each figure. For men (Figure 2), the effect of current dog and cat ownership on the family and local community was not significant. The regression analyses that were significant were from family involvement to local community involvement (standardized $\beta = 0.205$, $p = 0.002$) and well-being (standardized $\beta = 0.179$, $p = 0.001$), and from local community involvement to well-being (standardized $\beta = 0.233$, $p < 0.001$) and general trust (standardized $\beta = 0.208$, $p = 0.002$). The other regression analysis was not significant. All factors were significant in the results of the factor analysis for family and community involvement ($p < 0.001$). The standardized factor loadings for family involvements were 0.595 for talk time (F1), 0.847 for talk about oneself (F2), and 0.496 for sharing space (F3), whereas for local community involvement, the values were 0.350 for community activity (LC1), 0.564 for hobby (LC2), 0.400 for volunteer (LC3), and 0.443 for classmate (LC4). In addition, all covariance relationships, as added with the modified index, were significant ($p < 0.001$). The standardized estimates were 0.577 for community activity (LC1) and volunteer (LC3), −0.112 for volunteer (LC3) and classmate (LC4), 0.308 for family talk time (F1) and space sharing (F3), −0.289 for CEI and general trust, −0.187 for CEI and well-being, and 0.453 for general trust and well-being.

For women (Figure 3), current dog and cat ownership predicted family involvement (dog: standardized $\beta = 0.043$, $p = 0.078$; cat: standardized $\beta = 0.053$, $p = 0.032$). The relationship between dog and cat ownership and local community involvement was not significant. The regression analyses that were significant were from family involvement to local community involvement (standardized $\beta = 0.178$, $p < 0.001$), CEI (standardized $\beta = -0.101$, $p < 0.001$), and well-being (standardized $\beta = 0.184$, $p < 0.001$). Involvement with the local community was also significantly related to well-being (standardized $\beta = 0.248$, $p < 0.001$) and general trust (standardized $\beta = 0.159$, $p < 0.001$). The other regression analysis was not significant. All factors were significant in the results of the factor analysis for family and community involvement ($p < 0.001$). The standardized factor loadings for family involvements were 0.641 for talk time (F1), 0.809 for talk about oneself (F2), and 0.586 for sharing space (F3), while for local community involvement, the values were 0.391 for community activity (LC1), 0.504 for hobby (LC2), 0.403 for volunteer (LC3), and 0.532 for classmate (LC4). In addition, all covariance relationships, as added with the modified index, were significant ($p < 0.001$). The standardized estimates were 0.577 for community activity (LC1) and volunteer (LC3), 0.308 for family talk time (F1) and space sharing (F3), −0.289 for CEI and general trust, −0.187 for CEI and well-being, and 0.453 for general trust and well-being. Moreover, all the covariance relationships, as added with the modified index, were significant ($p < 0.001$). The standardized estimates were 0.520 for community activity (LC1) and volunteer (LC3), −0.131 for community activity (LC1) and classmate (LC4), 0.210 for family talk time (F1) and space sharing (F3), −0.304 for CEI and general trust, −0.267 for CEI and well-being, and 0.483 for general trust and well-being.

3.3.2. Effects of past ownership of dogs and cats

The results for males and females are shown in Figures 4, 5, respectively. The standardized regression coefficients and factor loadings between the components are also shown in each figure.

TABLE 1 Fitness of each model.

Model	Chi2	CFI	TLI	RMSEA	SRMR
Dogcat_now_male	76.134	0.968	0.950	0.033	0.032
Dogcat_now_female	174.917	0.958	0.934	0.039	0.029
Dogcat_before_male	52.751	0.990	0.984	0.019	0.025
Dogcat_before_female	175.839	0.957	0.933	0.039	0.030

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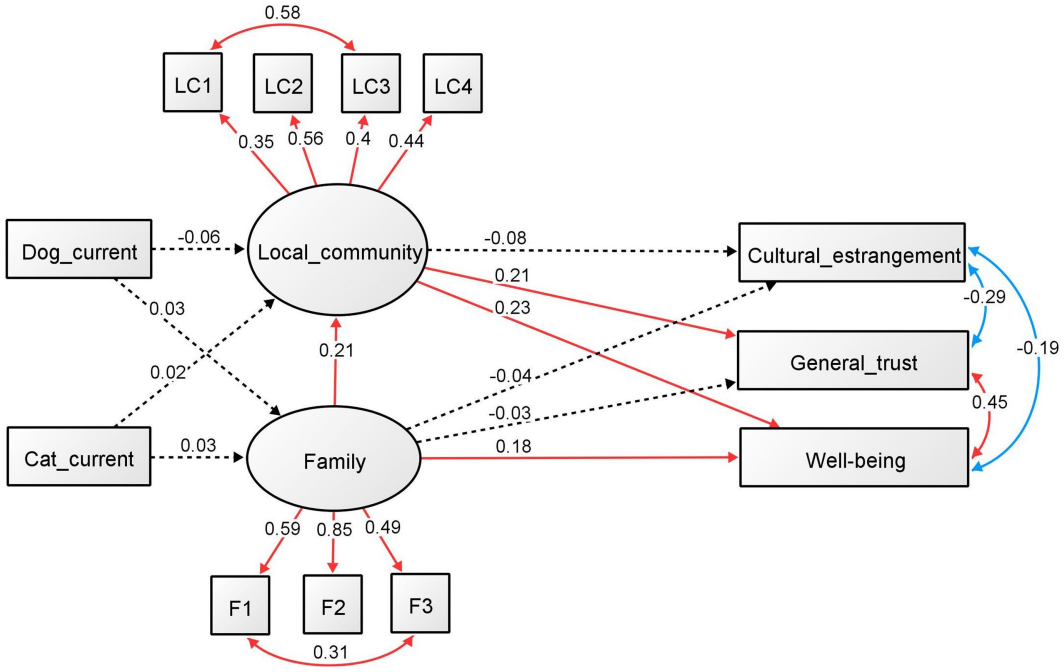

FIGURE 2
SEM of the effects of the current ownership of dogs and cats (males). Standardized regression coefficients and factor loadings between the components are shown.

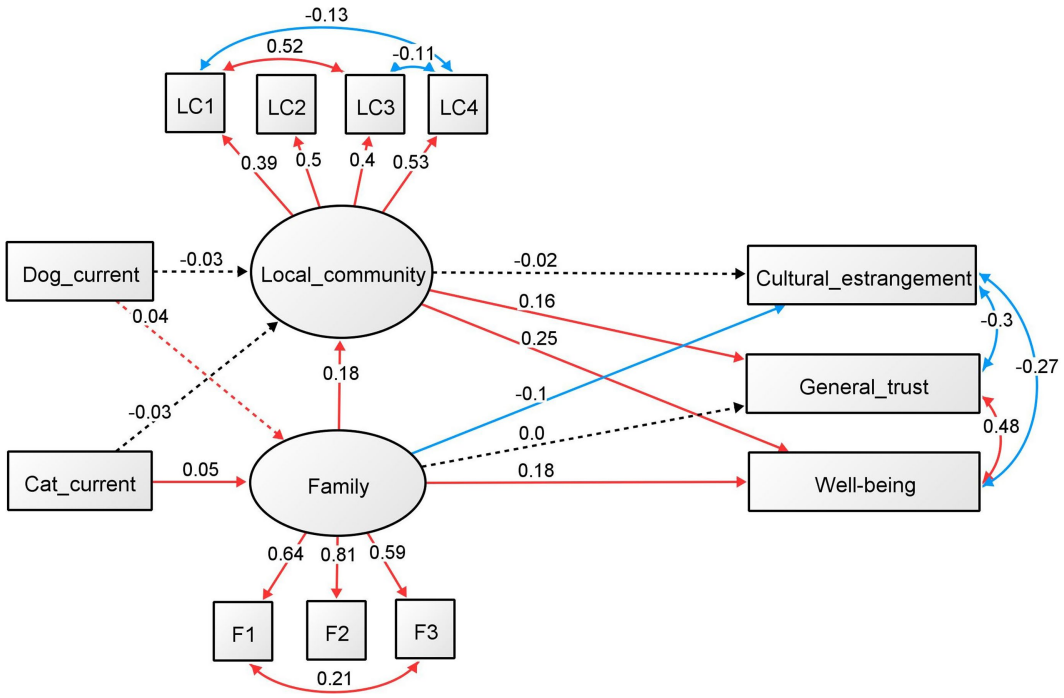

FIGURE 3
SEM on the effects of current ownership of dogs and cats (females). Standardized regression coefficients and factor loadings between the components are shown.

For men (Figure 4), the effect of past dog and cat ownership on the family and local community was not significant. Family involvement was significantly associated with local community involvement (standardized $\beta = 0.199$, $p = 0.003$) and well-being (standardized $\beta = 0.186$, $p = 0.001$). Local community involvement was significantly associated with well-being (standardized $\beta = 0.228$,

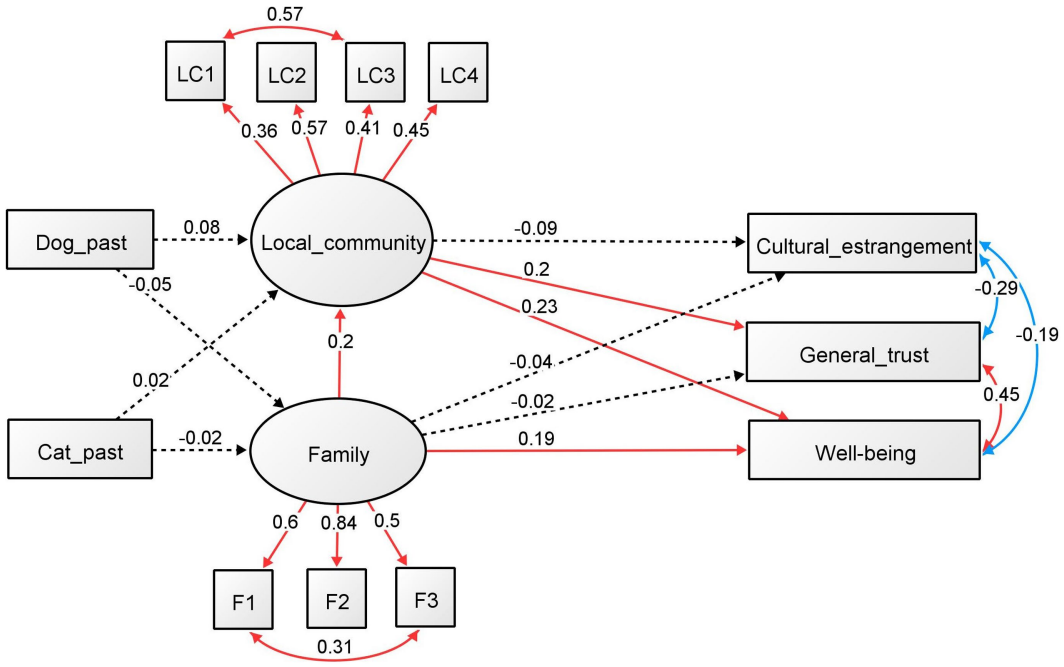

FIGURE 4
SEM on the effects of past ownership of dogs and cats (males). Standardized regression coefficients and factor loadings between the components are shown.

$p < 0.001$) and general trust (standardized $\beta = 0.199$, $p = 0.002$). The other regression analysis was not significant. All factors were significant in the results of the factor analysis for family and community involvement ($p < 0.001$). The standardized factor loadings for family involvements were 0.600 for talk time (F1), 0.840 for talk about oneself (F2), and 0.497 for sharing space (F3), while for local community involvement, the values were 0.355 for community activity (LC1), 0.570 for hobby (LC2), 0.405 for volunteer (LC3), and 0.445 for classmate (LC4). In addition, all the covariance relationships, as added with the modified index, were significant ($p < 0.001$). The standardized estimates were 0.573 for community activity (LC1) and volunteer (LC3), 0.305 for family talk time (F1) and space sharing (F3), −0.289 for CEI and general trust, −0.187 for CEI and well-being, and 0.453 for general trust and well-being.

For women (Figure 5), the effect of past dog and cat ownership on the family and local community was not significant. Family involvement was significantly associated with local community involvement (standardized $\beta = 0.187$, $p < 0.001$), CEI (standardized $\beta = -0.104$, $p < 0.001$), and well-being (standardized $\beta = 0.183$, $p < 0.001$). The other regression analysis was not significant. All factors were significant in the results of the factor analysis for family and community involvement ($p < 0.001$). The standardized factor loadings for family involvements were 0.628 for talk time (F1), 0.821 for talk about oneself (F2), and 0.573 for sharing space (F3), while for local community involvement, the values were 0.324 for community activity (LC1), 0.532 for hobby (LC2), 0.391 for volunteer (LC3), and 0.471 for classmate (LC4). In addition, all covariance relationships, as added with the modified index, were significant ($p < 0.001$). The standardized estimates were 0.553 for community activity (LC1) and volunteer (LC3), −0.078 for volunteer (LC3) and classmate (LC4), 0.226 for family talk time (F1) and space sharing (F3), −0.304 for CEI and general trust, −0.267 for CEI and well-being, and 0.483 for general trust and well-being.

Details on these effects are included in Table 2.

4. Discussion

We hypothesized that owning dogs or cats during late adolescence would have high involvements with family and community, which relate with individual personality and well-being. To test this hypothesis, we conducted a questionnaire survey and SEM.

According to the SEM results, among females, those who currently owned dogs or cats in late adolescence had more family involvement. Family involvement also affected their local community involvement positively. However, no relationship was observed between owning dogs or cats and local community involvement. Adolescents owning dogs or cats have high family involvement. In addition, adolescents that had previously owned dogs had high levels of local community involvement. However, in the SEM, a significant effect was observed only for current ownership of dogs and cats. The absence of any observed effect of past ownership on the SEM could be explained as follows. When multiple factors were considered, the impact of other factors could outweigh that of owning dogs or cats, leading to relatively small effects.

Including certain factors, such as conversation time and content, as well as time spent in the living room with family and increased time spent together in the same room with pets as a central focus, may have led to increased connections with the family by owning dogs or cats. Previous research has reported that pet ownership in families of children with autism spectrum disorder improves family functioning (39). This study suggests that owning pets in the families of adolescent

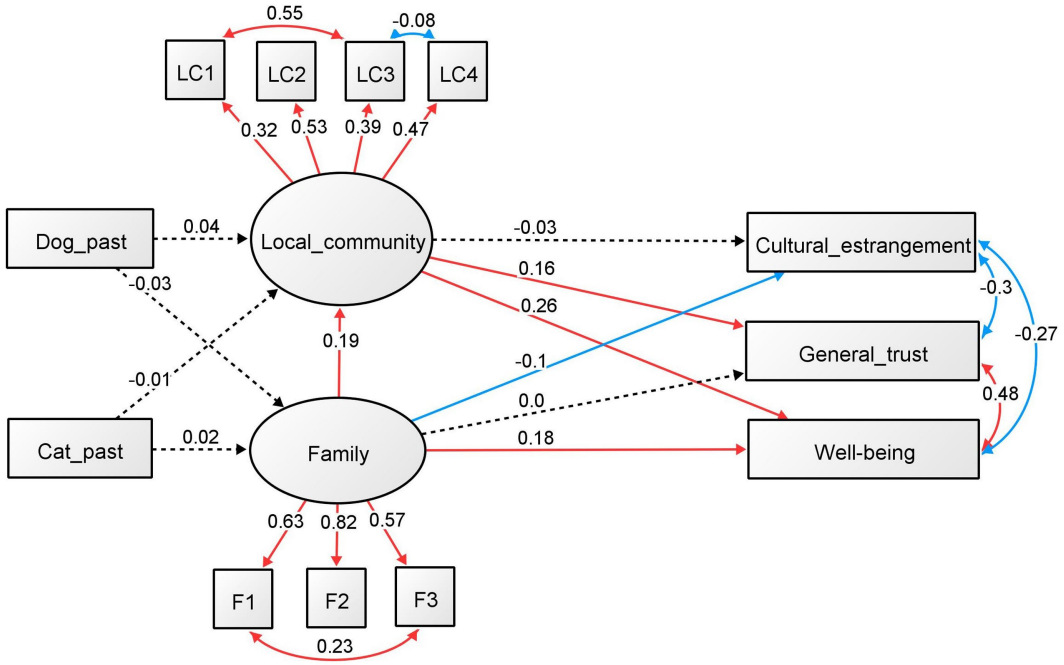

FIGURE 5
The standardized regression coefficients and factor loadings between the components are shown.

females with no or minimal emotional or developmental difficulties may improve family functioning through increased connections between adolescents and their families.

The effects of owning dogs and cats through family and community involvement on well-being was different from in the Tokyo Teen Cohort Study on cat ownership (31). While the Tokyo Teen Cohort Study found negative effects of cat ownership on adolescent children (31), this study also found positive effects of owning cats. One possible explanation for this difference is age, as suggested by Poresky et al. (40). According to their study, the self-concept scores of individuals aged 14–49 years were influenced by the age at which they first owned a pet (40). Individuals who owned pets before the age of 5 years or during adolescence (12–15 years old) had higher positive, physical, and social scores on the Tennessee Self-Concept Scale than those who started owning pets between 6 and 11 years of age (40). Additionally, it has been posited that emotional support from cats can act as a substitute for social support from people (24). Several studies have also demonstrated that pet ownership can alleviate feelings of loneliness and social isolation (27, 41–43). These findings imply that pet ownership may diminish the need to interact extensively with others by reducing feelings of loneliness. Furthermore, the depth of attachment to pets differs depending on the family structure (44, 45), and adolescents' attachment to pets affects their family relationships (29). Therefore, it is crucial to consider variables such as timing of pet ownership, depth of attachment to pets, and degree of interaction with pets to enhance our understanding of their impact.

Interestingly, the factors that influenced the CEI differed between males and females. For males, local community involvement increased their degree of value alignment with their surroundings through ties with the local community. In contrast, in females, both family and local community involvement increased their degree of value alignment with their surroundings. Communities could play a significant role in shaping personality development among males and females in different ways. Previous studies reported that social networks differed between males and females, and females had more family centered networks, while males had more non-kin networks centered on colleagues (46). Even in adolescence, boys have larger friend networks than girls (47). Furthermore, during childhood, boys met their friends more frequently and invested more in them than girls did (48). Women who emphasized close-knit communities had a greater influence on the formation of their values.

Both men and women demonstrated positive effects of local community involvement on general trust. People with low levels of general trust tended to limit their opportunities to engage in new communities by confining their interactions to small networks (34). The transition from late adolescence to adulthood is a period during which people engage in new communities. However, during this period, individuals with limited interactions with their friends and the community, and those who remained in small networks were more likely to have low levels of general trust.

Both men and women showed positive effects on well-being through their involvement with their families and communities. Having meals with family members was linked to high levels of adolescent well-being (49–54). Family, community, and friends involvement enhanced well-being. The strength of social cohesion in the local community was linked to a lower likelihood of experiencing depression and anxiety symptoms in adolescents (55), suggesting that creating a socially cohesive local community could lead to increased well-being. Additionally, friendships and social networks could provide social support for dealing with problems encountered in social life and alleviate perceived stress (56, 57).

This study has several limitations. First, it is a cross-sectional study. Therefore, the causal effects of pet ownership remain unclear.

TABLE 2 Summary of the effects of structural equation modeling.

	Current ownership						Past ownership					
	Male			Female			Male			Female		
	Standardized estimate	SE	*p*	Standardized estimate	SE	*p*	Standardized estimate	SE	*p*	Standardized estimate	SE	*p*
Regressions												
Dog→Family	0.025	0.045	0.577	**0.043**	**0.024**	**0.078**	−0.053	0.047	0.259	-0.027	0.025	0.279
Dog→Local community	−0.062	0.047	0.191	−0.035	0.028	0.263	0.084	0.051	0.103	0.040	0.031	0.195
Cat→Family	0.033	0.046	0.473	**0.053**	**0.025**	**0.032**	−0.022	0.048	0.649	0.019	0.026	0.451
Cat→Local community	0.017	0.054	0.747	−0.032	0.028	0.263	0.023	0.050	0.640	−0.015	0.030	0.620
Family→CEI	−0.045	0.046	0.323	**−0.101**	**0.029**	**0.078**	−0.044	0.046	0.336	**−0.104**	**0.029**	**0.000**
Family→Well-being	**0.179**	**0.054**	**0.001**	**0.184**	**0.032**	**0.000**	**0.186**	**0.054**	**0.001**	**0.183**	**0.032**	**0.000**
Family→General trust	−0.031	0.056	0.578	0.002	0.032	0.938	−0.023	0.056	0.677	0.001	0.032	0.967
Family→Local community	**0.205**	**0.068**	**0.002**	**0.178**	**0.037**	**0.000**	**0.199**	**0.067**	**0.003**	**0.187**	**0.039**	**0.000**
Local community→CEI	−0.088	0.059	0.136	−0.025	0.032	0.435	−0.089	0.058	0.125	−0.027	0.034	0.438
Local community→Well-being	**0.233**	**0.064**	**0.000**	**0.248**	**0.037**	**0.000**	**0.228**	**0.063**	**0.000**	**0.255**	**0.039**	**0.000**
Local community→General trust	**0.208**	**0.066**	**0.002**	**0.159**	**0.037**	**0.000**	**0.199**	**0.066**	**0.002**	**0.164**	**0.039**	**0.000**
Latent variables												
Family→F1	**0.595**	**0.062**	**0.000**	**0.641**	**0.029**	**0.000**	**0.600**	**0.061**	**0.000**	**0.600**	**0.061**	**0.000**
Family→F2	**0.847**	**0.091**	**0.000**	**0.809**	**0.036**	**0.000**	**0.840**	**0.089**	**0.000**	**0.840**	**0.089**	**0.000**
Family→F3	**0.496**	**0.059**	**0.000**	**0.586**	**0.029**	**0.000**	**0.497**	**0.058**	**0.000**	**0.497**	**0.058**	**0.000**
Local community→LC1	**0.350**	**0.048**	**0.000**	**0.391**	**0.044**	**0.000**	**0.355**	**0.049**	**0.000**	**0.324**	**0.034**	**0.000**
Local community→LC2	**0.564**	**0.046**	**0.000**	**0.504**	**0.031**	**0.000**	**0.570**	**0.045**	**0.000**	**0.532**	**0.030**	**0.000**
Local community→LC3	**0.400**	**0.049**	**0.000**	**0.403**	**0.044**	**0.000**	**0.405**	**0.050**	**0.000**	**0.391**	**0.039**	**0.000**
Local community→LC4	**0.443**	**0.049**	**0.000**	**0.532**	**0.042**	**0.000**	**0.445**	**0.049**	**0.000**	**0.471**	**0.036**	**0.000**
Covariances												
LC1↔LC3	**0.577**	**0.068**	**0.000**	**0.520**	**0.041**	**0.000**	**0.573**	**0.067**	**0.000**	**0.573**	**0.067**	**0.000**
LC1↔LC4				**−0.131**	**0.034**	**0.000**						
LC3↔LC4				**−0.112**	**0.036**	**0.002**				**−0.078**	**0.026**	**0.002**
F1↔F3	**0.308**	**0.068**	**0.000**	**0.210**	**0.037**	**0.000**	**0.305**	**0.068**	**0.000**	**0.305**	**0.068**	**0.000**
CEI↔General trust	**−0.289**	**0.044**	**0.000**	**−0.304**	**0.026**	**0.000**	**−0.289**	**0.044**	**0.000**	**−0.289**	**0.044**	**0.000**
CEI↔Well-being	**−0.187**	**0.038**	**0.000**	**−0.267**	**0.024**	**0.000**	**−0.187**	**0.038**	**0.000**	**−0.187**	**0.038**	**0.000**
Well-being↔General trust	**0.453**	**0.044**	**0.000**	**0.483**	**0.026**	**0.000**	**0.453**	**0.044**	**0.000**	**0.453**	**0.044**	**0.000**

Results that were statistically significant are in bold.

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Second, there was bias in the participants' demographic characteristics. The participants were not randomly selected. They were recruited from among individuals who had registered with a survey company, which might have biased the results toward individuals with a higher interest in surveys. Third, the proportion of women was higher than that of men, and male data accounted for less than half of the female data. The analysis was conducted separately for men and women, which might have led to Type II errors. Therefore, future studies should use larger sample sizes to reduce demographic bias and improve statistical power. Although health status was an important factor involved in well-being, it was excluded from this survey. Given our teenage target demographics, we anticipated that a substantial number of respondents would not report significant health issues. Furthermore, to avoid overwhelming the participants, we limited the number of questionnaire items. However, this decision certainly warrants further reflection. Additionally, the survey did not analyze the impacts of pet species other than dogs and cats. This could be attributed to the fact that we did not inquire about the specific species of pets owned by the participants. A comparison between the effects of dog and cat ownership and the ownership of various other species could provide valuable insights into the unique characteristics of these popular pet types.

Notwithstanding these limitations, this study revealed that late adolescent women who owned a dog or cat had high involvement with their family, which resulted in higher well-being. However, no significant effects were observed among men. Previous studies reported that men's sociability increased with pet ownership and greater interactions during childhood (58). It was possible that the effect of pets temporarily declined among men with broader networks, particularly during late adolescence when the experiences of social connections were more diverse. Further cohort studies are required to track the effects of pets on different age groups.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Ethical Committee for Medical and Health Research Involving Human Subjects of Azabu University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

HK, SO, TK, and MN contributed to the conception and design of the study. HK, SO, and MN organized the database. HK and SO performed the statistical analysis. HK, TK, and MN acquired funding and wrote the first draft of the manuscript and revised it accordingly. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fvets.2023.1220265/full#supplementary-material

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The state of coursework on horses in human services at universities and colleges in the United States: a scoping review

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An increasing number of universities and colleges in the United States are offering coursework on adaptive/therapeutic riding and the incorporation of horses in human service areas such as psychotherapy, education, occupational therapy, physical therapy, and speech-language pathology. The first study to identify coursework in these areas was published in 2018. In order to track development over time, we conducted a replication study to determine the prevalence of coursework on horses in human services at higher education institutions. Information gathered for the 2021–2022 academic year included the institution name, geographic location, number of courses and their focus, academic department offering the course, and level of study. We identified 122 courses provided by 48 higher education institutions in 29 states in the following areas: adaptive/therapeutic riding (N = 82, 67.2%), mental health (N = 19, 15.6%), education/learning (N = 2, 1.6%), and equine movement in physical therapy, occupational therapy, and speech-language pathology (hippotherapy) (N = 1, 0.8%). Survey or overview courses (N = 18, 14.8%) were also identified. These courses were offered both at the undergraduate (N = 114, 93.4%) and the graduate level (N = 8, 6.6%) by a total of 48 departments that either focused on animals, such as equine science, animal science, and agriculture (N = 27, 54%) or focused on humans, such as health science or liberal arts (N = 23, 46%). The results inform a discussion on changes over time as well as current challenges and opportunities for academic programs offering coursework about horses in human services.

KEYWORDS

horse, equine, equine-assisted therapy, equine-assisted services, college, university, higher education, course

1 Introduction

Interest in the inclusion of horses in human services and in adaptive/therapeutic riding continues to grow in the United States of America (USA). There are several human service and activity areas where horses are involved, which determine the training required of the professional providing the service. In the U.S., horses are included in two broad areas of human services: in therapy services and in education or learning services (1). Therapy services involve a licensed therapist with additional training who may incorporate elements of equine interactions, equine movement, and the equine environment in their overall treatment approach and plan, tailored to the client's needs and goals (2). Examples include the use of equine movement (hippotherapy) in physical therapy, occupational therapy, or speech-language

pathology services (3) and interactions with horses that are incorporated into psychotherapy (4). Professionals providing educational or learning services that are based on learning frameworks and focused on goals related to areas such as skill development, academic achievement, or organizational development can include equine interactions to enhance the service they are providing (1). Adaptive riding, a term used concurrently with therapeutic riding and therapeutic horsemanship lessons (stylized in this publication as adaptive/therapeutic riding) is provided by an instructor and provides access to horses and horsemanship activities for those who may experience disability-related barriers for interacting with horses in typical equestrian environments or who otherwise need accommodations when doing so (1).

Coursework focused on horses in human services and in adaptive/therapeutic riding at universities and colleges in the United States has become more common. Undergraduate and graduate students who are interested in pursuing a career that includes interacting with horses within these services or activities can find a variety of programs, courses, majors, minors, and certificates offered by higher education institutions. The content of these offerings varies widely in prerequisites, scope, specificity, learning objectives, and cost (5). With the exception of a conference that was organized by Middle Tennessee State University in 2014, specifically addressing coursework of this nature in higher education (6), no dedicated network exists for academic professionals who administer coursework in these areas. This may contribute to delays in adopting the latest terminology, concepts, and guidelines, and a lack of clarity about what constitutes foundational and advanced knowledge in the focus area of the coursework. The Professional Association of Therapeutic Horsemanship International (PATH Intl.) offers a higher education membership to academic institutions whose coursework enables students to become certified primarily in adaptive/therapeutic riding or that offer activities in this area at their college equestrian center (7). At the time of publication, 12 higher education institutions are members.

Coursework on horses in human services and adaptive/therapeutic riding in higher education has not received much attention in previous literature. A total of eight English-language articles were identified (5, 8–14), of which four were published as conference abstracts (8, 9, 13, 14). These articles focused primarily on adaptive/therapeutic riding, including feasibility to implement coursework (12) and the education and skills preferred by adaptive/therapeutic riding centers when hiring staff (10). In addition, four doctoral dissertations related to higher education coursework were found (15–18). Service-based learning opportunities in undergraduate programs involving adaptive/therapeutic riding have also been discussed (11, 19, 20).

With the exception of a survey focusing on the number of academic institutions with connections to North American Riding for the Handicapped Association (NARHA) adaptive/therapeutic riding centers (NARHA is now PATH Intl.) (8), the first comprehensive review of coursework in U.S. universities and colleges concerning horses in human services and adaptive/therapeutic riding was published in 2018 (5). The study, which was led by the second author of the present study, found 110 courses offered in the 2016–2017 academic year at 39 U.S. higher education institutions (universities and colleges). Courses were categorized per course content focus area, per geographic location (state), per level of learning (undergraduate or graduate), and per the department or academic area where the course was offered.

The purpose of the present study was to determine the current prevalence and nature of coursework focused on horses in human services and adaptive/therapeutic riding in U.S. higher education institutions through a comprehensive scoping review, which included number of courses, number of higher education institutions, geographic location, course focus area, level of learning, and department or academic area for the 2021–2022 academic year. In order to track development in this area over time, we replicated the most recent review conducted in this area (5).

2 Methods

As no registry or database exists for coursework involving horses in human services and adaptive/therapeutic riding, and in order to replicate the 2018 study (5), we conducted a scoping review via internet search. Scoping reviews allow researchers to identify and map the available evidence and identify knowledge gaps, and are especially appropriate when a topic has minimal preexisting academic research (21). We consulted the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) in our reporting (22).

2.1 Inclusion criteria

We used the following criteria for selecting courses for inclusion in this review:

a) The course was offered by an accredited post-secondary academic institution (university or college) in the United States.
b) The course was listed in the 2021–2022 publicly accessible, online academic course catalog, or, in the case of academic certificates, an online record of certificate being offered during 2021 or 2022.
c) The course title and/or description referenced adaptive riding/therapeutic riding or specified the incorporation of horses or equines in mental health; physical therapy, occupational therapy, speech-language pathology; education/learning, or was described as a survey course on one or several of these areas.

Special topics courses, elective courses, internships, and practicums that were not clearly identified in the course catalog as meeting criteria (c) were excluded from the review.

2.2 Information sources and search procedure

The search was conducted between April, 2022 and January 2023 (10 months) using the internet search engine Google. The search terms used were "equine," "horse," "therapeutic," "adaptive," "equine-assisted," "facilitated," and "human-horse," paired with "course," "university," "college," and "higher education." Examples of search results included a course or program webpage, a course catalog entry, a news story or

other informational item related to the institution. After evidence of a course and accompanying academic institution was identified through search results, we located the 2021–2022 course catalog through the institution's website search function and searched it using the following terms: "equine," "horse," "therapeutic," "adaptive," "equine-assisted," "facilitated," "therapy," "learning," and "human-horse." In addition, when a course that met all three inclusion criteria was identified, it was cross-checked with the dataset used in the 2018 study.

2.3 Data extraction and categorization

During data extraction, we recorded the following information: the course title and description, the name of the institution offering the course, the geographic location of the institution, the level of study (undergraduate or graduate), and the academic department or academic area through which the course was offered. All items could be accessed for each course.

In the United States, undergraduate courses are offered within four-year bachelor's degree programs, and two-year associate degree programs. In this study, we defined graduate-level courses as those offered within master or doctoral programs, post-masters programs, or other graduate-level certificate programs offered by a university. Following the groupings created in the 2018 study (5), we categorized departments or academic areas as either primarily focused on animals, such as equine science, animal science, and agriculture, or on humans, such as health science, social science, and liberal arts.

2.4 Determination of course content focus area

To track development over time in coursework prevalence, we used the same five categories created in the 2018 study (5) to determine course focus area. Due to updates in terminology and concepts, we renamed and updated the descriptions for each category (1). This did not substantially alter the nature of the categories. Importantly, when determining the focus area of each course, it was necessary to evaluate the nature of course content not simply through terms used but through the context provided by the course description. All focus area determinations were rated by both authors and any discrepancies were resolved by discussion. We used the following descriptions for the focus areas.

2.4.1 Adaptive/therapeutic riding

Adaptive riding, also known as therapeutic riding and therapeutic horsemanship (1), is the provision of riding and other horsemanship lessons to individuals who may experience disability-related barriers for interacting with horses in typical equestrian environments or who otherwise need accommodations when doing so. This is provided by a riding instructor.

2.4.2 Mental health

Mental health professionals, such as clinical psychologists, mental health clinical counselors, clinical social workers, marriage and family therapists, psychiatrists, and psychiatric nurse practitioners who provide psychotherapy or clinical counseling, may include equine interactions within their theoretical orientation and chosen therapy approaches with the purpose of enhancing treatment outcomes for the client if specifically trained to do so (4).

2.4.3 Education/learning

Educational or learning-based services are based on learning frameworks and focused on goals related to areas such as skill development, academic achievement, and organizational development. Professionals working in these areas can include equine interactions to enhance the service they are providing (1).

2.4.4 Equine movement in physical therapy, occupational therapy, and speech-language pathology

Occupational therapists, physical therapists, and speech-language pathologists use purposeful manipulation of equine movement as a therapy tool, also known as hippotherapy, to engage sensory, neuromotor and cognitive systems to promote functional outcomes within the patient's plan of care (2).

2.4.5 Survey/overview course

This category comprised of survey, overview, and introductory courses that included an overview of several focus areas.

2.5 Comparison with previous scoping review

We compared the results of our scoping review with the results of the 2018 study (5) to track changes over time.

3 Results

3.1 Courses and institutions

A total 122 courses were offered at 48 higher education institutions across the United States.

3.2 Geographic location

Higher education institutions in a total of 29 states (57.9%) offered coursework while 21 states did not have any academic institutions offering relevant coursework (Figure 1). The state with the largest number of courses offered was North Carolina ($N = 14$) and the state with the largest number of higher education institutions offerings coursework was Pennsylvania ($N = 5$). Except for the Pacific Northwest, all major geographic areas of the contiguous United States had higher education institutions offering relevant coursework. No coursework was identified in Hawaii or Alaska.

3.3 Course content focus area

Categorizing the 122 courses according to content focus resulted in the following: adaptive/therapeutic riding ($N = 82$, 67.2%), mental health ($N = 19$, 15.6%), education/learning ($N = 2$, 1.6%), equine

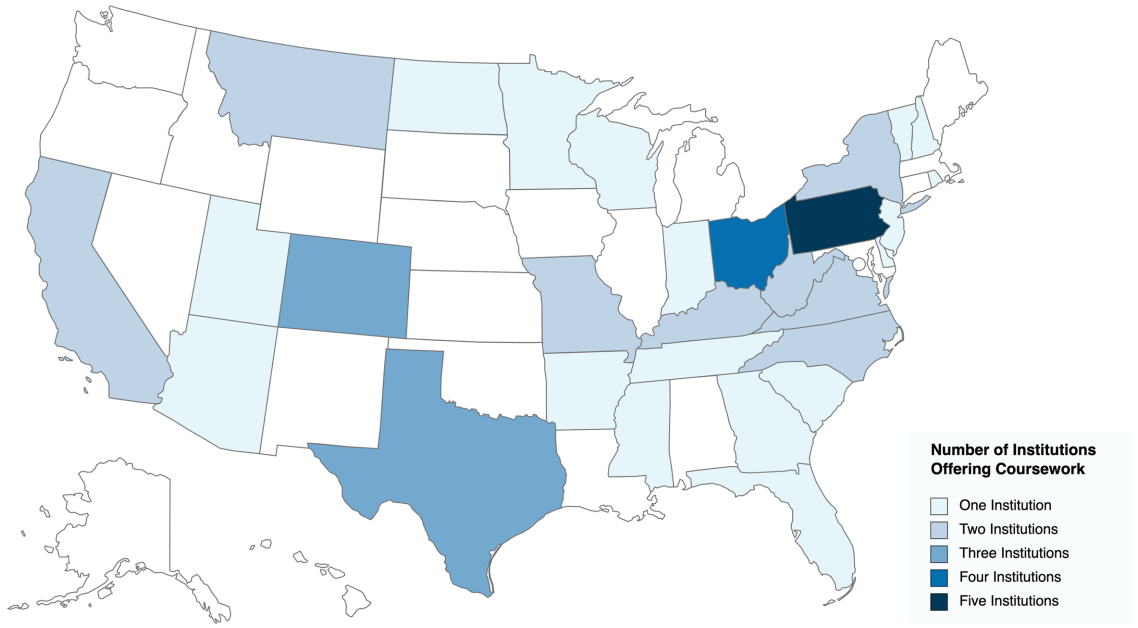

FIGURE 1
A map of the number of higher education institutions per state offering coursework on horses in human services and adaptive/therapeutic riding in the 2021–2022 academic year.

TABLE 1 Coursework by focus area on horses in human services and adaptive/therapeutic riding in the 2021–2022 academic year compared with the 2016–2017 academic year, as reported by Ekholm Fry et al. (5).

	Total courses	Adaptive/ Therapeutic riding	Mental health	Education/ Learning	Equine movement in PT, OT, or SLP*	Survey/ Overview
2021–2022	122	82	19	2	1	18
2016–2017†	110	71	23	7	1	8

*PT, Physical therapy; OT, occupational therapy; SLP, speech-language pathology. †Data from Ekholm Fry et al. (5).

movement in physical therapy, occupational therapy, and speech-language pathology ($N = 1$, 0.8%), and overview/other ($N = 18$, 14.8%) (see Table 1). The largest number of courses was offered in the area of adaptive/therapeutic riding ($N = 82$) and the smallest number of courses was on the topic of equine movement in physical therapy, occupational therapy, and speech-language pathology ($N = 1$).

3.4 Level of learning

A total of 114 courses (93.4%) at 43 institutions were offered at the undergraduate level and a total of 8 courses (6.6%) at 5 institutions were offered at the graduate level. If a course was open to both undergraduates and graduate students, it was counted only once and categorized as an undergraduate course.

3.5 Department

A total of 48 departments or academic areas provided relevant coursework at 48 higher education institutions. Of the 48 departments offering coursework, 26 (54.2%) were focused on animals, such as equine science, animal science, and agriculture and 22 (45.8%) were focused on humans, such as health science, social science, and liberal arts. From a course perspective, a total of 70 courses (57.4%) were offered by primarily animal-focused departments and 52 (42.6%) by primarily human-focused departments.

3.6 Comparison to previous scoping review

When comparing results from the present study for academic year 2021–2022 with results from the academic year 2016–2017 (5), we found that the number of total courses offered has increased by 12, from 110 to 122 courses total. The number of higher education institutions offering courses has increased by 9, from 39 to 48 institutions. Geographically, the same number of states have institutions offering relevant coursework ($N = 29$). There was an increase in undergraduate courses, from 93 in 2016–2017 to 114 in 2021–2022, totaling 21 courses. Meanwhile, there was a decrease in graduate courses, from 17 in 2016–2017 to 8 in 2021–2022, totaling 9 courses. The number of departments offering relevant coursework has increased by 11, from 39 to 48. The percentage of coursework offered either through primarily animal-focused or human-focused

departments has changed slightly. In the academic year of 2016–2017, coursework was offered by 19 departments (48.7%) that were focused on animals, such as equine science, animal science, and agriculture, and by 20 (51.3%) departments focused on humans, such as health science, social science, or liberal arts. In the academic year of 2021–2022, coursework was offered by 27 departments (54.0%) focused on animals, and by 23 (46.0%) focused on humans (see Table 2). Regarding course focus area, there was an increase in adaptive/therapeutic riding courses and survey/overview courses, and a decrease in mental health and education/learning courses. There was no change in courses offered on equine movement in physical therapy, occupational therapy, and speech-language pathology (see Table 1).

4 Discussion

We conducted a study focused on the prevalence of coursework in U.S. higher education in areas of horses in human services and adaptive/therapeutic riding for the academic year of 2021–2022. This study successfully replicated the first comprehensive scoping review in this area (5) and provides data for tracking coursework development over time. Our results show an increase in coursework offered by higher education institutions by comparing offerings in the academic year of 2016–2017 with 2021–2022. By recording the number of courses and institutions, the geographic location of the institution, the focus of course content, the level of study (undergraduate or graduate), and the academic department or academic area through which the course was offered, we discovered several notable developments.

An additional 9 academic institutions started offering coursework in the five-year time period covered by the data comparison, bringing the total number of institutions from 39 in 2016–2017 to 48 in 2021–2022. In addition, 12 additional courses were offered in 2021–2022, primarily at the undergraduate level. The number of departments offering coursework increased from 39 to 48. Institutions offering relevant coursework are located in over half of U.S. states and location by state remained more or less the same in the comparison period. When considering course focus, the largest increases were found in the number of adaptive/therapeutic riding courses and in the survey/overview courses offered. One exception to the overall increase in coursework was in the focus areas of horses in mental health and horses in education where a decrease in offerings was found. One institution that in 2016–2017 had offered 10 courses total at the graduate level, five courses in mental health and five in education/learning, had stopped doing so by 2021–2022, which likely has a large impact in those areas. This may have also impacted the overall number of courses offered at the graduate level, which had declined by 2021–2023. The percentage of courses offered primarily through departments focused on animals, such as equine science, animal science, and agriculture, in contrast with those focused on human health science, social science, or liberal arts had also changed somewhat between the two comparison points. In the 2016–2017 academic year, 48.7% of coursework was offered by departments focused on animals, and 51.3% by departments focused on humans. In the 2021–2023 academic year, 56.6% of coursework offered by departments focused on animals and 43.4% by departments focused on humans.

While coursework in the relevant areas has increased, the issues noted in the previous scoping review have remained, namely those surrounding terminology and conceptualization of services and activities that involve horses. These challenges have been discussed extensively in recent years (1, 4). Issues concerning the terms used to describe services and how to understand interactions with horses in human services and adaptive/therapeutic riding impacted the current study in several ways. Identifying and categorizing coursework is dependent on shared understanding of what is described. The most challenging aspect of conducting this scoping review was to discern what a course was about based on the available course title and description. Often, the course title included the word "therapy," but the course description focused solely on adaptive/therapeutic riding, referencing riding lessons, instructions, adapted equipment, and such. Categorizing such a course offering in one of the two healthcare service areas, mental health or equine movement in occupational therapy, physical therapy, or speech language pathology, would have been incorrect, although these are the only areas that involve therapy. As such, conducting any kind of review in the area of horses in human services and in adaptive/therapeutic riding requires considerable knowledge about the nature of services and activities, not just commonly used terminology, as this may be used inappropriately. Using combinations of words that involve "therapy" or "intervention" while meaning adaptive/therapeutic riding emerged as the largest issue concerning terminology for higher education institutions to address, as the majority of course offerings are focused on adaptive riding lessons for individuals with disabilities.

Appropriate conceptualization of horses in human therapy and learning services and the separate activity of adaptive/therapeutic riding is also necessary in order to not mislead students about course offerings. For instance, a total of 13 courses with a specific focus on therapy services were offered at the undergraduate level in 2021–2023. When courses that focus on therapy services where equine interactions are included are offered at the undergraduate level, it should be clear to

TABLE 2 Coursework on horses in human services and adaptive/therapeutic riding in the 2021–2022 academic year compared with the 2016–2017 academic year, as reported by Ekholm Fry et al. (5).

	Total courses	Total institutions	Total states	Total undergraduate courses	Total graduate courses	Total departments	Total departments per type
2021–2022	122	48	29	114	8	48	27 (a)* 23 (h)**
2016–2017†	110	39	29	93	17	39	19 (a)* 20 (h)**

*Animal-focused departments (e.g., equine science, animal science, agriculture). **Human-focused departments (e.g., health science, social science, liberal arts). †Data from Ekholm Fry et al. (5).

students that they cannot provide psychotherapy, occupational therapy, physical therapy, or speech language therapy independently without a master's degree in the U.S. and that this does not change when equine interactions are included as part of the service. The choice of department by which a course about horses in human services is offered is another interesting aspect. Unlike education/learning services, where no specific level of academic training is required for professionals in most cases, human services, such as psychotherapy, require advanced academic degrees and licensure in order for the professional to provide the service. As such, courses offered by animal-focused departments may be limited in how they are able to prepare students for professional work in human services. In light of these limitations, it makes sense that adaptive/therapeutic riding, the largest area of coursework by far, is offered at an undergraduate level by primarily animal-focused departments. Interestingly, in a recent survey of adaptive/therapeutic riding center staff involved in hiring decisions, less than half (42%) indicated that having a bachelor's degree was a major consideration in hiring for a management position, and only 22% indicated that they "strongly agreed" or "agreed" that having a bachelor's degree with major/minor in adaptive/therapeutic riding or with a focus on horses in human services was important (10).

Another conceptual challenge arises when institutions offer minors within bachelor's degrees with titles that reference horses in human health or adaptive/therapeutic riding, but do not offer any courses specific to the topic area. Instead, students may complete credits in areas such as human development, anatomy, equine science, and equine business. Institutions with minors or tracks built this way were not included in this study as they did not meet the inclusion criteria. It is arguably misleading for students to pursue a minor where they do not get direct instruction in the topic area they are interested in.

The delineation of and descriptions used for the four main course focus areas in this study follow currently proposed terminology and conceptual guidelines (1, 2, 4). As the most current national guidelines were published immediately preceding the 2021–2022 academic year, it is not expected that coursework included in this review would be informed by them. Perhaps due to the lack of opportunities for professional exchange between instructors who offer academic courses in these unique areas, there appears to be large differences in course content, which only further contributes to issues with terminology and conceptualization. Based on course descriptions reviewed in this study, no agreement seems to exist regarding what constitutes basic or introductory knowledge in these distinct course topic areas, and, as a result, what should be included in survey courses or taught at different academic levels.

4.1 Limitations and future directions

As no database exists outside of course catalogs for individual institutions, it is possible that courses meeting criteria have been omitted due to not having been found during internet searches. In addition, the inclusion criteria leave out student-designed electives and other academic activities taking place outside of standard courses. Course offerings are not static, and the data provided in this article is specific to what took place during the 2021–2022 academic year. The possible impact of COVID on the development of new course offerings and delivery of existing courses in this area should also be taken into consideration when reviewing the data.

Our suggestions for future research echo those proposed in the 2018 review (5) and feel particularly critical in light of the increase in course offerings. Examination of curricula and their connection to competencies and standards of professional practice in the various areas of coursework is of central importance. Surveying instructors and course creators could result in telling information about how course content varies across institutions. Finally, an increase in support and information exchange between instructors and academic units across institutions may serve to strengthen the development and quality of course offerings in this area.

Data availability statement

The datasets presented in this article are not readily available because identifiable data for institutions will be withheld. Requests to access the datasets should be directed to nina.ekholm-fry@du.edu.

Author contributions

KC: Conceptualization, Data curation, Methodology, Visualization, Writing – original draft, Writing – review & editing. NEF: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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

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The potential usefulness of standardized assessments to measure participant outcomes of adaptive/therapeutic horseback riding: a survey study

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Adaptive or therapeutic riding (A/TR) is a recreational activity which provides mounted and ground-based horsemanship opportunities adapted to the abilities of the participants. A/TR provides physical and psychological benefits to participants with diverse disabilities, including physical, developmental, cognitive, and age-related disabilities, promoting higher quality of life. A/TR professionals may be limited in their capacity to implement outcome assessments and report the benefits of their community-based A/TR services to a broad audience. The purpose of this study was to identify whether and how A/TR professionals currently measure participant outcomes; benefits and barriers to implementing standardized assessments in A/TR; and characteristics which would make assessments useful in the community-based A/TR environment. To address this purpose, we conducted a survey among A/TR professionals. We found that while A/TR professionals measure outcomes among their participants, they typically do not use standardized assessments. Survey respondents believed benefits of implementing standardized assessments included bolstering the A/TR profession, acquiring funding, and communicating about A/TR services to a broad audience. Respondents also identified several barriers to implementing standardized assessments including time, systemic, and expertise constraints. Respondents reported that useful standardized assessments would be relevant to all age groups and populations who receive A/TR services. Finally, respondents shared that for standardized assessments to be useful, they would need to be low-cost, require less than 10–20 min, and available in either paper or computer format. This study revealed that standardized assessments may be a strong support to the A/TR profession; however, assessments must meet the unique needs of A/TR professionals.

KEYWORDS

therapeutic riding, adaptive riding, equine-assisted services, adaptive recreation, standardized assessment

1 Introduction

Adaptive riding, or therapeutic riding (A/TR), is a recreational activity in which horseback riding is adapted to the needs of participants with diverse abilities and diagnoses (1). A/TR typically occurs in a group setting, with a therapeutic riding instructor teaching skills that address horsemanship goals, allowing diverse populations to access the natural benefits of horsemanship (1). A/TR provides an engaging recreational activity for people with diverse disabilities, such as individuals with autism spectrum disorder or cerebral palsy, veterans with post-traumatic stress disorder, and older adults with dementia (2). Furthermore, A/TR has been proposed to improve a variety of outcomes, including: self-confidence, motivation, courage, social involvement, self-perceived physical competency, and gross motor function (3–6). There are different levels of certifications available to therapeutic riding instructors; certified therapeutic riding instructors (CTRIs) are certified for entry-level riding instruction, while advanced (ATRIs) and master (MTRIs) instructors can provide intermediate/advanced instruction and program management, and MTRIs have even further expertise in equine-assisted services broadly.

Many researchers have identified broad benefits of participating in A/TR (3–6); however, therapeutic riding instructors and A/TR centers are limited in their capacity to gather and report the benefits of their community-based services. The field of human-animal interaction research has often identified the need for increased use of valid and reliable outcomes assessments that are used consistently across studies, in order to advance the field (7). This same need for valid, reliable, and consistent outcomes measures exists in community-based practice, but the needs of community-based professionals differ from the needs of researchers. The assessments often used in A/TR research may not be useful in a community-based A/TR setting. For example, many assessments used in research require administrators to have advanced training in standardized assessments (8), which is not required to become a CTRI/ATRI/MTRI. Additionally, some assessments used in A/TR research are validated for a specific age range or diagnosis, whereas A/TR centers often serve many different populations concurrently. Finally, many of the assessments used in research are costly and may not be sustainable for long-term use in the A/TR context. Due to these limitations, A/TR professionals currently do not have standardized assessments that can be feasibly used in their community-based context. Therefore, there is a need to identify high-quality standardized assessments which A/TR professionals can use to measure participant outcomes of their services; identifying such assessments could bolster the profession's credibility and facilitate improved communication about the benefit of A/TR services to participants, funders, and the community.

A key consideration when identifying standardized assessments to be used in community-based services is the *clinical usefulness* of the assessment (9). Clinical usefulness is defined as whether an assessment improves the quality of services, is acceptable to administrators and participants, can improve the quality of services, and is worth the cost of its use. The purpose of the current study was to gather feedback from A/TR professionals pertaining to elements of standardized assessments which make them *clinically useful* to measure participant outcomes of community-based A/TR. To achieve this aim, we asked the following research questions:

1. How are CTRIs/ATRIs/MTRIs currently measuring participant outcomes, if at all?
2. Do A/TR interested parties believe it is important to identify standardized assessments to measure participant outcomes of A/TR? If so, what participant outcomes do A/TR interested parties believe are most important to assess and most likely to change as a result of A/TR participation?
3. What do A/TR interested parties believe would be benefits of, and barriers to, implementing standardized assessments to measure participant outcomes of TR?
4. What qualities of standardized assessments would be most useful in the community-based A/TR setting (e.g., for what populations is the assessment validated, frequency of assessment, assessment length and cost, etc.)?

2 Methods

2.1 Study design and participants

The Temple Grandin Equine Center (TGEC) at Colorado State University (CSU) and the Professional Association of Therapeutic Horsemanship, International (PATH, Intl.) formed a working group of A/TR interested parties. The working group was developed and met prior to this study. The ongoing work group consists of 11 members, selected because they represent different perspectives related to A/TR, including CTRIs, leadership from PATH, Intl. centers, researchers, and representatives from: TGEC, PATH Intl, the American Hippotherapy Association Inc., and the Horses and Humans Research Foundation. This work group provided feedback that greatly influenced the methods presented below.

This study was approved by the CSU Institutional Review Board (#3229) and a study survey was distributed to A/TR interested parties. To be eligible to complete the survey, respondents were required to be age 18 or older, understand English, and self-identify as one of the following A/TR interested parties: CTRI, center leadership, A/TR volunteer, A/TR participant, or caregiver of an A/TR participant. To be included in analyses, survey respondents had to complete at least 50% of the survey. Survey responses were submitted anonymously.

2.2 Data collection

The survey was created in Research Electronic Data Capture (REDCap), a secure, web-based software platform (10, 11). The survey was distributed to a national mailing list of A/TR interested parties maintained by PATH, Intl., the educational and credentialing body for A/TR professionals and centers. The email invitation included details of the study, including that participation was voluntary and 1 respondent would be randomly selected to receive a $100 gift card; clicking the survey link indicated consent. The survey was open for 8 weeks. Survey questions fell into five categories: (1) general information about the respondent; (2) if and how the respondent currently measures A/TR outcomes (for CTRIs and PATH., Intl leadership only); (3) the perceived importance and likelihood to change of possible participant outcome constructs (e.g., horsemanship skills, social skills, physical improvements); (4) benefits of and barriers to implementing standardized outcome assessments in community-based A/TR; and (5) considerations that may affect the usefulness of standardized assessments in the A/TR context (e.g., time and cost, etc.).

The survey consisted of Likert-scale questions, "Select all that apply" questions, "Yes or No" questions, and open-ended short-answer questions (e.g., "Please describe," or "Please list…"). The survey included 107 distinct questions, and operated using branching logic, such that each respondent answered a set of questions based on their previous answers; for example, respondents who self-identified as a CTRI were presented with different questions than those who self-identified as an A/TR participant. Depending on their answers, respondents were presented with an average of 50 questions. The survey allowed respondents to save their responses and return at a later time.

2.3 Data analysis

Survey data were exported from REDCap and downloaded to Microsoft Excel for analysis. We calculated descriptive statistics such as frequencies, percentages, medians, and interquartile ranges (IQR). For "Select all that apply" questions, total percentages across all response options summed greater than 100%, as respondents were allowed to select multiple responses. For short-answer questions, we category-coded responses into pre-existing answer options or created new codes derived from participant answers; we report category counts to summarize the short-answer responses (12).

3 Results

3.1 Respondent characteristics

Three hundred forty-seven total respondents completed portions of the survey. Two hundred seventy-seven participants completed at least 50% of the survey and therefore, were included in further analyses. Two hundred sixteen (78%) respondents identified as A/TR instructors, 99 (36%) identified as PATH, Intl. Center staff, 23 (8%) identified as A/TR volunteers, and 8 (3%) identified as either an A/TR participant or a caregiver of an A/TR participant. Due to the dearth of volunteer, participant, and caregiver respondents, we chose to focus all further analyses on respondents who identified as either A/TR instructors or PATH, Intl. center staff. A total of 233 A/TR instructors or PATH, Intl. center staff completed at least 50% of the survey, and 221 completed the entire survey. The remainder of the manuscript provides the results from these 233 A/TR instructors or PATH, Intl Center leadership.

Of the 216 respondents who identified as A/TR instructors, 200 (93%) identified as CTRIs; 27 (13%) identified as Advanced Therapeutic Riding Instructors (ATRIs), and 11 (5%) identified as Master Therapeutic Riding Instructors (MTRIs). These instructor types were combined for further analysis and will be hereafter identified as CTRIs. One hundred forty-one (65%) respondents reported being employed at a PATH, Intl. A/TR center, 37 (17%) reported working at a non-PATH, Intl. A/TR center, 22 (10%) reported contracting with PATH, Intl. centers, and 22 (10%) reported not currently working with an A/TR center.

3.2 Current assessments

One hundred and ninety-one respondents (82%) reported they currently measure participant outcomes of A/TR. Table 1 includes participant outcome constructs currently assessed by survey respondents.

Among the 191 survey respondents who reported tracking participant outcomes, respondents reported using several methods, including progress notes ($n = 178$, 93%), interviews ($n = 78$, 41%), unstandardized assessments ($n = 71$, 37%), standardized assessments ($n = 24$, 13%), and "other" ($n = 12$, 6%). "Other" reported methods included observation ($n = 4$), tracking skills/objectives ($n = 3$), conversations/stories from participants and caregivers ($n = 3$), and end-of-session reports ($n = 1$). Respondents who currently assess A/TR participant outcomes reported measuring outcomes for various reasons, including the following:

- Tracking participant progress ($n = 183$, 96%),
- Program evaluation ($n = 108$, 57%),
- Acquiring funding ($n = 103$, 54%),
- Program support (e.g., reports to board or participants, $n = 101$, 53%),
- Research ($n = 12$, 6%), and
- "Other" ($n = 12$, 6%).

"Other" responses included demonstrating progress to participants, instructors, or the public ($n = 8$), improving the quality of services ($n = 3$), student projects ($n = 1$) and to support future research ($n = 1$).

Among the 71 respondents using unstandardized assessments, respondents most commonly implemented the assessment before and after a *session*, which was defined as a period of consecutive weeks or months during which A/TR lessons are provided (e.g., a 10 weeks session of A/TR lessons; $n = 42$; 59%). The next most common time to implement the unstandardized assessment was after a lesson, defined as a single A/TR lesson ($n = 23$; 32%). Similarly, of the 24 respondents using standardized assessments, they most commonly implemented the assessment before and

TABLE 1 A/TR outcome constructs currently assessed by A/TR professionals.

Outcome construct	Number of responses (%) N = 191
Horsemanship skills	178 (93%)
Cognitive skills	156 (82%)
Communication skills	151 (79%)
Physical outcomes	142 (74%)
Emotional regulation	125 (65%)
Social outcomes	122 (64%)
Self-efficacy outcomes	110 (58%)
Recreation/leisure outcomes	105 (55%)
Empathy outcomes	89 (47%)
Quality of life outcomes	84 (44%)
Activities of daily living outcomes	45 (24%)
Community integration	38 (20%)
Instrumental activities of daily living outcomes	27 (14%)
Other	7 (4%)

"Other" outcomes included transference of skills to daily life, independence, and mental health.

after a session ($n = 17$; 71%) or after a lesson ($n = 4$; 17%). Respondents reported spending a median of 15 min (IQR = 10–30) implementing unstandardized assessments and a median of 20 min (IQR = 20–30) implementing standardized assessments.

Respondents identified utilizing several different types of unstandardized assessments, including participant and caregiver surveys ($n = 18$, 25%), "in-house" assessments created by A/TR centers ($n = 9$, 13%), modified standardized assessments ($n = 2$, 2.5%), and surveys completed by A/TR instructors ($n = 1$, 1.4%). The most common standardized assessments were Goal Attainment Scaling [GAS; $n = 9$, 38%, (13)] and the Rider Instruction, Development, and Evaluation System [RIDES, $n = 3$, 13%, (14)]; these both represent a standard manner of setting and measuring progress on individual horsemanship goals. Other standardized assessments measure a diverse range of constructs and were only used by 1–2 respondents each:

- Pediatric Evaluation of Disability Inventory-Computer Adaptive Test [PEDI-CAT, $n = 2$, 8%, (15)],
- Strengths and Difficulties questionnaires [$n = 2$, 8%, (16)],
- Subjective Units of Discomfort Scales [SUDS, $n = 1$ (17)],
- Naples Assessment Tool ($n = 1$, 4%),
- Post-traumatic Stress Disorder Checklist [$n = 1$, 4%, (18)],
- Patient Health Questionnaire [PHQ-9, $n = 1$, 4%, (19)],
- Quality of Life Enjoyment and Satisfaction Questionnaire-Short Form [QLES-Q-SF, $n = 1$, 4%, (20)],
- Military to Civilian Questionnaire [M2C-Q, $n = 1$, 4%, (21)],
- Insomnia Severity Index [ISI, $n = 1$, 4%, (22)], and
- Recreation Therapy Assessment ($n = 1$, 4%).

3.3 Importance of identifying a standardized outcome assessment

Figure 1 illustrates the extent to which CTRIs and PATH, Intl. staff believed it is important to identify a standardized assessment to measure participant outcomes of A/TR. While a notable minority (29%) found it "unimportant" or "very unimportant", most respondents (64%) reported it was "important" or "very important" to identify standardized assessments to measure participant outcomes of A/TR.

Figure 2 illustrates the participant populations for whom respondents believed it would be important to measure outcomes. Over 90% of respondents reported that it would be important to measure A/TR outcomes in all participant age and diagnosis groups.

Table 2 illustrates respondents' perception of the importance and likelihood to change of several different potential participant A/TR outcomes that could be measured. Twenty-six survey respondents reported "other" outcomes which they believed were important or likely to change. Their responses were coded as: outcome importance depends on individual goals and abilities ($n = 4$, 15%), connection with the horse ($n = 4$, 15%), self-regulation ($n = 3$, 12%), sensory integration ($n = 2$, 8%), relationship building (in a family or between peers; $n = 2$, 8%), academic performance ($n = 2$, 8%), and self-confidence and leadership skills ($n = 2$, 8%).

3.4 Benefits of and barriers to implementing standardized outcome assessments

Respondents reported several benefits of identifying an assessment to measure A/TR outcomes, including gathering data to demonstrate the value of A/TR to society ($n = 197$, 85%), communicating outcomes to potential A/TR funders ($n = 183$, 79%), communicating outcomes to participants ($n = 176$, 76%), communicating outcomes to future participants ($n = 172$, 74%), guiding how A/TR is delivered or implemented ($n = 146$, 63%), other ($n = 22$, 9%), and none ($n = 3$, 1%). The "Other" responses fell into several categories, including advocating for insurance coverage/funding ($n = 7$, 32%), instructor benefit ($n = 4$, 18%), research ($n = 3$, 14%), communication with other professionals ($n = 3$, 14%), and increasing the credibility of the A/TR profession ($n = 2$, 9%).

Respondents also reported potential obstacles to implementing standardized assessments at their A/TR centers, including: time constraints ($n = 152$, 65%), lack of a system to organize assessments ($n = 149$, 64%), lack of expertise in administering standardized assessments ($n = 137$, 59%), lack of staff to implement assessments ($n = 118$, 51%), assessment cost ($n = 94$, 40%), participant buy-in for assessments ($n = 59$, 25%), lack of knowledge about which assessments to implement ($n = 48$, 12%), other ($n = 26$, 11%), and "none" ($n = 12$, 5%). "Other" responses were coded into the following categories: diversity of PATH, Intl. centers and services provided ($n = 7$, 27%), individual participant variability (e.g., ages, diagnoses, contexts, cultural considerations; $n = 7$, 27%), participant/family burden ($n = 3$, 12%), increased focus on assessment results rather than providing high-quality services ($n = 2$, 8%), and variability inherent to community-based A/TR (e.g., changes in volunteers/horses, participant absences, $n = 1$, 4%).

Given the perceived benefits of and barriers to implementing outcome assessments, respondents were asked to report how likely they would be to use standardized outcome assessments if they were recommended by PATH, Intl. Most respondents reported they were likely (46%, $n = 108$) or very likely (39%, $n = 90$) to implement recommended standardized assessments, while fewer reported they were unlikely (12%, $n = 28$) or very unlikely (3%, $n = 7$).

3.5 Usefulness of implementing A/TR outcome assessments

Most survey respondents ($n = 178$, 76%) reported that CTRIs would be the best individuals to report on A/TR participant outcomes, followed by A/TR participant caregivers ($n = 134$, 58%), A/TR participants ($n = 118$, 51%), and "other" ($n = 31$, 13%). Respondents indicated that they would be willing for CTRIs to complete assessments that require a median length of 20 min (IQR = 10–22.5), and that they would feel comfortable asking A/TR participants to complete assessments lasting a median length of 10 min (IQR = 10–20). Additionally, of the 221 total survey respondents, 97 respondents (44%) indicated that they would prefer assessments via a computer/iPad, 94 respondents (43%) identified that they would implement assessments in either computer/iPad or pencil/paper format, and 30 respondents (14%) stated that they would prefer pencil/paper

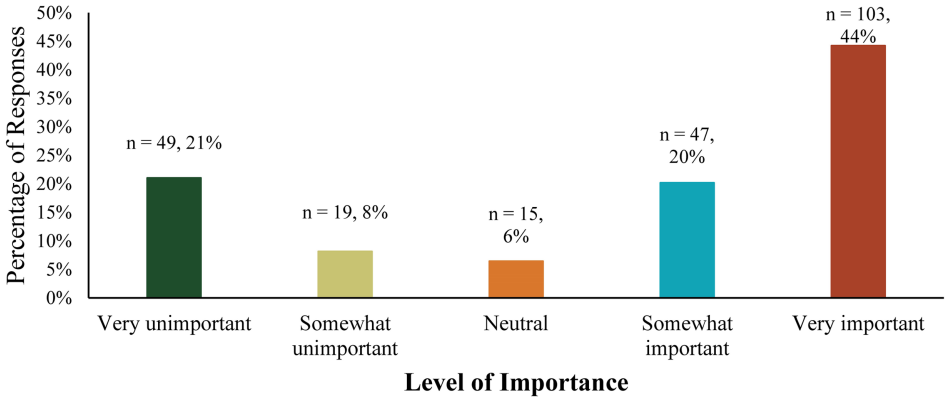

FIGURE 1
Reported importance of identifying a standardized assessment to measure participant outcomes of A/TR.

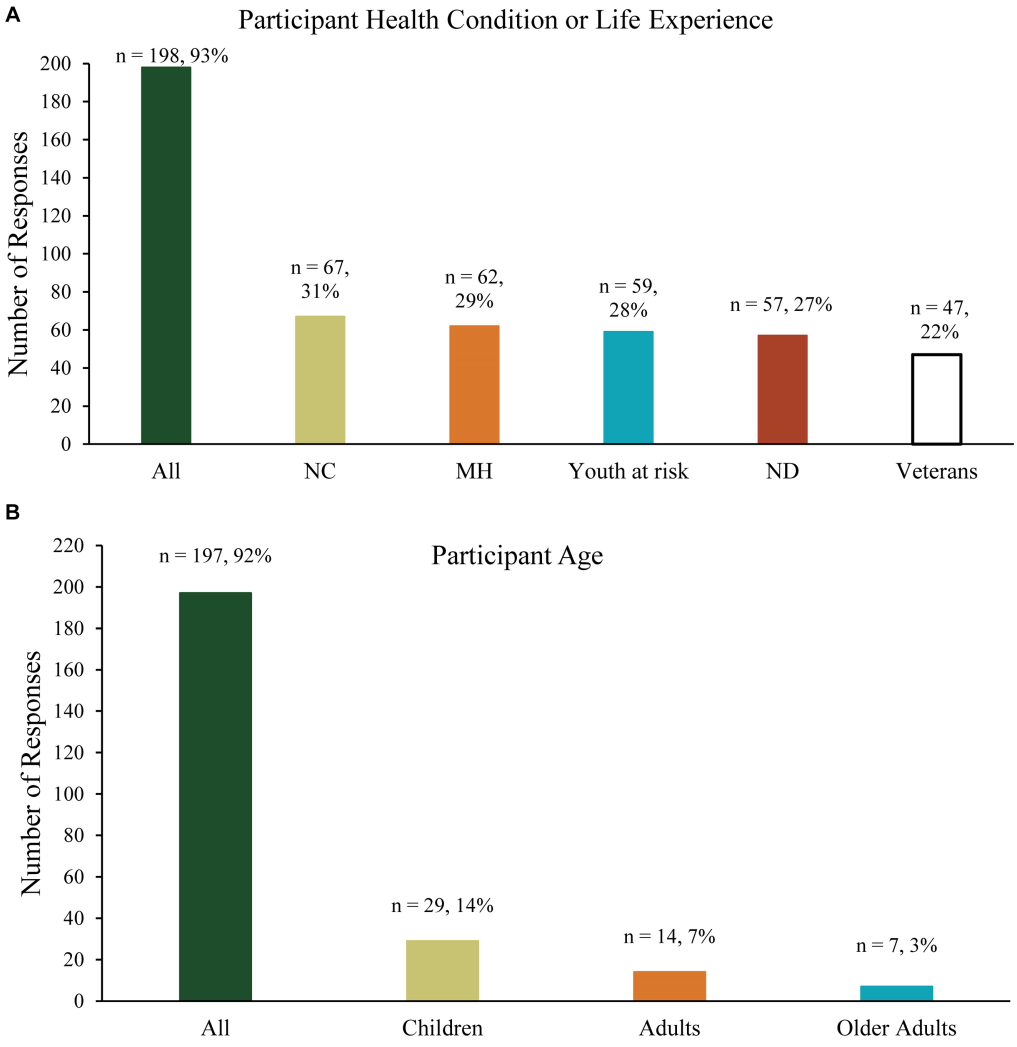

FIGURE 2
(A) Participant age groups identified as important to measure A/TR outcomes in, and **(B)** populations identified as important to measure A/TR outcomes in. NC, neurodevelopmental conditions; MH, mental health conditions; ND, neurological disorders.

TABLE 2 Importance and likelihood to improve of participant outcome constructs.

Participant outcome construct	Importance			Likelihood to improve		
	Very unimportant/ unimportant	Neutral	Important/ very important	Very unlikely/ unlikely	Neutral	Likely/very likely
Physical	8 (3%)	10 (4%)	215 (93%)	3 (1%)	19 (8%)	202 (89%)
Cognition	6 (3%)	14 (6%)	213 (91%)	0 (0%)	13 (6%)	210 (92%)
Communication	5 (2%)	15 (6%)	213 (91%)	0 (0%)	19 (8%)	206 (91%)
Emotion regulation	9 (4%)	11 (5%)	213 (91%)	2 (1%)	14 (6%)	207 (91%)
Quality of life	5 (2%)	18 (8%)	210 (90%)	3 (1%)	27 (12%)	193 (85%)
Self-efficacy	9 (4%)	15 (6%)	209 (89%)	1 (0.44%)	22 (10%)	202 (89%)
Social	10 (4%)	16 (7%)	207 (89%)	5 (2%)	28 (13%)	190 (84%)
Recreation/leisure	8 (3%)	21 (9%)	204 (87%)	3 (1%)	31 (14%)	190 (84%)
Empathy	7 (3%)	28 (12%)	198 (85%)	1 (0.44%)	5 (2%)	219 (95%)
Horsemanship skills	6 (3%)	32 (14%)	195 (84%)	1 (0.45%)	27 (12%)	195 (85%)
Daily living activities	33 (14%)	74 (32%)	126 (54%)	17 (8%)	122 (54%)	86 (38%)
Community integration	34 (15%)	75 (32%)	124 (53%)	17 (8%)	116 (52%)	92 (41%)
Instrumental activities of daily living	28 (12%)	92 (39%)	113 (49%)	22 (10%)	141 (63%)	60 (26%)

assessments. Finally, most respondents identified that that they would only use assessments that are either free ($n = 106$, 48%) or cost \$1–2 per use ($n = 79$, 36%). Fewer respondents stated that they would use assessments costing \$3–5 per use ($n = 33$, 15%) or \$6–10 per use ($n = 3$, 1.4%).

4 Discussion

The current study gathered feedback from CTRIs and PATH, Intl center leadership pertaining to the current use of and attitudes towards standardized assessments to measure participant outcomes of community-based A/TR. As further discussed below, results substantiated there is an existing need across the A/TR industry to identify standardized assessments that can be used for this purpose, and elucidated qualities of standardized assessments that would be *useful* in the community-based A/TR setting.

4.1 Substantiating the need for standardized assessments in the A/TR industry

Most respondents reported currently measuring participant outcomes of A/TR participation, primarily through progress notes, interviews, or un-standardized assessments. While these commonly reported methods of recording participant information may be useful to track progress or communicate about participants within centers, they do not easily facilitate communication across centers, between professionals, and to the public. Outward Bound, an organization that provides outdoor education programs, provides an example of how a community-based recreation and learning program can benefit from a standardized assessment to measure participant outcomes. The *Outward Bound Outcomes Survey* "allows all 11 regional Outward Bound schools to collect consistent data on how students are impacted by their Outward Bound experiences in key areas of social–emotional development" (23). Therefore, this comparable program that provides recreational access to both general and vulnerable populations may serve as a model for how the A/TR profession may begin using standardized assessments to measure participant outcomes, facilitating communication between centers and to the public.

While the majority of respondents (64%) reported that it is important to identify standardized assessments to measure outcomes of A/TR participation, a notable minority (29%) of respondents did not think it was important. The rationale for those respondents who reported that it is "not important" to identify a standardized outcome assessment is not clear, as respondents did not have the opportunity to describe why they selected their answers. Other authors have reported that community-based service professionals feel that standardized assessments may not reflect the unique characteristics of their community, programs, and the skills and resources of their participants (24). Furthermore, education on standardized assessments is not included in CTRI training materials (25); therefore, the "unimportant" responses could result from a lack of knowledge about standardized assessments. Despite this disagreement among respondents on the importance of standardized assessments, a large majority of respondents stated they would be either likely or very likely to implement standardized assessments recommended by PATH, Intl. Therefore, results of this survey suggest that if standardized assessments were available and recommended for A/TR professionals, they would be likely to use them. However, the lack of standardized assessment availability is indicated by the fact that only 13% of respondents reported currently using standardized assessments. Therefore, this study substantiated that there is currently an unmet need to identify or develop standardized assessments to measure participant outcomes of community-based A/TR.

4.1.1 Current assessments

The current survey collected information from the few respondents who are using standardized assessments, which may provide helpful insights for identifying ideal assessments to be used in the A/TR context. The most frequently used standardized assessments

measure improvements in *horsemanship skills*, the primary focus of A/TR services. The Therapeutic Riding Assessment Impact Network [TRAIN; (26)] designed a TR-specific goal-attainment scaling process that was implemented by 9 respondents; this process involves the development and rating of goals to measure changes in horsemanship skills as a result of participating in A/TR. The next most prevalent standardized assessment, the RIDES tool, was developed by an A/TR center to assess horsemanship skills, develop goals, and track goal progress (14). The RIDES and TRAIN assessment tools could be valuable resources for A/TR professionals interested in measuring improved horsemanship abilities. However, they do not measure the natural benefits of horsemanship in participants' everyday lives outside of the equine context (e.g., physical outcomes and cognitive outcomes, etc.), which were more often identified by respondents as important constructs to measure (see Table 2).

There was much less consensus among survey respondents regarding standardized assessments currently used to measure the natural health or wellbeing benefits of horsemanship, outside the equine context. This reflects the diverse populations who participate in A/TR and the myriad of benefits which engaging with A/TR provides (2). However, survey results also highlight the difficulty of communicating A/TR outcomes across different centers, and further substantiates the need to identify or develop standardized assessments that can be used across several diverse PATH, Intl centers.

4.1.2 Benefits of and barriers to implementing standardized outcome assessments

The benefits of implementing standardized A/TR assessments reported by survey respondents mirror national trends for program development and evaluation. In recent decades, there has been a national emphasis on evidence-based policies and programs, including community-based programs. Program funders, such as policymakers and funding agency leaders, often require programs to demonstrate their efficacy through research or program evaluation (27). Additionally, for programs to receive national attention and support, they must be evaluated at regular intervals (28). One such method of program evaluation involves using standardized assessments to measure the outcomes which programs claim to address among participants. Standardized assessments are used to measure whether participants are eligible for programs/services, to ensure high quality intervention, and to communicate with internal and external interested parties. This aligns with respondents' perceived benefits of using standardized assessments in the current survey, which included demonstrating the value of A/TR, communicating with funders and other professionals, advocating for insurance coverage and funding, and bolstering the A/TR profession's credibility. These responses are similar to benefits of standardized assessments reported in other professions (29–31). Furthermore, consistent use of the same standardized assessments across centers could facilitate consistency in future A/TR research, a stated priority for increasing rigor in human-animal interaction research (7, 32). Overall, the A/TR profession has an opportunity to strengthen its national credibility by implementing standardized assessments to effectively communicate the broad benefits of A/TR participation.

Despite these potential benefits, there are significant barriers to A/TR programs implementing standardized assessments. A/TR programs are not required to implement standardized measures, and training for CTRIs does not include education about how to implement standardized outcome assessments (25). The PATH, Intl course which potential CTRIs are required to take includes a section on participant evaluation and progress notes, but it does not provide education on implementing standardized outcome assessments to track participant progress or measure program effectiveness. Most barriers identified by survey respondents reflect restraints in the A/TR context, including the time, financial, and systemic restraints inherent in A/TR practice. Other professionals have reported similar barriers to those identified by survey respondents, including time, participant burden, and a lack of resources (29–31). These reported barriers should be considered when identifying potentially useful assessments to implement in A/TR settings.

4.2 Usefulness of standardized outcome assessments

Given the barriers to using standardized assessments discussed above, it is critical that standardized assessments identified to measure participant outcomes of community-based A/TR are *useful* in the A/TR context. Usefulness is particularly important for A/TR professionals, as they often serve diverse populations with varying needs and abilities and are constrained by the limited time they spend with their participants, limited financial resources, and credentialing restrictions. Over 90% of respondents reported that a useful standardized outcome assessment would be appropriate for use with A/TR participants of all ages and diagnoses/life experiences. Additionally, respondents consistently reported that a wide variety of outcome constructs (i.e., cognitive outcomes, communication outcomes, emotion regulation, and physical outcomes, etc.) are important to measure in A/TR practice. The outcome constructs identified by respondents are consistent with research findings in the A/TR literature; specifically, research has demonstrated that A/TR can improve mental functions (33), social functioning (34), emotional regulation skills (35), communication skills (34), physical function (36, 37), quality of life (38, 39), and community integration (40). Given these findings, a battery of standardized outcome assessments proposed for use in the A/TR setting should measure a wide variety of outcomes in A/TR participants from a variety of age groups, diagnoses, and life experiences. Such a battery of assessments would then likely need to be accompanied by a decision-tool and training to guide A/TR professionals in selecting and implementing the assessment(s) most pertinent to the participants they serve.

Regarding the logistics of implementing standardized assessments, there was not consensus among survey respondents about who should provide information for the assessment (i.e., CTRI-administered assessment vs. participant or caregiver-completed questionnaire), or how the assessment should be delivered (i.e., computer/iPad, paper-pencil, or both). The best standardized assessment format likely depends on individual characteristics of A/TR facilities so it would be beneficial for standardized assessments to be available in both virtual and paper/pencil forms. Most respondents agreed that assessments should not take longer than 10–20 min to administer and should be freely available or low-cost. Therefore, if multiple assessments are identified, they should require no more than

10–20 min total, and the cost for administering assessments should remain minimal.

4.3 Limitations

This study includes several limitations. Firstly, respondents were not asked their geographical location or demographic information. These data would have allowed us to understand if trends existed in different areas across the country or based on gender, age, race, or ethnicity. Such demographic data should be included in future studies. Additionally, some sections of the survey did not include a short-answer section, forcing respondents to identify a pre-written response and limiting our capacity to understand the nuances of their answers. Finally, this study is limited by the absence of responses from A/TR participants and their caregivers, whose opinions should be considered in relation to if assessment is important to them, what outcomes should be assessed, and how much time they would be willing to dedicate to participating in an assessment.

4.4 Future research directions and conclusions

To our knowledge, this is the first study to gather information from A/TR professionals about the potential usefulness of standardized assessments in community-based A/TR services. Future research should identify or develop standardized assessments that may be useful. To this end, a Delphi study of A/TR experts could aid in developing a prioritized list of potential standardized assessments to measure participant outcomes of A/TR. Once assessments are identified, they should then be piloted in community-based A/TR to understand whether they are feasible in actual A/TR environments. Future directions may also include bolstering community-academic partnerships, to support the implementation of standardized assessments in community-based A/TR. Overall, implementation of standardized assessments in A/TR could enhance the credibility of the profession and provide a means for communicating the vast benefits of community-based A/TR to a variety of audiences.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Colorado State U IRB #1, Colorado State University. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because the study was designated as minimal risk, and the survey was completely anonymous. Written informed consent would have been the only way to link participant information to the study if it were obtained. Participants indicated consent by reading the consent form and choosing to complete the survey.

Author contributions

MH: Formal analysis, Writing – original draft. KA: Conceptualization, Data curation, Methodology, Resources, Writing – review & editing. BF: Methodology, Writing – review & editing. RG: Methodology, Writing – review & editing. AS: Supervision, Writing – review & editing. LS: Supervision, Writing – review & editing. BP: Conceptualization, Data curation, Methodology, Supervision, Writing – review & editing.

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Conflict of interest

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

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Characterizing stress during animal interaction: a focus on the human endocrine response during equine-assisted services

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Repeated stresses applied to the rider may contribute to the documented physical and psychosocial outcomes from equine-assisted services. In this brief review, a summary of neuroendocrine markers of stress, including immunoglobulin A, serotonin, cortisol, progesterone, and oxytocin, is presented within the context of the physiology of stress modulation. Results are mixed with regard to the effects of these hormones on rider physiology before, during, and after equine-assisted services. However, some results from existing studies are promising with regard to the attenuation of stress. Future research should include a cross-disciplinary approach when conducting well-controlled studies with proper treatment and experimental fidelity, while also considering exogenous and endogenous factors that influence rider physiology.

KEYWORDS

equine-assisted activities and therapies, hippotherapy, horse physiology, neuroendocrine, rider physiology, therapeutic horseback riding

1 Introduction

Equine-assisted services (EAS) include various services in which the horse and other equines are utilized to benefit individuals (1). These services include therapy, learning, and horsemanship (1). Previous terms used to denote therapy in this unique setting have included equine-assisted therapy and hippotherapy. Learning and horsemanship have been previously referred to as equine-assisted activities or therapeutic horseback riding. However, these latter terms have been recommended to be discontinued in favor of more inclusive language [for a more detailed summary and consensus on current terminology, see (2, 3)].

During EAS, the rhythmic movement of the horse is used as a tool to improve physical, emotional, and mental health in the rider (4). The physical (5) and psychosocial (6) outcomes of EAS in the rider have been summarized previously. While these exogenous effects have been characterized, the endogenous changes that may allow for improvements in overall function during EAS have not been summarized to date. More specifically, these changes include the stress applied to the rider. Stress is defined as the threat, or perceived threat, to an organism's homeostasis (7). Repeated stresses on bodily systems can lead to physiological adaptations and re-establishment of homeostasis, eliciting an improvement in functional capacity and physical function (7, 8). As the rhythmic movement of the horse elicits repeated bodily movements in the rider during EAS, it follows that the physical adaptations [e.g., gross motor function, balance, posture, muscle asymmetry, spasticity; (5)] to EAS occur, in part, due to the application of acute bouts of stress.

In humans, this adaptive stress response is influenced by cellular, molecular, and neuroendocrine factors located in the central nervous system and periphery (7, 9). When in a stressful state, a fast and slow response occurs (10). The fast response is mediated by the sympathoadrenomedullary (SAM) system, which promotes an increase in epinephrine and norepinephrine from the adrenal medulla and an additional increase in norepinephrine from the sympathetic nerves (10, 11). Once released, these hormones initiate the contraction of muscle cells in the vasculature, skeletal muscle, heart, and other organs (12, 13), resulting in increased physiologic responses that include, but are not limited to, vasoconstriction, blood pressure, heart rate, cardiac output, oxygen consumption, thermogenesis, arousal, alertness, and vigilance (10). The slow response is derived form the activation of the hypothalamic-pituitary-adrenal (HPA) axis, a critical structure both centrally and peripherally located to mediate the stress response (7, 10, 14). The activation of the HPA axis causes a release of corticotropin-releasing factor (CRF) from the hypothalamus in the brain (10). Interestingly, equines present with a similar neuroendocrine profile as humans under periods of stress. Both the SAM system and HPA axis also modulate the release of these hormones in equines (15, 16).

Changes in neuroendocrine responses can attenuate stress in humans following animal interaction (17). Other endogenous markers that have been positively affected in the rider following human-animal interaction include serotonin (18), immunoglobulin A (19), and oxytocin (20). In this brief review, a summary of the neuroendocrine markers of stress is presented. Concentration changes before, during, and after EAS are provided. A brief summary of the stress incurred by the equine during EAS is also presented. Finally, future directions for research are discussed.

2 Immunoglobulin A

Immunoglobulin A (IgA) is the most dominant antibody in immunity, regulating mucosal homeostasis (21). Once secreted in the lumen, it binds to antigens and prevents toxins from entering the submucosa and circulation (22). Acting as the primary barrier to pathogens and irritants, increased concentrations may promote immune health (21). As the immune system is integrated with other organs in the body, including the brain, behavior and activity (including tactile contact between mammals) can positively affect immunity (23). Additional lifestyle habits may increase concentrations of IgA, including listening to music (24), relaxing (25), or watching a funny movie (26). Markers of immunity and the associated physiological stress response have remained mostly unexplored in the interaction between humans and equines. However, concentrations of IgA did not change after 15 min of equine-facilitated learning (i.e., moving around a horse while focusing on the response of the horse with awareness of their own bodily sensations) in healthy older adults (27).

3 Serotonin

Serotonin, a neurotransmitter in the central nervous system, is implicated in the function of the cardiovascular, pulmonary, metabolic, gastrointestinal, and genitourinary systems (28). The influence of serotonin on gastrointestinal function and gut microbiome is great, as more than 90% of circulating serotonin in the periphery is synthesized by cells in the gastrointestinal tract (29). Metabolically, it contributes to glucose homeostasis and adiposity, thus influencing the course and progression of chronic diseases (29).

Serotonin receptors are expressed in many regions of the brain, and thus help to regulate the nuclei in these regions involved in behavioral output. In addition to well-known attributes such as mood, sleep and appetite, there are multiple behavioral attributes that are regulated by serotonin, including perception, reward, anger, aggression, memory, and attention (28). More specifically, serotonin may play a key role in emotional regulation and behavioral flexibility, social cognition and control of social interactions, anxiety, and learning and memory (30, 31). The influence of serotonin may therefore be very important to quantify before and after the administration of EAS. There are no known studies that include the measurement of serotonin following an acute or long-term EAS intervention in chronic disease populations. However, serotonin concentrations increased by 5% following 8 weeks of horseback riding in a therapeutic setting in older adults (32).

4 Cortisol

When secreted from the hypothalamus, CRF stimulates the nearby anterior pituitary gland to release adrenocorticotropin (ACTH), eliciting the release of cortisol from the adrenal cortex into the circulation (33). Its metabolic effects include lipolysis, protein catabolism, and an increase in blood glucose by stimulating liver enzymes, although this glucose is blocked when delivered to working tissues (34). However, this mobilization of energy is thought to be the primary function of cortisol during periods of stress (35).

Cortisol responses to EAS have been mixed. Morning salivary cortisol concentrations did not change over the course of 6 weeks of equine therapy in veterans with PTSD (36), or after 10 weeks of therapeutic horseback riding in children with autism spectrum disorder [ASD; (37)]. However, a 20 and 24% decrease in salivary cortisol concentrations were observed after 1 month (38) and 12 weeks (39) of weekly hippotherapy sessions, respectively in male children with ASD. There are positive results reported in healthy populations. Cortisol concentrations decreased by 6% following 8 weeks of horseback riding in a therapeutic setting in older adults (32). In addition, cortisol levels were decreased in these participants when compared to a control group following the riding protocol (32). Finally, 11 weeks of equine-facilitated activities performed once per week, 90 min per session, decreased salivary cortisol concentrations by 20% in healthy adolescents (40). In healthy adults without horseback riding experience, no change in cortisol concentrations was observed in healthy adults following a 2-h horse-riding lesson program (41). However, among healthy adults with horseback riding experience, a 61% and 64% decrease in cortisol concentrations were observed immediately following, and 1 h following, a 2-h horse-riding lesson program, respectively (41). The observed decrease in cortisol concentrations

following EAS may be expected, as many of those who participate in these interventions experience relaxing effects during the treatment (42).

5 Progesterone

Traditionally thought of as a female sex hormone, progesterone is produced in the corpus luteum in the ovaries and metabolized primarily in the liver in women (43). In men, progesterone is secreted by the adrenal cortex, and can be metabolized to other sex hormones, including testosterone and estradiol (44). Progesterone also influences mood and behavior via emotion processing (43). Inclusive to emotion processing are emotion recognition accuracy and emotional memories (45). When progesterone concentrations are high, there is a faster response to negative stimuli, which typically presents as a heightened sensitivity to physical threats (46–49). Emotional memories are mediated by the HPA axis, and elevated progesterone levels are correlated with emotional free-recall and recognition memory (50, 51). To date, these phenomena have been only observed in women. However, due to the influence of progesterone on the HPA axis and the brain, the hormone may have positive effects on mood, cognition, and neuronal growth in men and women (52–54).

Acute assessments of progesterone have been completed in male children with ASD after one session of hippotherapy. An increase of 80% in salivary progesterone was observed after 30 min of therapy (38). Longer-term assessments have also been made, with a 21% and an 83% increase in salivary progesterone after 1 month (38) and 12 weeks (39) of weekly hippotherapy sessions, respectively, in the same population. Based on these results, the regulation of mood may be enhanced with EAS in children with ASD due, in part, to the release of progesterone derived from the rider's motivation to bond with the horse (55).

6 Oxytocin

Oxytocin is primarily synthesized in the hypothalamus and released from the pituitary gland (56). Once activated, its presence in the blood affects other organs, including the mammary glands and kidneys (57). Oxytocin may therefore play a crucial role with stress-related behaviors due to its influence within the HPA axis (57). More specifically, the release of oxytocin may elicit decreases in glucocorticoids and concomitant increases in parasympathetic nervous system function, thereby decreasing heart rate and blood pressure (BP) responses (17, 58). Indeed, the active form of oxytocin is related to reduced anxiety and relaxation in children (59). Oxytocin is also implicated in the underlying mechanisms of the development and maintenance of attachment in mammals (60). More specifically, tactile contacts (e.g., touch, warmth, vibration), which are critical for social bonding, may be facilitated by oxytocin (61). The human-animal interaction and, specifically, tactile contact, stimulates the release of salivary, plasma, and urinary oxytocin (62, 63). The validation of salivary oxytocin has recently been shown in mammals (62, 64).

7 Other stress-related measures

Cardiopulmonary measures, including heart rate, BP, pulmonary function, and heart rate variability (HRV), have been characterized as stress-related markers during EAS. Overall, hippotherapy and EAT does not alter heart rate in children with neurologic disorders (65–67) or adults (68), respectively. However, heart rate responses may change based on the level of disability of the rider. Indeed, therapeutic horseback riding may elicit increases in heart rate in children with a moderate to severe pathophysiology (69), particularly when compared to youth with less motor impairment (70). Heart rate responses are lower when riders are grooming and petting horses when compared to walking and leading them (71). A single session of, or training over time involving, EAT or hippotherapy also does not alter BP (65–67, 71) or respiratory responses (67, 69, 71) when assessed after sessions have ended vs. baseline. Fifteen minutes of equine-assisted learning may, however, increase respiratory responses in older adults (27). Finally, based on HRV measures during EAS, there may be an attenuation of sympathetic nervous system activity and an increase in parasympathetic nervous system activity [see (72), for a comprehensive review], thereby resetting balance during periods of perceived stress, and promoting improvements in cognitive and emotional control (73, 74).

8 Considerations of the horse

The stress level of the horse should be considered to ensure the health and welfare of these animals are maintained (75). Because horses are prey animals, they have a heightened awareness to their environment, unlike dogs or cats (36). As such, they are able to perceive, respond, and learn from subtle stimuli in a therapeutic setting (76). Equines can respond to a human presence through changes in the rider's physiology, body language, and vocal tones (76). This response may be accompanied by acute stress in the horse, either from the rider or from another environmental stimuli. Confusion and related conflict behaviors in the horse, when accompanied by stress, can then lead to injury to horse riders and handlers and perpetuate the idea that horses exhibit unpredictable behavior (77). Indeed, if the rider is stressed, this may increase the likelihood of a startled reaction in horses via a transmission of stress, thus increasing the risk of injury (78). Elevated stress levels can elicit negative effects on immunity in horses, which may lead to an increased incidence of colic and gastric ulcers (79–81). Also, strong emotional reactions may impair learning performance in equines (82–84). Taken together, these effects may decrease equine performance and attenuate the benefits received by the rider during EAS.

Although stress responses can be variable, the therapy setting typically does not add stress to the horse. No difference in cortisol concentrations was found between modes of riding [i.e., therapeutic vs. traditional; (85)] or between time points within and across EAS sessions (41, 71). This is significant, as serum-free cortisol concentrations increase within 10 min after exposure to acute stress in equines (86). Furthermore, cortisol, ACTH, and glucose maintained normal ranges over time, and between riders with and without posttraumatic stress disorder (75). Alternatively, a

decrease in cortisol levels in the horse by up to 45% may occur when children with psychomotor disabilities participate in EAT (87).

Stress can also be objectively measured in horses using cardiovascular measures, including HRV. Similar to measurements in humans, HRV measures in horses are sensitive and reliable indicators of fear or anxiety (27). Basal HRV variations can be influenced by genotype, behavior, environment, temperament, and dietary habits (88). During a 15-min equine-facilitated learning session with older adults, very low frequency (VLF) ranges of HRV were recorded (27). Power within the VLF band is consistent with improved health (89), with the activity of the parasympathetic nervous system contributing most to VLF power (90). In another study, no changes in HRV were found in horses after several phases and sessions of EAT with riders who had varying health statuses (68, 71, 91). However, HRV measures were different between horses who performed equine-assisted activities and therapies and horses who performed dressage, jumping, and eventing activities (92).

9 Conclusion and future directions

In this review, IgA, serotonin, cortisol, progesterone, and oxytocin were summarized in the context of rider physiology during EAS. Although the characterization of the concentrations of these hormones is mixed throughout the literature, results from existing studies are promising with regard to the attenuation of stress in the rider during EAS. The positive outcomes in stress modulation may contribute to the physical and psychosocial benefits observed across populations of varying age, diagnoses, and horseback riding experience. However, it appears that periods of chronic stress, physiologically manifesting as high concentrations of glucocorticoids and catecholamines, can influence the ability for horses to perform during EAS and can negatively impact the human-animal bond.

Due to the cross-disciplinary nature of this topic, and the difficulty in obtaining and analyzing blood and saliva samples, future research teams should include biologists, biochemists, or some healthcare practitioner (e.g., nurse, phlebotomist, exercise physiologist). More well-controlled studies with proper treatment and experimental fidelity to allow for accurate quantification of stress-related hormone concentrations are needed in this area. A number of physiological factors in the rider should be considered, including method of data collection (salivary vs. plasma and/or serum), time of day (i.e., circadian rhythm), timing of data collection before, during, and after EAS sessions based on knowledge of peak hormone concentrations, and unique sex characteristics (e.g., male vs. female, timing of female menstrual cycle), as any of these can influence neuroendocrine responses to stress (93–95). With these future directions, the next steps can be made in the process of seeking to make EAS more affordable and accessible.

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Becoming a matter of veterinary concern

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Horses in Great Britain are living into increasingly older age and are often regarded as friends or family members by their owner. The horse is reliant on their owner to meet their needs and this paper discusses how horse owners frame an issue that becomes a matter of veterinary concern within the context of the older horse. Qualitative methods were used to explore the experiences of owners and veterinarians. Data were collected and analysed using a grounded theory approach during the period 2019–2022. Analysis identified that owners undertook an ongoing and iterative process of assessment, monitoring and decision making in relation to the animal and any changes they observed. Matters that became a veterinary concern required the owner to formulate the issue as something that fell within the knowledge domain of the veterinarian. Veterinarians had a medicalised view of older horse health and their perspectives on socially acceptable care were shaped by their understanding of species-specific needs, and whether owners were providing appropriately for those needs. The formulation of a matter of veterinary concern was itself shaped by an owner's experiential knowledge of both veterinary matters and their horse. The extent to which owners felt like they and their individual horse mattered during interactions with veterinarians affected whether they adopted veterinary advice and the nature of future veterinary employment. Findings demonstrate how matters of health, disease, and the role of professionalised forms of medical knowledge, are not static but constantly changing and interacting over time. An issue that became a matter of veterinary concern was contextual, and rooted in individual relationships. The significance of veterinarian-owner interactions in shaping future consumption of veterinary health care may be underestimated.

KEYWORDS

ageing, health care, horse–human relationships, sociology, veterinary medicine

1 Introduction

We live in a world of interwoven multispecies relationships (1, 2). Issues of everyday life are in a constant state of "becoming" within the networks of social, material, and political structures in which they arise (3) and animals play an important role in the creation of health knowledges (4). While humans and animals live together in society and many are viewed as family members (5), society does not take responsibility for animals which are seen as privately owned. The state steps in where the actions of owned animals disrupt

everyday life, e.g., dog fouling, dog bites, zoonotic diseases, but in the main, the animal remains the sole responsibility of their owner.

From the perspective of the veterinary profession, veterinarians play a central role in animal care and preside over the body of knowledge and expertise associated with animal health and welfare (6). Society grants veterinarians legal powers to prescribe, treat and conduct certain technical procedures on the basis of their education and training. However, epidemiological research has reported that there is a reduced uptake of "routine" veterinary services (namely for the provision of vaccinations) by owners of older horses as their horse ages and upon a horse's retirement (7, 8). This change in the use of veterinary services was used as the point of departure in this study. This paper explores the relationships between an older horse, their owner, and their veterinarian, to understand how networks are drawn upon in decision making regarding the consumption of health care services and why an issue becomes a matter of veterinary concern.

Many people (hereafter, owners) are caring for their horse into old age (9, 10). The equine life course is often thought of in similar ways to that of humans, with socially constructed phases of education, work and retirement. Studies indicate that owners of older horses report changes such as increasing grey hair, stiff joints or lack of joint flexibility, loss of muscle tone and deepening of supraorbital hollows, and often attribute these to signs of ageing (8, 11). The veterinary-reported prevalence of chronic disease amongst the older horse population is considered to be high (12). However, literature reports differences between owner-reported and veterinary-identified signs of disease (13, 14), suggesting that there may be divergent views on the meaning of disease and its amenability to treatment. These observations, along with the reduced uptake of routine veterinary health care services by owners as their horse ages, suggest that lay constructs of disease and perceptions of the role of the veterinarians in older horse care, do not necessarily align with professional notions.

Veterinarians are dependent upon animal owners for their employment. For animal owners to employ the services of a veterinarian they have to frame an animal's need as a matter of veterinary concern. The skills and competencies of the veterinary profession reach into many areas of an animal's life, including preventive health practices and areas that may be deemed relevant to the good practice of life (15). Whether or not an animal owner chooses to consult a veterinarian and follow their advice depends upon a whole host of complex factors.

Veterinary services are reported to be just one of many sources available to owners to assist in the management of their horse's health (16, 17). An owner's networks of advice and support may include; peers, livery (horse housing) staff, online communities, friends and health care providers such as physiotherapists, and veterinarians (18). Exactly where the veterinarian fits into the care of the older horse varies enormously between owners, and in relation to the horse in question. When asked, owners report valuing the veterinarian's opinion in relation to expensive or long-term veterinary care and euthanasia decision making (10, 19). However, the timing and nature of veterinary involvement varies. A study of Australian horse owners reported that veterinarians were consulted for serious issues or as a last resort, and there was little mention of their role in preventive health care (20). A study examining horse owner approaches to responding to equine colic found that three (not mutually exclusive) strategies were adopted: "wait and see", "lay treatment" or "veterinary assistance" (21). Therefore, veterinary involvement is likely to take place alongside other management strategies.

Where a veterinarian is involved in an animal's care their decision making is reportedly influenced by the nature of the animal carer's wishes alongside the animal's health (22, 23). In the context of the older horse, there appears to be a focus on identifying diseases that have become associated with old age. Literature on older horse health and husbandry uses language such as aged, geriatric or senior, reflecting an association with decline (10, 24, 25). A small survey of Austrian veterinarians indicated that advanced horse age eased their management of euthanasia decisions (26). Whilst differences in owners' approaches to involving a veterinarian are clear, the role of the veterinarian in shaping these approaches, has not previously been explored.

The approaches of, and interactions with, medical professionals are known to be linked to health outcomes. In the human health care context, cultural meanings regarding matters of health and disease are known to differ between groups, affecting the reported prevalence of a particular condition. Where a disease is contested, this may for example result in users of health care services being resistant to being labelled as having that disease, or where patient experiences do not fit within a medical construct, left being unable to access treatment (27). The concept of mattering—feeling significant, valued and heard by other people—and its significance as a predictor of outcomes such as academic performance, academic stress, life satisfaction, and happiness has been described (28). Therefore, this paper is concerned with the interactions of different social groups (horse owners and veterinarians) and their respective health knowledge(s) and the extent to which this affects owners' uptake of, and future engagement with, veterinary health care services.

This exploratory research sought to understand how owners of older horses made decisions regarding their horse's management and health care provision. This paper draws on empirical data to discuss how owners' experiences impact on their decision making and how issues with their horse are constructed as a matter of veterinary concern.

2 Methods

This paper draws on data collected as part of a wider study that examined how horse owners and veterinarians make decisions regarding care of the older horse. The research was reviewed and approved by the University of Liverpool's Veterinary Research Ethics Committee (reference VREC901).

This research was underpinned by a social constructionist epistemology in order to understand the way in which people construct their realities, the meaning they take from them and how this shapes their decision making. A symbolic interactionist theoretical perspective was used to enable the exploration of how people's attitudes and beliefs changed with time and context. This study adopted a constructivist grounded theory methodological approach as described by Charmaz (29) in order to generate theory from data (30).

2.1 Data collection

Multiple sources of qualitative data were purposively sampled from participants located in different regions across Great Britain. The

collection of data included: 12 online open-access discussion forum threads containing 326 comments (open-access, based in Great Britain, active during 2016–2020 see (18) for further details); 25 semi-structured interviews with owners of older horses, nine semi-structured interviews with respective veterinarians and 13 sets of veterinary clinical records pertaining to the interviewed owner's horse(s) covering the previous 2 years (collected during the period 2020–2022). Horse owners were recruited for interviews using an online advertisement and veterinarians were recruited based upon their involvement in the care of the owner's horse. All participants responding to the advertisement, as well as the veterinary practices/veterinarians contacted directly, were provided with a study information sheet. One participating owner and one veterinarian were known to Rebecca Smith (RS) beforehand, while all other interviewees had no prior relationship. There were a few owners who had no veterinarian to nominate, and one veterinarian declined to be contacted for interview when the participating owner had mentioned the study to them. In some instances, the veterinary practice submitted the clinical records pertaining to the interviewed owner's horse but the veterinarian was not interviewed, or vice versa. Reasons for being unable to obtain clinical records or interview the nominated veterinarian included a lack of response or reported time constraints.

Most interviews were held online or by telephone due to restrictions related to the COVID-19 pandemic. Following introductions and opportunity for participants to ask questions about the study, RS obtained informed consent for participation (see Supplementary Data 1). All interviews were audio-recorded. Interviews followed a semi-structured approach with an interview topic guide used to prompt discussion of relevant topics. Follow-up questions varied depending on responses during each interview (see Supplementary Data 2). Interviews with owners were generally around 60–90 min duration, whilst interviews with veterinarians were mostly shorter, of around 45–60 min. As part of the wider study, a number of retirement livery premises were visited (once travel restrictions lifted), and one veterinarian was recruited via this route. Fieldnotes including reflections and initial impressions were written by RS following the interviews and fieldwork.

2.2 Data analysis

The analysis of data took place alongside its collection using a constructivist grounded theory approach (29). RS was primarily responsible for collecting and analysing all data. Data were anonymised before being inductively coded—fractured down to words, phrases or lines—and conceptual labels or "codes" applied. These were grouped in conceptual categories and their relationships interrogated to create conceptual models. Coding and theory development was discussed in-depth with Elizabeth Perkins (EP) and frequent discussions took place throughout the project with the whole research team. Constant questioning and comparison of data enabled analysis to move in new theoretical directions and drove theoretical sampling. This enabled greater detail of decision-making processes and the properties of categories to be developed which produced a dense theory that was grounded in people's experiences (29–31). This paper presents a substantive theory about decision making in relation to veterinary involvement in older horse care.

2.3 Reflexivity

RS engaged in an ongoing process of reflexivity as data collection and analysis evolved. RS, a female veterinarian with experience of caring for (but not owning) horses was, at the time, a PhD scholar trained in social research methods. This role as a relative 'outsider'—being a small animal, rather than equine, veterinarian—enabled the questioning of colloquial language and worldviews during the initial coding process. These experiences and understanding also assisted in building rapport with interview participants. The research team also included EP, a social scientist with experience in health and social policy research and herself a horse owner, as well as three veterinarians with expertise in epidemiology and equine medicine who had previous experience of working in multidisciplinary teams on qualitative research projects.

3 Results

Analysis identified that, in their life with their horse, owners undertook an ongoing and iterative process of recognising and responding to change on a daily basis. The role of the veterinarian, and the way in which matters were understood to be of veterinary concern, was situated within this context and shaped by past experiences with veterinarians. This paper presents four interrelated themes through which the factors that shape, and the consequences of, decision making within these networks of relationships are discussed. Firstly, the process of recognising and responding to change will be described. In part two, the ways in which issues were raised to those perceived to require veterinary attention are discussed. The third section presents findings on how (sometimes differing) perspectives were generated regarding what made an issue a matter of veterinary concern. In the final section, the consequences of veterinarian-owner interactions for horse health, and for owners' views of the role of the veterinarian, are presented.

3.1 Recognising and responding to change

Over time through their interactions with their horse, owners developed knowledge about each horse as an individual. Many owners had established daily routines of care, creating a normative understanding of their horse. Deviations from this norm raised questions for the owner about their management of the horse and the reasons for this change:

> "We controlled the laminitis [painful condition affecting the tissues of the horse's foot] fine and then it just felt like, I don't know, I wouldn't say he had laminitis, he just started to look a little bit footy and you think, he had the same routine and suddenly the routine wasn't working as well." (Sarah, owner).

Owners processed information about a horse's changing condition in their everyday context and made early attempts to attribute meaning to the changes they observed. For example, one owner Jill talked about noticing a change in her horse's gait. She interpreted the meaning of this in the context of the environment and

her knowledge of her horse's physical and mental characteristics. This understanding was also influenced by how the horse changed over time:

> "Umm, so it was slightly pitted from the winter poaching…just slightly at one end and uh, I saw him walking and he was pottery…but he was pottery all round, you know and I kept thinking is it the ground, cos he does he is a bit of a ponse you know for um sort of delicate feet you know, uh doesn't like walking on gravel things like that you know. um and uh I sort of, but within a couple of days the rain had come back, ground had gone a little bit softer so I thought maybe it was him just being like that." (Jill, owner).

As Jill demonstrates in her quote above, owners look to common sense explanations first before settling on a course of action. Within a dynamic model, care could be adapted to fit everyday changes that took place. Subtle changes however, were sometimes reported to be difficult to recognise, especially in the context of caring for a group of horses.

Owners adopted strategies in order to resolve issues and these differed depending upon their experience and the perceived severity and urgency of the issue. Owners commonly talked about increasing their monitoring of the horse, or a particular issue of concern, during the problem-solving process. Increased monitoring allowed an owner to establish whether an issue was of concern. This 'watch and wait' could be the only strategy adopted or could take place alongside management changes:

> "So, every 2 hours I would go up and check on her, because I was terrified of her going down in the stable and not getting up." (Emma, owner).

The process of recognising and responding took place continually over time, and therefore, problem-construction was an iterative process:

> "Well when he first started itching I thought he'd got lice. Then I thought, "Oh no, it's sweet itch [allergic reaction to insect bites]" Then it went on all through winter, and I thought, "No, it can't be sweet itch." I was just sort of trying everything really." (Lorna, owner).

Knowledge of a particular horse and through extension, horses in general, was developed through experience and reflection on past experience. One participant described how she had previously managed recurrent colic in her mare. The recurrent nature of colic, by contrast with another horse and with hindsight, led the owner to label the horse as 'a colicky horse':

> "I guess I reacted if she was ill. She was quite a colicky horse. She suffered … I wouldn't have said that, at the time, but having Magic now who is not colicky at all, I can look back and think, 'Yes.'" (Susanne, owner).

Although owners could recognise a change, social influences shaped whether a change was considered to be problematic or not. For example, the livery yard environment (where multiple horse owners share use of a premises) could, in some circumstances, be helpful in attributing a cause of the horse's issues:

> "Well, he dropped quite a lot of weight and muscle quite quickly and the yard I was on, at the time, one of girls said, "Have you thought about getting him looked into for Cushing's [Endocrine disorder Pituitary Pars Intermedia Dysfunction (PPID)]?" But I didn't know a great deal about it there were things I'd seen about it like maybe get a curly coat and stuff like that, so I was like, "Hmm, I've not." (Mary, owner).

Monitoring change over time was an important feature of care in this study. In instances where horses developed chronic conditions, owners developed individual ways of monitoring their horse, and in turn, of recognising change. One owner valued riding her horse in order to pick up changes:

> "Because I can't tell from the ground completely. I've always been able to pick up his lameness very, very quickly when I'm on him. You can't see it when he's walking around the field." (Patricia, owner).

The environment, facilities and resources available to an owner shaped how management changes were made. For one owner who cared for multiple ponies, finances were a consideration and dental assessments were not part of her 'routine' care provision for her horses. In response to her perception of a dental issue she adopted a lay management strategy, namely, the adjustment of her pony's feed. The owner spoke about the fact that her pony had responded well to this, and for her, this meant that the pony did not require professional dental assessment unless anything else changed:

> "With Jimmy, it was coming up to autumn, into winter last year that his condition dropped quite drastically, quite quickly. It was to do with his teeth. Now, I haven't had his teeth checked out, but he now gets a feed supplement to maintain his condition. He's on Veteran Vitality, a veteran mix and Chaff as well. He's getting a decent feed … He'll probably get his teeth checked out the next time that his injections are due unless he changes. But he's doing well." (Leah, owner).

In instances where solutions to problems were unclear, owners sought advice from those deemed to have relevant knowledge. Depending on the owner's individual understanding of what type of issue warranted veterinary advice meant their advice-seeking behaviours might be directed differently. This could be through independent research or study, or through speaking to friends or professionals. For some owners, experiential knowledge was valued and sought from peers via online equestrian communities:

> "My elderly mare has started having seizures. I've been told that the likely cause is a tumour. Vet has been talking about possible treatment, but I feel very strongly that I don't want to put her through lots of invasive tests and pump her full of drugs … Anyone been in a similar position?" (forum user).

Sources of advice were adopted differently depending on availability and the perceived relevance of knowledge for that particular issue.

3.2 Becoming a matter of veterinary concern

The way in which veterinarians were employed partly depended upon an owner's understanding of their horse's need for a health care measure; for example, vaccination or dental treatment. While some services could only be accessed from a veterinarian, dental care could also be performed by other professionals such as equine dental technicians. Therefore, decisions made by the owner determined who was then able to provide a particular service for the horse. In addition to such health care services, veterinary advice could be sought for problems perceived to be specifically veterinary-related, or if the horse was 'just not right' and the owner believed that veterinary knowledge would assist in resolving the issue. However, what made an issue a matter of veterinary concern was not straightforward and varied between individuals. Perceptions of the role of the veterinarian were influenced by past interactions and factors including the veterinarian's communication style, technical skills, medical knowledge and their interaction with the horse. While in theory, veterinary visits were opportunities for evaluation and planning for a horse's long-term care, some owners reported that veterinarians did not use consultations as an opportunity to find out about the horse:

> "They didn't ask me any questions at all about what they did, what they didn't do. And I found that really odd and I said to Nathan, "I don't think I'm going to like him as a vet." They've no interest whatsoever in anything about the horse, they just came down, gave him an injection and went. (Emma, owner).

Some owners saw regular (annual tetanus or biennial influenza) vaccination as an essential part of care which reflected their ongoing commitment to the horse into older age. Others believed that regular vaccination was unnecessary because previous vaccinations conferred life-long immunity for their aged horse. Alongside a reduction in perceived risk—often related to reduced or more localised activities with the horse, or few horses entering or leaving a premises—some owners stopped influenza vaccination, or vaccinations entirely, as the horse aged and their lifestyle changed. The perceived necessity of involving a veterinarian for such measures was also related to an owner's ideas about what expertise, and type of service, their veterinarian could provide.

Owners knew in what instances they would go to a veterinarian for issues that arose; however, this had individual meaning and could change over time. During the process of 'watch and wait' owners used individual and specific ways of actively monitoring their horse's health. This knowledge was then used to know when to involve their veterinarian:

> "We've, kind of, managed to keep it in check since then, but it was the scabby legs that we noticed. And she does still have it. It's not as bad as it used to be, and it doesn't seem to bother her, but when it gets a bit worse, we usually get her tested again, because you quite often find that her levels have gone up again." (Savannah, owner).

Owners used their past experience as a basis for managing certain issues and this knowledge could form the basis of actions that replaced 'watch and wait'. Owners were willing to substitute this experience for a veterinary consultation, particularly where there was a similarity between the past and a current presenting issue:

> "I think it just goes on experience really, like you sort of, you know with certain things that the advice you're probably going to get is box rest and bute [non-steroidal anti-inflammatory drug], so if you have them to hand I normally would give them a try at first. Unless it's something dramatic like when he couldn't put his foot down and then I'd be straight on the phone to the vet." (Mary, owner).

Where unable to resolve issues by themselves, owners sought veterinary services in order to access medical knowledge, diagnostic equipment, technical procedures or prescription medication. Where owners had an established relationship with their veterinarian or practice, they were sometimes offered the option of discussing an issue with their veterinarian by phone or using a messaging service. Uncertainty by an owner about whether an issue was something that constituted a matter of veterinary concern could prompt enquiries before a visit was booked. For instance, if a horse was 'just not right' and the owner was unsure of what was causing the problem, advice could be sought prior to a consultation:

> "He started just standing in the stable". And, again, he wasn't himself. I would be saying, "Are you okay? Are you okay? And he wasn't, you know. So, I said to Becky [veterinarian], "Look, he is not right. I am not sure what is not right."" (Susan, owner).

Where veterinarians became involved in a horse's care their approach hinged on the identification of problems and finding solutions to those problems. Therefore, the way in which the owner presented the horse, and the veterinarian and owner interacted, shaped the nature of decision making that took place. Issues that constituted a matter of veterinary concern could differ between owners and veterinarians. Veterinarians felt that some owners found it difficult to identify change as a problem and to seek timely advice. Varying levels of horse-related knowledge and experience were perceived by veterinarians to impact on how owners assigned meaning to a change, which was perceived to delay advice-seeking:

> "He called us out initially because he thought that the horse wasn't moving very well and had slowed down when she was out on hacks. He is a very novice owner, which I'm sure he would admit himself. So, his complaint was that he was hacking the horse and she slowed down. I went out to see her and obviously she presented with actually quite significant hindlimb lameness which was very positive to flexion." (Laura, veterinarian).

An owner's understanding of a veterinary-related issue informed the course of the consultation. In some cases, owners expressed their concerns about a horse's health in terms of a diagnosis which made the veterinarian's first course of action more straightforward:

> "Sometimes clients call us, "I think my horse might be Cushingoid. Please can you come and test them."" (Laura, veterinarian).

The interplay between owner and veterinarian meant that the meaning of a veterinary-related problem was co-constructed during

the consultation. Once within the purview of the veterinarian, the issue of concern could be reconstructed. This could present opportunities for discussion around aspects of a horse's management, such as ridden exercise, that were relevant to the horse's health:

> "Because she was on Danilon [non-steroidal anti-inflammatory drug], regular Danilon, obviously he had to prescribe that and so he would get to see her a couple of times a year. Then we'd just talk about general management, really… Even though she was quite stiff, she used to love hacking out, and she'd still want to try and gallop off if she could, so it was Matt that said, "Actually, Isla, I think you need to retire her now," because she was getting quite … She used to stumble sometimes, and she might be extra stiff after a ride, so he would advise me on managing her arthritis anyway, and then just generally managing her condition." (Isla, owner).

Where time permitted, veterinarians appreciated questions from owners, believing that it reflected the owner's motivation to look after their horse and that they valued veterinary advice. Veterinarians recognised that discussions with owners opened the possibility of exploring wider issues which might be relevant for the owner.

The time frames in which owners sought advice from veterinarians depended upon; their understanding of the problem and its urgency, response to lay management strategies, relationships with veterinarians and consultation fees, e.g., the consideration of increased fees for out of hours emergency consultations. The importance of each owner's construction of a matter of veterinary concern had implications for the presentation to a veterinarian, and as later discussed, this presentation shaped decision making by the veterinarian. However, owners did not always restrict themselves to registering their animal with one practice. A few owners spoke about using different veterinary practices for different services—namely differentiating between vaccinations and problem-based consultations. Issues of concern regarding different aspects of the animal's health care could result in owners directing that horse to one practice or another. Therefore, veterinary knowledge of the horse was not necessarily confined to one practice and the owner was central to the co-ordination of care.

3.3 Perspectives on what made an issue a matter of veterinary concern

Veterinarians' judgements about the nature and timing of their involvement was based on their medically-informed notions of health and their ideas about acceptable ways to manage a horse in old age. These related to their understandings of how the body functions and their knowledge of species-specific needs. While owners drew on a much wider knowledge base including their own experiences with the horse over time. Apparent 'delays' in advice-seeking could be emotionally upsetting for veterinarians, particularly when horses were presented to them in significant pain:

> "The other sad thing, I think, is they get—not on purpose—neglected more because they're often just retired, so in a paddock, and you don't see them walking on concrete, so they miss the early onset laminitis. And they think, "Oh, it's losing weight because it's old", when it isn't. It's because it's got something going on with it." (Annelise, veterinarian).

The extent to which veterinarians sought to involve the owner in decision making during the consultation was informed by their assessment of the horse's condition and judgements about owner knowledge—as reflected in their advice-seeking behaviours. A veterinarian's ideas about what constituted a concern regarding the horse's wellbeing, and a possible way to resolve it, had to be negotiated in the context of what might be possible for the owner. Veterinarians talked about many possible considerations when finding solutions to problems identified, such as the horse's personality, owner finances, family commitments, housing environment, access to facilities, as well as the owner-horse relationship. These factors were seen as elements that necessitated the 'negotiation' of a form of appropriate care, which inevitably required a deviation from the veterinary 'ideal':

> "I think basically from my point of view we would say what's gold standard in terms of having them in and the box rest required and what they could eat, and we would probably then compromise on something that was not awful but not great. So, it was, yes, cornering off sections of paddock and having smaller paddocks, especially when they got, I think it was Gem that used to get abscesses, when she had abscesses and stuff, they couldn't be out in the field, but we managed it with small pens and stuff. So, yes, explained gold standard and then compromised on something that was acceptable but not gold standard." (Frank, veterinarian).

Veterinarians reported using strategies to shift an owner's thinking into the need for extra health care interventions. In the following example this involved the suggestion of a joint supplement:

> "So, I try and start them off on the Devil's claw, Boswellia-type things first to introduce them to the idea that they need some help. Then, as soon as they see there's an improvement and they see the horse looks happy, they soon come around quite often." (Annelise, veterinarian).

Different perspectives on what constituted a problem, or an appropriate solution, became more salient for veterinarians when they were presented with a horse experiencing worsening chronic problems, or where additional acute problems necessitated emergency consultations. These were cases where horse welfare was a more significant and acute concern: for example, colic requiring surgery, an inability to stand, or chronic worsening issues that were significantly impacting on quality of life such as long-term musculoskeletal pain. For veterinarians, these could prompt consideration of concerns such as unrelenting pain, suffering and end-of-life. In such contexts, veterinarians felt a moral obligation to get owners to comply with their advice. However, solutions could be challenging to navigate with owners if they were not on the same page:

> "And all of a sudden you're here on a Saturday night saying, "Your horse has some sort of bad intestinal lesion and it needs to be put to sleep." I think in those cases it's challenging because you've got to get the owner from, "My horse was healthy two hours ago," to a, "It's essentially going to die without anything else." So, the

> owner-Yes, it's trying to explain to the owners that that is the case." (Paul, veterinarian).

Veterinarians could feel powerless in certain situations particularly if they felt that the horse was suffering. Similarly, owners could feel powerless if they perceived that the veterinarian had not achieved an understanding of their horse as an individual. This could influence the way in which an owner received veterinary advice:

> "I was frightened that I would come under intense pressure to euthanise her, and I wasn't willing to do that. If I felt they understood my horse and had given me that advice I might have accepted it, but they didn't understand my horse." (Steven, owner).

The involvement of a veterinarian reflected that the owner understood the issue with their horse to necessitate veterinary expertise. However, the nature of the issue and what types of decisions it required them to make were not necessarily the same as the attending veterinarian. The way in which owners received and acted upon advice was influenced by how veterinary knowledge was situated alongside their own knowledge and beliefs, and whether successful communication had taken place:

> "I didn't really respond to it. I thought, "I understand why you're saying that. You're saying that because you think that's how he's going to get exercised." I don't think I responded to it. I thought, "It's a good thing because she thinks he's well enough to be ridden so I'll take that as a sign that she thinks he's well enough to be ridden but I won't be doing it." From memory, she doesn't really say it now. I think she realises I'm not going to be doing it." (Hazel, owner).

Even within longstanding veterinarian-owner relationships owners reported that there were gaps in the veterinarian's knowledge of how a horse was actually managed on a day-to-day basis by the owner.

3.4 Consequences of veterinarian–owner interactions for horse health

Veterinarians could provide a source of support and reassurance for owners that socially acceptable care of the horse was being undertaken: for example, if this was questioned by other owners, professionals or the general public. However, where unfamiliar veterinarians attended, this could sometimes challenge the construction of an appropriate form of old age care. Although there was a common desire to act in the horse's best interests, veterinarians and owners did not base their actions and decisions on the same type of knowledge:

> "And then, Christine [veterinarian] left and then we got a succession of young vets. Which, technically, they were right, but the amount of painkillers she was on was at too high a dose. Which, technically, they were right, but it was keeping the pony comfortable. And, we did reduce the amount of painkillers, and, so from then, she was back into pain and she didn't live very long." (Julie, owner).

When doing what they considered was best for their horse, owners could choose not to follow, otherwise adapt advice to their own context or seek further advice from other sources. In this study, owners interpreted the veterinarian's advice according to their own knowledge even when they were making decisions in the context of veterinary medicine:

> "Once I got him on one tablet a day then we stayed on that until recently, about three months ago, and now he's on half a tablet one day and a full tablet the next day. So, I just alternate it. James said to drop it down to half a tablet each day, but I was a bit dubious about doing that because of the ACTH [Adrenocorticotropic hormone] levels going high at this time of year anyway. I just thought it was a bit too risky to drop it that much, just in case he got laminitis again." (Patricia, owner).

The veterinarian's interactions with both horse and owner influenced an owner's preferences over which veterinarian attended. A sense of mattering for both veterinarian and owner was reflected in owners requesting a particular veterinarian to attend. These requests could generate long-term relationships:

> "Just, we know each other better. And also, because she'd always request me to come and see them. So, 9 out of 10 visits would be me, so I know the ponies quite well as well. Their little habits and that sort of thing. I think the continuity is quite good because it's easier to pick up changes and notice things that have changed from one visit to the next." (Ruth, veterinarian).

> "Ruth's been coming here long enough to know that if she tells me to do something I'll do it. So she pretty much trusts me I think, to get on with the caring without wanting to keep coming back. She knows I'll let her know if there's a problem." (Lorna, owner).

Past experiences with veterinarians shaped how owners managed future relationships and the timing of veterinary involvement. Owners developed knowledge of how to respond to certain changes in their horse, and for the most part, owners dealt with issues that arose on their own. This in turn influenced the timing of any advice-seeking:

> "And over the years I've thought to myself, and especially with Athena, "Actually, you don't need to go rushing off for an investigation, because, at the end of the day, they just tell you to put them on box rest." (Emma, owner).

Through experience, owners valued certain professionals to deal with certain problems. This was based upon perceptions of the professional's area of expertise and their availability when needed. For example, some perceived a suspected foot abscess as a veterinary issue whilst others believed their farrier was best placed to resolve this problem:

> "I tend to just speak to the farrier and say, "Look, I've got somebody who is hopping lame, wasn't lame yesterday, can you just come out and just check for an abscess before I talk to the vet." I tend to do that now because I find the farrier deals with an abscess probably better." (Kathy, owner).

Not all owners wanted close relationships with their veterinarians, but all wanted a high level of expertise:

> "I will get him in to do things like scoping for ulcers and different things like that. They're not my friends. I don't feel close. I don't feel I could talk to them about anything. I restrict what I discuss with them." (Jessica, owner).

Even in relationships with a veterinarian that were perceived as optimal by the owner veterinary advice was negotiated by the owner in the context of their life with their horse. The veterinarian played one part in a complex web of lay and professional advice, and through this worldview, owners constructed an understanding of what was best for their horse. Interactions with veterinarians informed owners' ideas about their role in the management of the horse's health.

4 Discussion

This study uses empirical data from the everyday experiences of owners and veterinarians and demonstrates the processes by which matters of veterinary concern are constructed. There were multiple decisions preceding the decision to call a veterinarian. The particularities of the interactions between veterinarian and owner during a consultation had consequences for the way in which veterinary expertise became integrated (or not) into horse care practices. Furthermore, the role that a veterinarian played in managing issues that arose was shaped by past interactions with veterinary professionals. Findings suggest that the impact of single interactions on the future consumption of veterinary services by owners may currently be underestimated.

Owners in this study experienced an ongoing process of assessing and reworking care strategies over time. An owner's reasons for involving the veterinarian were temporally contingent due to the individualised and multidimensional nature of managing and monitoring the older horse. As contextual factors in the life of the human and horse are constantly interacting, co-producing and reconstructing one another in a dynamic way (18) the complex interplay between symptom recognition and actions described by Wyke et al. (32) becomes even more dynamic. Issues that became matters of veterinary concern represented a gathering of factors at a point in time (33). Analysis suggests that advice-seeking behaviours are inextricably linked to the extent to which owners perceive veterinarians to have a role in the matter of concern they have identified. In our study, single interactions appeared to have lasting effects on owners' perceptions of veterinarians and ideas about their role in a horse's management. These findings reflect a recent study of UK pet owners' experiences of using veterinary services, which reported that single incidents could lead to a breakdown in trust that could prompt an owner to move veterinary practice (34). While previous work has identified the importance of the social determinants of horse health (21, 35), less attention has been paid to the role of veterinarians in shaping owner's ideas about issues that require veterinary involvement.

Issues could become a matter of veterinary concern where a change in the horse, within the context of that individual human-horse relationship, was perceived to require veterinary expertise. In common with the complexities in human health care (36), slow change in the horse may result in difficulties in differentiating 'normal' from 'abnormal'. This is likely to be individualised in nature as a result of how the horse ages and the context in which human-horse interactions take place. Zola wrote extensively about patient treatment-seeking behaviours (37). In his study of people with chronic disease he reported:

> "At the time of the decision there may have been an acute episode, but this was not the first such time the symptoms had reached such a "state" but rather it was the perception of them on this occasion as interfering with the social and interpersonal relations that was the trigger or final straw." (37).

Nevertheless, access to veterinary services when it was required was important for owners. Similar to a study of owners of dogs with chronic disease (38), owners in this study usually felt they knew when they needed to involve the veterinarian in their horse's care. In Riley's (39) research, farmers constructed and presented the farm, and farming practices, as embedded in multiple dimensions of past history. In this study, horse owners had a similar perspective on veterinarians and the issues that required their involvement. Issues that allowed time for reflection and consultation with other sources of advice before a veterinarian was consulted meant that a veterinarian's visit occurred within a context filled with particular hopes, expectations, beliefs and values.

The social construction of health, disease, and the relevance of veterinary medicine to creating a 'good' life for a horse were found to differ between owners and veterinarians. Veterinarians made judgements about owners' knowledge and motivation based upon decision making regarding their horse's health. Unlike veterinarian's intermittent and rather formulaic involvement in older horse care, owners experienced and developed their own knowledge about older horse care through their fluctuating human–horse relationship. A study involving observations of 34 routine consultations involving patients with chronic health conditions and health care professionals in Australia, found that although professionals attempted to elicit patient's own goals for their health, there was less attention paid to patient responses that seemed unrelated to the condition itself (40). Zola (37) suggests that without attention to the factors that prompt patients to seek medical care, patients are more likely to break off from treatment plans. This was reflected in this study, where the relevance of veterinary advice to achieving good outcomes for the horse was reviewed and filtered by owners, and influenced the extent to which advice was adopted. Zola argues for the need for doctors to recognise the significance of these triggers for health care seeking even if they do not fit with the doctor's understanding of what constitutes health and disease:

> "we found that where the physician paid little attention to the specific trigger which forced or which the individual used as an excuse to seek medical aid, there was the greatest likelihood of that patient eventually breaking off treatment … being a specialist and only seeing certain kinds of problems did not exempt the physician from having to deal with this issue." (37).

Difficulties arose for veterinarians when they perceived care was not being implemented appropriately by the owner. Veterinarians' medically-informed perspectives about the health care needs of older horses meant that they sometimes felt conflict between serving the horse's health and negotiating with the owner. Veterinarians in small

companion animal practice report the importance of prioritising the animal through the provision of their medical care (23). However, other contextual factors such as the owner's financial means to pay for treatment or an owner's wishes to continue treatment in instances where a veterinarian perceives an animal to be suffering, also appear to influence veterinarians' decision making (23). In our study, even where there was agreement between owners and veterinarians on the 'problem' *per se*, perspectives on the correct course of action could differ. Differences were, however, not merely due to a miscommunication but because of differences in the foundations of knowledge within which issues, and ideas about how to resolve them, were defined. Irving Zola argues that medicine's foundations lay upon an objective truth and its claim to what is 'real' regarding an individual's experience is argued to be one of the limitations of the medicalisation of life (41). This perspective may be limiting veterinarians' acknowledgement of the complexity through which owners decide to seek their involvement in a horse's care, and the extent to which an owner's life with, and knowledge of, their horse shapes their views about what is best for them.

The knowledge developed by owners in their relationship with their horse is reflective of their sense of self and ability to care well for their animal. When issues were raised to necessitate veterinary involvement the perceived success of the consultation from the owner's perspective fed back into how they managed everyday life with their horse. In common with the way in which lay knowledge is incorporated into the management of chronic disease in humans (42), horse owners' knowledge 'capital' was not always mobilised or valued in the veterinary consultation. As a result, we identified evidence of owners filtering or choosing not to follow veterinary advice regarding their horse's management. Research regarding goal-setting for people with chronic conditions suggests that the healthcare professional's approach heavily influences what goals are valued and legitimized and the extent to which the patient plays a role in decision making (40). Veterinarian-owner interactions that result in aligned aims for the animal and trust in the veterinarian are known to be important for owners (43, 44). Relational factors such as trust and shared understanding were also found to be important in the co-production of knowledge that was more likely to be enacted by farmers (45). Therefore, the mobilisation of owners' knowledge 'capital' during interactions appears to be a crucial component of successful interactions. The values that veterinarians orientate towards, and thus their behaviours towards the involvement of owners in decision making, may be a target for interventions.

Research suggest that a sense of mattering—of feeling important and feeling heard—varies with different relationship types and on an individual basis (28). In this study, single interactions could provide what an owner needed from their veterinarian. However, the specific meaning of what they needed was rooted in their relationship with their horse at that time and whether the veterinarian was able to provide for it. Where long-term relationships between veterinarians and owners were established this could create tacit knowledge about how an individual horse was ageing, the owner's life context and their goals for the horse. Some owners spoke about valuing veterinarians in the long-term management of their horse's health. However, even where established relationships existed much of this knowledge remained tacit and was not overtly shared in a medical record or care plan. This could prove problematic if new veterinarians unfamiliar with this knowledge attended the horse. Raising health issues of the horse to matters of veterinary concern is a multifaceted process affected by relationships. The long-term impact of single interactions with veterinarians on the uptake and future consumption of veterinary expertise may be underestimated. With increasing interest outside of the veterinary setting, mattering as a predictor of outcomes may be an important concept for the veterinary profession to consider (28). Veterinary work within a complex network of multispecies relationships, involving animal, owner, profession and society, also offers a novel setting for future enquiry in the particularities of mattering.

The limitations of this study include the collection of data from a relatively small subset of the equestrian and veterinary communities. Interview participants were selected based on certain inclusion criteria and the online advertisement for participation may have also impacted on who had access to participate in the study. In addition, there was a lack of male owners recruited, and although reflective of the demographics of the wider horse-owning community (46), it may have been useful to strategically sample from this group. Veterinarians in the study were sampled based on their relationship with a particular owner who had volunteered. Recruitment of veterinarians was difficult (either due to a failure to respond to invitation, or declining due to a lack of time) and therefore the sample size was relatively small. However, as the methodological approach was adopted to generate in-depth understanding rather than a generalisable 'truth' the sample obtained was satisfactory for this purpose.

5 Conclusion

Matters of veterinary concern were the product of the constant interaction, co-production and reconstruction of contextual factors in the life of the owner and their older horse. There is a distinction between matters of concern and the point at which they are deemed to be a matter of veterinary concern. Veterinarians' and owners' divergent experiential contexts come together where consultations take place and their interplay affects the extent to which veterinary expertise becomes integrated (or not) into horse care practices.

Owners' sense of mattering was affected by interactions with veterinarians, and this affected the nature and timing of their advice-seeking behaviours. Findings indicate that developing, and maintaining, a sense of mattering for both owners and veterinarians will be important if different types of expertise in relation to older horse health are to be brought together as an animal ages. The long-term impact of single interactions on the future consumption of veterinary services requires further investigation.

Data availability statement

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

Ethics statement

The studies involving humans were approved by University of Liverpool's Veterinary Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. GP: Writing – review & editing, Supervision, Funding acquisition, Conceptualization. CM: Writing – review & editing, Supervision, Funding acquisition, Conceptualization. JI: Writing – review & editing, Supervision, Funding acquisition, Conceptualization. EP: Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

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Supplementary material

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The feasibility of wildlife immersion experiences for Veterans with PTSD

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Introduction: Animal-assisted interventions (AAI) offer potential physical and psychological health benefits that may assist Veterans with post-traumatic stress disorder. However, more feasibility studies are needed regarding intervention details, adverse events, reasons for study withdrawal, and animal welfare.

Methods: This mixed methods feasibility trial involved a modified crossover study in which Veterans with PTSD/PTSD symptoms were provided a series of 8 nature and wildlife immersion experiences to evaluate feasibility and preliminary efficacy. The sample included 19 Veterans with PTSD/PTSD symptoms who were followed for a mean of 15.1 weeks. The intervention was comprised of a baseline forest walk, assisting with wildlife rehabilitation, observation in a wildlife sanctuary, and bird watching. Post study bird feeders were provided for sustainability. The theory of transcendent pluralism, which is grounded in mutual human and ecological dignity, guided the study. We viewed feasibility from the perspective of pattern integration with the natural world.

Results: This AAI nature/wildlife immersion intervention was feasible, acceptable, and safe to administer to Veterans with PTSD/PTSD symptoms with appropriate support. Logistical and relational facilitators were identified that supported the wildlife immersion activities. Participants reported greatly enjoying the activities. Attention to animal welfare and care was an important ethical foundation that also contributed to feasibility.

Discussion: AAI immersion experiences with wildlife are feasible and can safely be administered to Veterans with PTSD/PTSD symptoms. Logistical and relational facilitators are important to support nature and wildlife immersion activities.

KEYWORDS

feasibility, human-animal interaction, human-wildlife interaction, animal-assisted intervention, Veterans, PTSD, transcendent pluralism, wildlife immersion

Introduction

Human-animal interaction (HAI) encompasses many areas of study (1). In the context of health care, HAI focuses on the ways in which encounters between humans and other species enhance human physical and/or psychological well-being (2). Within the field of HAI, an animal-assisted intervention (AAI) is defined as "a goal oriented and structured intervention that intentionally includes or incorporates animals in health, education and human services (e.g., social work) for the purpose of therapeutic gains in humans" (3), (p. 5). Types of AAI include therapy, education, activities, and coaching (3). A meta-analysis of 49 studies with

animal-assisted therapy found improved outcomes with moderate effect sizes in medical conditions, behavioral problems, emotional well-being, and autism-spectrum symptoms (4).

One of the areas in which AAI has shown promise is for persons with post-traumatic stress disorder (PTSD). Approximately 6% of the U.S. adult population experiences PTSD at some point in their lives. Lifetime prevalence rates are 7% in Veterans and as high as 29% among those that served in Iraq and Afghanistan (5). Veterans with PTSD face a higher risk of isolation, homelessness, substance abuse, suicide, and stigma about getting help (6, 7). Animal-assisted interventions may circumvent stigma due to "the nonjudgmental nature of human-animal interactions" (6), (p. 55). A systematic review of AAI in 10 studies showed improvement in PTSD symptoms as well as levels of depression and anxiety (8).

However, some of the literature with AAI suggests the need for further methodological development. Broad qualitative and quantitative approaches are needed to capture the complexity of HAI (9). HAI research must provide more detailed information regarding interventions (10, 11), best practices (10), animal welfare considerations (10, 12, 13), adverse events, and reasons for study withdrawal (14).

Most research with HAI has focused on domesticated animals (companion and agricultural) (1), although there is some literature showing potential benefits from human interaction with wildlife (15–17). A growing body of literature also supports favorable health benefits from nature contact itself (18, 19). The term "green care" has been proposed as a concept that encompasses the health benefits from natural resources, including animals (20). As with domesticated animals, however, human-wildlife interactions can pose risks to health such as zoonotic diseases (12, 21). It is critical for research to identify the conditions under which such interactions might be beneficial and safe.

We conducted a pilot feasibility study to examine the influence of animal-assisted activities with wildlife for Veterans with PTSD/PTSD symptoms. This study builds on recent research by the principal investigator (PI) on human-wildlife interactions (22, 23). The overall study purpose was to assess feasibility and preliminary efficacy of the intervention. Feasibility studies are helpful when there are few studies on a particular intervention to determine whether the intervention is practical in a real-world setting and appropriate for further testing. Feasibility studies may also include an experimental design to address the question, "Can it work?" (24), (p. 4). The purpose of this paper is to address findings from the first study aim to determine the feasibility, safety and acceptability of an AAI intervention comprised of wildlife immersion activities for a sample of Veterans with PTSD/PTSD symptoms.

Materials and methods

Study overview/human subjects protection

The intervention was a nature/wildlife immersion for Veterans with PTSD/PTSD symptoms which was designated as an animal-assisted activity. Animal-assisted activities are a type of AAI which involve informal goal-oriented interactions for purposes of education, motivation, and recreation (3). We utilized a modified crossover design in which participants engaged in a series of wildlife immersion activities within groups of 2–8 individuals. Institutional Review Board (IRB) approval was obtained from the PI's university (# H00016795). Participants were provided with a $30 gift card after each of the first seven activities, a $100 gift card after the final activity, and a $30 gift card after the follow up interview. Sustainability was built into the study through providing each participant with a home birdfeeder and supplies. At the conclusion of the study, participants were also provided with the study wrist monitors to keep. Data were collected from July 2019 to December 2022. The study was on hold from March 2020 until August 2021 due to the Covid pandemic, which limited access to study sites.

Theoretical perspective

The study was guided by the PI's theory of transcendent pluralism which is grounded in mutually evolving human and ecological dignity (25). This framework has been influenced by the philosophy of Bernard Lonergan, Native American teachings, and a unitary-transformative nursing perspective (26–28). It had originally been used to study relations between diverse groups of people but has recently been expanded to explore relations between humans and other species. In transcendent pluralism, pattern is the expression of an individual or group's way of being in the world and includes consciousness and behavior (25). Patterns are dynamic and can evolve over time.

From this lens, the central questions for a feasibility study explore how the patterns of the study participants can be integrated with natural and organizational patterns of the study activities. Will the participants choose to engage in these new patterns (recruitment)? Which aspects of the intervention do they find agreeable (acceptability) and how consistently will they participate in the intervention (retention)? In what ways do they choose to integrate new patterns in their lives after the study is over (sustainability)? And how can these patterns of the intervention be implemented in such a way that supports the dignity of humans and wildlife, including physical safety and emotional well-being?

Recruitment

Veterans with PTSD/PTSD symptoms were recruited through Soldier On, a non-Veterans Administration community partner, which has a residential facility serving Veterans in Western Massachusetts. Soldier On is a non-profit organization dedicated to ending Veteran homelessness by providing temporary and permanent housing. Each Veteran that enters Soldier On is provided with supportive services including a case manager with whom participants typically discussed study enrollment. Inclusion criteria were: PTSD/PTSD symptoms (per self-report), age 18–70, comfortable interacting with animals, ability to walk or use wheelchair up to one mile at a leisurely pace, cognitive ability to complete assessments, vision or hearing impairments (if present) corrected through glasses and/or hearing aid, service animals allowed within behavioral parameters, free of substance abuse for at least 30 days, stated willingness to refrain from drug/alcohol use during activities, no severe outdoor allergy, and not presently enrolled in Veterans' Treatment Court program. During the late Covid phase, requirements were added for Covid vaccination. Participants were recruited through flyers, word of mouth, and referral by case manager. A Veteran at Soldier On undertook a research

assistant role to facilitate recruitment. The PI also went to the facility to attend community meetings and explain the study. The PI met with each participant to obtain consent and complete baseline data collection.

Setting

The intervention was provided at four community partner organizations with a strong history of introducing members of the public to nature and wildlife, safe/accessible sites, and experts on staff to provide education. The PI had an established relationship with two of the organizations from prior research. The travel time to each location ranged from 1 to 4 h. Transportation was conducted via vans owned by Soldier On or by chartered buses. Participants were provided with lunch and snacks for the ride home.

Intervention

The intervention consisted of a series of 8 nature/wildlife immersion experiences provided in four different settings. By "immersion experience" we mean that study participants were invited into natural settings and wildlife-rich environments. We define a wildlife immersion activity as *an embodied spatial–temporal experience in which human participants enter a space (setting) in which they consciously engage with wildlife in a manner that affirms the dignity of both the human and beyond-human animal with respect for natural rhythms.*

Each setting had some consistency in general patterns but actual conditions such as weather and animal availability varied on a day-to-day basis. The first activity was an introductory forest walk to control for confounding effects of nature alone followed by 3 wildlife activities. The immersion experiences included: baseline woodland walk (Harvard Forest); assisting with wildlife rehabilitation care (New England Wildlife Center); observation of wildlife sanctuary care/enrichment (Maine Wildlife Park); and bird watching/raptor program (Mass Audubon Broad Meadow Brook Conservation Center and Wildlife Sanctuary/Massachusetts Bird of Prey Rehab Facility).

Each immersion experience included a didactic education component as well as a nature/wildlife activity and was conducted at two time points to reduce novelty effect. The immersion experiences were held approximately 1 week apart and were of 3–4 h in duration. Due to the intervention being conducted in New England, no activities were held during the winter. Standard operating procedures were developed for the immersion intervention at each study site (Table 1). Participants were invited but not required to participate in activities at the sites.

TABLE 1 Sample standard operating procedure: Maine wildlife park (MWP).

Arrival logistics/preliminary data collection
1. PI arrives ½ h ahead of participants and sets up study materials on picnic table.
2. Participants driven to park from Soldier On; scheduled to arrive 15 min prior to activity for bathroom use etc.
3. Participants given name tags and asked to write first name.
4. Participants should have their wrist monitors with them.
5. Participants asked to record their heart rate after a 5-min rest.
6. On second visit: Participants given salivary cortisol packet and asked to obtain sample (discontinued during COVID period).
7. Participants reminded to apply tick spray and to check for ticks after activity.
8. Introduction given for morning speaker.
Intervention
MWP Visit 1
(Education and guided walk provided by Gamekeeper and Educational Specialist)
• Educational overview of MWP and animal husbandry in wildlife care (approximately ½ h)
• Wildlife immersion activity: Guided walk viewing different species in sanctuary (approximately 1–1.5 h)
MWP Visit 2
(Education and guided walk provided by Gamekeeper and Educational specialist)
• Educational overview of animal enrichment rationale and different strategies for animal enrichment (approximately ½ h)
• Wildlife immersion activity: guided walk viewing enrichment activities with animals (approximately 1–1.5 h)
Follow-up data collection
• Participants walk back to picnic table.
• Participants given data sheets and heart rate forms on clipboard with pen.
• Asked to record heart rate after 5-min rest.
• On second visit: participants given salivary cortisol packet and asked to obtain sample (discontinued during COVID period).
• Participants asked to complete survey forms.
• Participants asked to complete journal forms (participants asked to choose animal that was meaningful to them and to write down insights gained; option of sitting at table to write their insights or walking back to sit near animal).
Lunch break/free time
Closure/departure
• Departure in van/bus; Snack stop on way home.

Animal welfare

Animal welfare must be at the forefront of AAI practice and research (10, 29). When AAI is being conducted for human benefit, "there is an ethical obligation for these animals to achieve 'very good' welfare status" (29), (p. 56). Animal welfare includes being free of distress and able to engage in the natural behaviors of each species (29). This is congruent with the theory of transcendent pluralism in which 'non' human animals are viewed as having intrinsic value and are not merely human instruments (23). The intervention was grounded in mutual human and beyond-human dignity. Wildlife in this study were defined as, "non-domesticated amphibians, reptiles, birds, and mammals" (30). This included both free-living creatures as well as those living in temporary or permanent captivity due to animal care needs. The missions of the partnering wildlife facilities in this study were focused on animal welfare through direct animal care and/or public education. All the activities that participants observed or engaged in were standard activities for the wildlife under care. A wildlife veterinarian served as a consultant to the study.

Spatial territory is a core need for wildlife and must be respected during AAI to avoid animal stress and maintain human safety. Engagement in shared wildlife space requires attentiveness to one's own spatial relationship with the animal (22, 31). The study

intervention was guided by experts at each location so that appropriate boundaries, protocols, and assessment for animal stress were maintained. Activities were framed within the natural patterns of each species within its environment with education provided to help participants understand these rhythms.

Safety

A robust data safety and monitoring plan was instituted prior to study enrollment due to the risks of bringing individuals with both psychological and medical conditions into nature/wildlife immersion settings. Risk examples and associated strategies are outlined in Table 2. The PI, a registered nurse and wildlife rehabilitator, attended all study activities, carried a first aid kit, and was certified in wilderness first aid.

The emergence of the Covid-19 pandemic necessitated additional safety modifications. During 2020 and the first half of 2021, the study had to be put on hold because Covid-related restrictions prevented access to some activity sites. When the study resumed, we made modifications to reduce the likelihood of Covid transmission. This included requiring individuals to be fully vaccinated against Covid or, if partially vaccinated, to complete a home antigen test the morning of each activity and to text the results to the PI. While this involved some early morning logistics, there was 100% compliance, and we had no cases of Covid transmission. Although the vaccine requirement did impact recruitment (at least 2 who did not enroll due to vaccine), it was critically important due to participants with significant medical comorbidities engaged in group activities and travelling in a single vehicle. We also eliminated the salivary cortisol samples as these were being collected in a group setting.

TABLE 2 Risk reduction measures (examples).

Risk examples	Protective measures
Animal bite or scratch	• Education prior to activities. • Wearing gloves; long sleeves recommended. • Availability of first aid kit for all activities. • Follow up medical care available at VA.
Exposure to zoonotic disease	• Follow facility protocols. • Use of handwashing/gloves in wildlife hospital. • No handling of raccoons (rabies vector). • Exclusion of individuals with severe immunocompromised status.
Exacerbation of psychological symptoms	• Ongoing assessment by PI. • Action plan for acute referral if needed.
Substance abuse exacerbation during activity	• Inclusion criteria of 30 days or more free of drugs or alcohol abuse and willingness not to use substances before or during activities. • Narcan nasal spray included in first aid kit.
Tick bite during outdoor walk	• EPA approved tick sprays provided to participants with reminders for application. • CDC education sheet on tick bites provided with instructions to monitor for tick bites following activity and f/u with MD if needed.

Data collection/analysis

Feasibility evaluation included recruitment, enrollment, attendance/retention, adverse events, missing data, responses to a post activity survey, a focus group immediately after the final event (Table 3), individual interviews approximately 1 month later (Table 4), and observation by the PI. The PI maintained an observation journal and safety assessment was ongoing. In order to determine preliminary efficacy, psychological well-being was assessed at baseline (during enrollment; approximately 1–2 weeks prior to first activity) and after each activity through: Warwick-Edinburgh Mental-Well Being Scale (32, 33), Spielberger State/Trait Anxiety Inventory (short-form) (34), and Center for Epidemiologic Studies Depression (CES-D-10) scale (35). PTSD symptoms were evaluated through a PCL-5 at baseline and study conclusion (36, 37). Connection to nature and wildlife were measured at baseline and after each activity through the short-form Nature-Relatedness scale (NR-6) (38) and Transcendent Feelings of Animal Valuation Scale (23). Physiological parameters included self-monitored heart rate at baseline and pre and post each activity using commercial wrist monitors. Self-monitoring was selected so that all participants' heart rates could be obtained simultaneously. Salivary cortisol was measured at baseline and before/after the second activity at each site with the first 12 participants. Qualitative assessment also included an animal observation journal exercise during the Maine Wildlife Park activities.

Quantitative data analyses included tabulations of number of potential participants screened, number screened who were eligible, number of eligible who enrolled, and reasons for non-enrollment. We summarized characteristics of participants using frequencies for categorical characteristics and mean and standard deviation for continuous characteristics. To summarize attendance at wildlife immersion activities, we calculated within-participant percentage and mean and median number of activities attended, as well as the percentage of all participants attending for each activity. We also tabulated reasons for non-attendance. We tested whether attendance was different at the first and second sessions of each activity using McNemar's test (39). Associations of participant characteristics with study completion and with number of activities attended were assessed using Fisher's exact test and Wilcoxon 2-sample tests, respectively. To assess acceptability, participants evaluated each activity directly after its conclusion, using six 5-point Likert scales (1 = strongly disagree, …, 5 = strongly

TABLE 3 Focus group flexible interview guide (conducted by PI with each group at study conclusion).

1. How was this experience for you as a whole?
a) Probe: What are some of the most memorable of the activities for you?
2. What sorts of questions did you have as you were going through this experience?
a) Probe: Did the wildlife activities make you wonder about any new things?
3. What knowledge did you gain from this experience?
4. Has this experience led you to view anything differently?
5. Has this experience led you to take any new actions? If so, what?
6. How did this program influence your relationships with other Veterans in your group?
7. How has this experience been meaningful in your life?
8. Is there anything else you would like to add?

agree) regarding enjoyable, adequate instructions, stressful (reversed for analyses), felt good, would like to do again, and recommend to others. Ratings on each of the 6 aspects were averaged to provide a summary score from each participant for each activity attended (Cronbach's alpha = 0.85). Based on the observed distribution – minimum of 3.7 – these average scores were dichotomized as strongly agree (4.5 or higher) versus agree (<4.5). Activities were compared regarding percent of participants with a strongly agree rating using binomial logistic regression with a random effect for participant (40), adjusting for first versus second session of the activity. In addition, directly after each activity's conclusion, participants also reported satisfaction with the amount of time spent (just right, too long, too short). Finally, for attended activities, we tabulated whether the participant completed all data collection measures. Quantitative findings related to preliminary efficacy will be reported elsewhere.

Focus groups were audio recorded using two devices and analyzed by a secure transcription service. The PI listened to the tapes and edited as needed. The follow up interviews were transcribed from handwritten notes by the PI. Survey responses to open-ended questions were entered into Word documents and organized into tables. All text documents were read multiple times with topical codes developed. Responses related to feasibility were analyzed using relevant pre-existing categories, such as safety (41). Responses related to preliminary efficacy were analyzed separately using open-ended coding (41) and will be reported separately. The qualitative and quantitative feasibility findings are integrated below. Quotations from the participants are included to illustrate the findings with extraneous words such as "like" removed for clarity. Lincoln and Guba's standards for qualitative trustworthiness were followed including credibility (triangulation of data, prolonged engagement in field); transferability (rich description; purposive maximum variation sample); dependability (audit trail), and confirmability (audit trail, reflexivity) (42).

TABLE 4 Follow-up flexible interview guide (conducted by PI 4–6 weeks after study conclusion).

1. Could you please tell me how you found your experience with the wildlife program as a whole?
2. Could you think back to one of the times you observed or interacted with an animal that was particularly memorable. What made that experience meaningful for you?
3. How was your experience of doing the activities with the group?
4. Could you please tell me if you are using the home bird feeder? (yes/no)
5. How often do you look at the bird feeder on an average day?
a) 1× day___; 2–3 times per day___; 4 or more times per day___
6. How long do you spend watching the feeder each day? (in minutes)
7. How do you feel when you watch the birds?
8. Do you feel that connecting with wildlife is beneficial to you in any way and, if so, how?
9. Have you done any other wildlife activities since the program ended?
10. Do you plan to engage in any wildlife activities in the future? If yes, what activities?
11. Is there anything else that you want to add?

Results

Recruitment and retention (will participants choose to engage in new immersion patterns?)

Twenty-nine individuals were screened for the study. Of these, 28 were deemed eligible and one was not eligible due to being unvaccinated for Covid. Another individual indicated interest but was not vaccinated and did not sign up for screening. Out of those eligible, 9 subsequently did not enroll due to issues related to health (3), left Soldier On (1), logistical issues (1), or study placed on hold due to Covid (4).

Nineteen participants were enrolled in the study within 4 cohorts and together completed a total of 107 wildlife immersion experiences across 32 project activity sessions, 2 per activity location and 8 per cohort. One cohort was planned as an all-women's group due to some history of military sexual trauma in the population. Another group was coincidentally all women, and two groups were mixed. The mean study duration for participants who completed the study was 15.1 weeks from enrollment to follow up interview. Demographics are summarized in Table 5. Military branches included Army, Air Force, Navy, and Marines. We omitted the branches in the table tabulations in order to avoid any participant identification due to low cell count in some categories. In addition to PTSD, the majority of the participants had co-existing medical and psychiatric conditions. Three participants used walkers or canes and one required portable oxygen.

Participants attended an average of 5.6 out of 8 study activities (median 7). Twelve participants (63.2%) completed at least 6 activities. Attendance ranged from 84.2% at the first activity to 57.9% at the eighth and last activity (Figure 1). Although second-session attendance was lower than at the first session for the first three project activities, none of these differences was statistically significant ($p > 0.3173$). During 2019, when there were two cohorts, participants who missed an activity in Cohort 1 were offered the opportunity to attend the activity with Cohort 2. Participants did choose to make up a session on 4 occasions. Five participants (26.3%) withdrew from the study, accounting for 14 missed study sessions (Table 6). Four of these withdrew due to leaving Soldier On and moving to other geographical locations. Another individual did not formally withdraw but attended only one activity (data from this participant was retained because omission did not change overall results). No participants indicated that they withdrew for study-related reasons. In addition to study withdrawal (accounting for 9.2% of 152 (=19 participants × 8 activities) scheduled study activities), most common reasons for missing an activity were illness (3.9%), a health care appointment (4.6%), and unknown/no-show (6.6%). Median number of activities attended (Table 7) was higher in female than male participants (7 versus 3, $p = 0.06$) and in Black than White participants (8 versus 6, $p = 0.07$). Study completion (Table 7) did not differ significantly by any participant characteristics. Three activities were rescheduled due to rain, and most participants were able to attend the new date.

Regarding completion of specific protocol components, of the 107 activities attended, pre-activity pulse was measured in 98.1% and post-activity pulse in 96.3%. Among Cohort 1 and 2 attendees, participants completed 81 of 84 (96.4%) cortisol specimen collections (goal was 1 at baseline, 2 at the second session of each wildlife immersion activity per participant); of the 81 specimens collected, 74 (91.4%) had

TABLE 5 Participant baseline characteristics, $N = 19$.

Characteristic	*N* (%) or Mean (Std. Dev)/ Minimum – Maximum
Age in years	48.4 (12.9)/30–69
Gender	
Female	13 (68.4)
Male	6 (31.6)
Race	
Black	3 (15.8)
White	16 (84.2)
Residence	
Permanent/committed plan for permanent	12 (63.2)
Short-term	7 (36.8)
Medical history	
Cardiovascular disease	4 (21.1)
Respiratory disorder	4 (21.1)
Orthopedic/movement condition	7 (36.8)
Diabetes mellitus	3 (15.8)
Psychiatric disorder	14 (73.7)
PCL-5[a]	
Total score	41.0 (18.1)/7–65
Score ≥ 31	14 (73.7)
STAI	
Total score	50.5 (11.4)/20–70
Score > 36	18 (94.7)
CES-D-10	
Total score	15.3 (5.2)/5–23
Score ≥ 10	16 (84.2)

[a]Range 0–80 with 31–33 as cut-off score for provisional PTSD diagnosis.

adequate volume. Across the eight activities, the median percent of missing survey items was 5.2% (interquartile range 3.5, 6.9%).

Some participants indicated that recruitment for a long-term program among this population was difficult, especially since many individuals were at a point of trying to stabilize their lives.

> … You're looking at a place where the turnaround of people is incredible. You have people coming in and out… People have appointments… They're out looking for jobs… So that's what makes it hard for- a program for anybody to commit to.

Acceptability (will immersion experiences be positively perceived by participants?)

With the exception of one response (=3.7), all session evaluations were rated as agree or higher. The percentage of participants reporting strongly agree ranged from 70% for bird watching to 84% for wildlife sanctuary (adjusted $p = 0.72$). Percent reporting strongly agree also did not differ for first versus second session of an activity (77% versus 78%, adjusted $p = 0.995$). Across all activities attended, 93.3% ($n = 98$) participants reported that the activity time was just right. Only 1% ($n = 1$) reported too long, and 5.7% ($n = 6$) reported too short (rating missing for 2).

In qualitative assessments, participants' reception of the study was overwhelmingly positive. They described the activities as something they "looked forward to" and "loved every part of it." Several commented on how "it was amazing to see the animals up close…" As one participant noted, "It was very exciting. -I never really had a chance, being in the city, to focus on birds and their sounds." Several participants expressed sadness that the study was ending and asked if they could continue or re-enroll. For example, a participant shared:

> The whole experience… has given me something *good* to look forward to each week. And knowing that we're gonna go do another activity…. Has been *up*lifting. It's given me something exciting to think about. And it's been a lot of fun. So, I'm kind of sad that it's coming to an end.

Another stated, "Most of us wish it could have gone on longer and longer and longer." A number of participants noted that they enjoyed having different activities to participate in. "You learn something new when it's not repetitive".

Participants seemed very amenable to completing the surveys after each activity and collecting samples for salivary cortisol. Having participants monitor and record their own pulse pre and post activity worked very well, and several seemed to enjoy noting changes in their heart rate.

Safety and wellbeing (can interventions support dignity and wellbeing of both participants and wildlife?)

Safety occurrences

Safety incidents were reviewed and categorized as mild, moderate, or severe and as not related, possibly related, or related to the study. A few safety incidents did occur that were all in the mild or moderate category with no long-term sequelae experienced. Four of these were deemed related/possibly related to the study intervention and all resolved with no or minor intervention (Table 8). These included two participants who found ticks (American dog ticks, not embedded) on their skin after a forest walk (likely related to a parking/drop off area near high grass), a participant with Type II diabetes who reported mild hypoglycemic symptoms walking in the forest, a participant who experienced an acorn falling on her shoulder, and minor scratches on a participant's arm after feeding baby squirrels.

We were able to safely include individuals with moderate physical limitations through strategies such as having a registered nurse (PI) present at all study activities, obtaining baseline medical histories to be aware of needs, and providing all-terrain wheelchairs (Grit Freedom Chair). There were three individuals who used walking implements such as a walker or cane. Two participants used wheelchairs on the first activity but only periodically after that, such as on a steep incline. One individual chose to use the wheelchair as a walker, and occasionally using it to sit and rest. Another participant preferred to use their own walker, but the PI followed with the wheelchair as a backup. Although participants did not use the

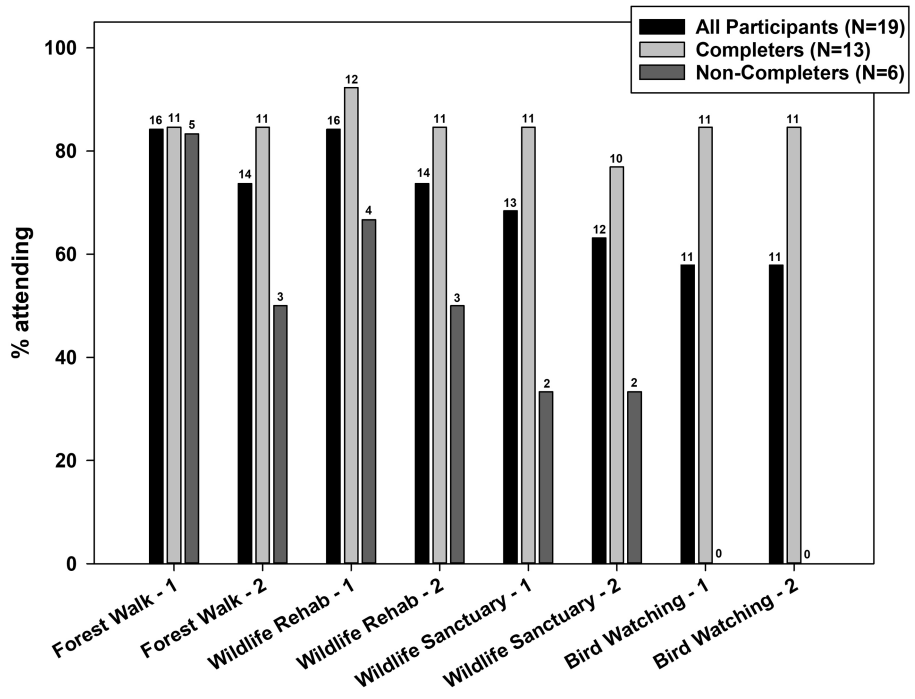

FIGURE 1
Attendance at wildlife immersion experiences.

TABLE 6 Reasons for non-attendance; across all 8 sessions per cohort and all 19 participants, 152 scheduled participant-sessions in total.

Reason	*N* (%) reporting reason
Withdrew from study	14 (9.2)
Unknown; no-show	10 (6.6)
Health care appointment	7 (4.6)
Illness	6 (3.9)
Work-related	5 (3.3)
Not interested	0 (0.0)
Other	7 (4.6)

wheelchairs all the time, having them available seemed to give individuals the confidence to enroll in the study. Honoring their decision to choose the method of assistance was important for respecting their ability to make their own choices. Participants navigated the terrain successfully. The pace was generally slow due to frequent education stops but the PI also carefully assessed activity tolerance and suggested a rest periodically. Other physical conditions that we were able to accommodate included portable oxygen use which required that participant to plan how many tanks would be needed for the activities.

Safety assessment was important at the wildlife rehab center where participants had the option to engage in direct animal care. This included feeding baby squirrels via syringe, feeding birds of prey, releasing animals whose treatment had finished, assisting with reptile examinations, and administering medication under the guidance of veterinary staff. Other than one mild arm scratch, there were no safety incidents. No animal stress was noted. On one occasion an interactive experience with an educational red-tailed hawk was postponed because staff assessed that he was not in a "good mood."

In accordance with study protocol, we notified the case manager if any participants had a high baseline score for anxiety or depression at study enrollment (as defined in literature) or a > 25% increase over baseline anxiety or depression scores during post intervention measurements. Communication of score elevations allowed case managers to assess whether results were clinically relevant, and address as needed. Case managers expressed appreciation for this communication. For the CES-D-10, the range is 0–30 and a score of 10 or higher indicates significant depression symptoms (43). The range of the STAI-Y-6 item is 20–80 with 34–36 considered normal (35, 44). Baseline anxiety scores were elevated for 18 of 19 participants and baseline depression scores were elevated for 16 of 19 participants. Anxiety elevations required notification for 3 participants (on 3 occasions for one participant). Depression score notifications were required for 5 participants (on 2 occasions for 1 participant). Participants' qualitative comments and general demeanor did not suggest that the elevated scores related to the wildlife activities. During one post study focus group, participants spontaneously noted that stressful events in their day-to-day lives were impacting their survey responses. It seemed likely that the high anxiety and depression scores reflected baseline diagnoses in concert with ongoing extraneous events rather than study activities. Of note is that no illicit substance abuse issues were manifested during any study activities.

Detractors/stress/anxiety

Participants were queried as to whether anything in the activity or surrounding area made them feel stressed or anxious. Some of the comments noted that challenges such as rocks or rough terrain when walking and insects such as ticks or mosquitos created stress. An

TABLE 7 Study completion and number of activities attended; all participants and by participant characteristics.

	Study completion			Total number activities attended, all participants ($N = 19$)	
	Completers: *N* (%) or Median (IQR)[a]	Non-Completers[d]: *N* (%) or Median (IQR)[a]	Test statistic/*p*-value[b]	Median (IQR) or Spearman correlation[a]	Test statistic/*p*-value[c]
Characteristic					
All participants	13 (68.4)	6 (31.6)	–	7 (3, 7)	–
Gender			0.2108/0.3201		37.00/0.0587
Female	10 (76.9)	3 (23.1)		7 (6, 7)	
Male	3 (50.0)	3 (50.0)		3 (2, 6)	
Race			0.2951/0.5170		47.50/0.0677
Black	3 (100.0)	0 (0.0)		8 (7, 8)	
White	10 (62.5)	6 (37.5)		6 (3, 7)	
Residence			0.0851/0.1287		56.50/0.2759
Permanent	10 (83.3)	16.7 (2)		7 (5.5, 7.5)	
Short-term	3 (42.9)	57.1 (4)		4 (3, 7)	
Age	56 (42, 59)	34.5 (30, 48)	40.00/0.1041	0.26	0.2631/0.2765
Baseline PCL-5 ≥ 31:			0.3689/1.0000		57.00/0.5460
No	4 (80.0)	1 (20.0)		7 (6, 8)	
Yes	9 (64.3)	5 (35.7)		6.5 (3, 7)	
Baseline STAI >36			0.6842/1.0000		17.50/0.2077
No	1 (100.0)	0 (0.0)		8 (8, 8)	
Yes	12 (66.7)	6 (33.3)		6.5 (3, 7)	
Baseline CES-D-10 ≥10			0.2951/0.5170		42.50/0.1869
No	3 (100.0)	0 (0.0)		7 (7, 8)	
Yes	10 (62.5)	6 (37.5)		6 (3, 7)	
Study completion			–		25.50/0.0069
Yes	13 (100.0)	0 (0.0)		7 (7, 8)	
No	0 (0.0)	6 (100.0)		3 (2, 4)	

[a]IQR = interquartile range (25th percentile, 75th percentile). [b]Fisher's exact test (test statistic presented is table probability) or Wilcoxon 2-sample test for age. [c]Wilcoxon 2-sample test for 2 subgroups, Kruskal–Wallis for 3+ subgroups, Spearman correlation for continuous characteristics. [d]Non-completers includes 5 participants that withdrew from the study as well as 1 who attended only one event but declined to withdraw.

individual with underlying respiratory disease noted some stress due to being short of breath while walking but that this was "normal for me." In the post activity Likert scale, across all 8 wildlife immersion activities, there were only 2 reports that an activity was stressful ($n = 2$).

We did not expose participants to euthanasia situations, but they were told that the injuries sustained by wild animals were sometimes not survivable. We informed participants in the consent form that they might be exposed to deceased and dying animals. In a few instances, participants witnessed deceased animals. This included taxidermy specimens during an educational presentation and a deceased bird on an outdoor walkway, likely due to an accidental window strike. No participants indicated stress from these instances. Two occasions which participants did note as stressful were seeing deceased animals, such as guinea pigs, when they were assisting in the food preparation area (diet for birds of prey) and finding a deceased squirrel in its enclosure. In both instances, the stress seemed to be transient. Two individuals participated in optional opportunities to feed deceased prey to raptors, with positive responses.

Although one participant felt that the long ride (4 h) to an out of state activity was too long, most participants felt that the drive was "worth it," and another participant reported that this activity was too short. We adjusted this activity by using commercial buses rather than vans and participants evaluated that trip as comfortable and enjoyable.

We tried to anticipate environmental stressors such as communicating with a local gun club to avoid holding research activities when large shooting events were scheduled. However, the environment could intrude in unexpected ways that could not be controlled. For example, while in a bucolic Maine park during autumn, participants were startled by acorns suddenly falling with a rat-a-tat sound upon the pavilion roof. A nearby screaming child was also noted as disruptive on a participant evaluation.

Experiences held different meanings for different participants. When we came upon a research tower during the forest walk, one

TABLE 8 Intervention-related/possibly-related safety events.

Incident	Severity level	Related to study?	Action taken
Two participants found ticks on themselves after forest walk (American dog ticks; not embedded).	Mild	Related	• Reinforcement of tick prevention education. • Earlier application of tick spray. • Provision of multiple options for tick spray (EPA approved). • Education regarding checking for ticks after activities. • Changed parking location away from high grass.
Participant with Type II diabetes reported feeling slightly hypoglycemic during forest walk.	Moderate	Possibly related	• Individual improved after eating candy. • Added hard candy to activity first aid kit.
Minor scratches to participant's arm after feeding baby squirrels.	Moderate	Related	• Individual washed arms and applied antiseptic; no sequelae.
Participant hit by falling acorn.	Mild	Related	• Resolved without intervention.

participant seemed to regard it as an adventure and was disappointed that climbing the tower was not allowed. Another participant indicated that the tower was stressful as it reminded them of military training.

Relational immersion facilitators

In addition to the logistical aspects of the study that enhanced feasibility, as described, above the findings suggest that positive nature and wildlife immersion experiences were facilitated by relational dimensions. This included the group-based intervention, community partners, animal welfare mission, research team support, and responsiveness to needs.

Group intervention

Qualitative findings as well as observation suggested that the group-based intervention enhanced recruitment, retention, and acceptability. Participants were living in group housing and individuals encouraged each other to join the study and reminded each other to attend activities. Participants found that sharing the experience with others was valuable. "When you had more than one person, you are able to talk to the other people… to see how they felt about the other animals".

Group members supported one another during activities. For example, a participant that had successfully fed several baby squirrels encouraged a more hesitant individual to give it a try and stood next to her as she did the feeding. At one point on the trail, participants spontaneously helped one another, such as by carrying another person's walker while that person used the wheelchair. The groups seemed to develop a cohesive spirit, perhaps reflecting their background as Veterans and unified military culture. Some participants indicated that the group activities promoted friendships and deepened relationships during the study and may have contributed to ongoing benefits after study conclusion. "I liked it in a group because everybody got to ask different questions. Afterwards somebody to talk about it with. 'Remember that time we saw the raccoons?'"

There were some minor challenges with the cohort model including occasional tension between group members that may have been related to differences in age and rehab status as well as time delays by individuals requesting a smoking break. There was also a logistical challenge when one individual experienced health issues during a forest walk, which slightly shortened the walk for others. Some participants had a history of social anxiety, and one individual expressed a need for solitude. Time away from the group was accommodated by giving the participants free time at lunch to explore and an option to write their animal reflection journal by themselves in front of the animal or with the group at the table after lunch. Overall, these challenges were minor, and the group model was largely perceived positively.

Community study partners

Recruiting participants from an organizational Veterans' program provided a solid foundation for participant support. We worked closely with Soldier On leadership, case managers, and psychiatric staff to ensure that participants were well supported during the program. Additionally, staff at each site were instrumental in providing background information, concrete activity instructions, and positive reinforcement. All the staff utilized an interactive format to actively engage participants in learning. This included ample opportunity to ask questions. Participants appreciated gaining knowledge and support from staff was instrumental in trying out new activities. For example, during the forest walk a staff member coached participants in how to measure tree trunk diameter, affirming afterwards, "That's perfect." At the wildlife hospital, the veterinarian coached participants in feeding a baby squirrel by demonstrating how to hold the animal and providing pointers on using the formula syringe. One participant described how the veterinarian's encouragement helped her overcome fear of holding a boa constrictor.

> The most memorable was the snake. Being able to actually hold it… That was big for me. I have a new appreciation. Because I was not going to. That vet said, "Come on". I was surprised. It was relaxing.

Animal welfare mission

Study acceptability was enhanced by the participants' perception that the animals were being well cared for. They appreciated the opportunity to assist with the animal welfare mission through care activities. One participant reflected:

> I liked the way that things turned out for a lot of these animals that were inside the wild park… it showed that people… do care about these animals that are injured and… at least they've got a place to stay.

The notion of animal welfare as a *relational* facilitator reflects the connection between humans and other species and that wildlife are viewed as living beings with their own needs. Participants valued the animals and expressed concern for their well-being. Witnessing and sometimes assisting with animal care seemed to enhance participants' appreciation of the activities. Thus, animal welfare was not only an important ethical principle but seemed to enhance acceptability of the intervention.

Research team

The study team had interdisciplinary expertise in human-animal interaction, health care, Veterans' mental health, forest park management, and statistics, which provided integrated knowledge for the study plan. From an interventional perspective, the Soldier On Veteran research assistant facilitated trust and connections within the group and was instrumental in recruitment and retention. The PI, as a nurse, intentionally created a caring presence for study participants. This did not constitute providing therapy but rather a welcoming and supportive environment. Appreciation for this approach was reflected in feedback from participants that they felt "respected" and that the program was "non-judgmental." For example, one participant who was having some psychosocial struggles, seemed unsure as to her being welcome to attend a future event. The PI told her that we would love to have her attend and hoped that she could. The following week, at the end of the activity, she gave the PI a hug and said, "I had a relapse last week and want to thank you for being part of my recovery."

Responsiveness to need

Relational feasibility included being responsive to participants, community partners, study occurrences, and the evolving larger study context. While the core study design remained stable, we did make numerous minor IRB protocol modifications to address the needs of participants and partners as well as emerging contextual changes.

For example, a participant asked if they would receive a certificate after the study conclusion, so we created framed certificates of completion for participants who attended at least six of the eight activities. Participants expressed that the certificates were meaningful to them. Another modification came through a request from one of our community partners who asked to post a video of a participant activity on their social media page. Given that our partners were largely non-profit organizations with a need to demonstrate their outcomes to the public it seemed reasonable for them to highlight their work. We submitted an IRB amendment that allowed them to post photos or videos provided that the participant had given permission, and the community partner signed a form indicating that they would not identify the individual or indicate that the photo was taken during a research study.

Modifications were also made to address safety issues. For example, a mild hypoglycemic reaction experienced by a participant with Type II diabetes prompted the addition of hard candy to the first aid kit.

Sustainability (will participants choose to integrate new patterns in their lives post-study?)

We viewed sustainability as an ethical research principle by which participants would be provided with means to continue enjoying nature and wildlife following study conclusion. We explored three approaches to sustainability: home bird feeders, information about volunteer activities, and journalling about wildlife. The primary sustainability feature was providing participants with home bird feeders, birdseed, a bird identification book, and window decals to prevent accidental bird window strikes. The final immersion experience was focused on birds and included education on bird watching in the local region. The bird feeder provision required some navigation of residence hall rules and safety in a region with Black bears. We developed a collaborative plan with our community partner through dialogue with participants and administrators. The final plan allowed for bird feeders that could be affixed to participants' windows with lower floor residents advised to put out birdseed only during winter months when bears were hibernating (Figure 2). Participants were provided with shelled sunflower seed to minimize ground debris. At follow up interviews, 1 month after the final activity, 7 participants had put up their bird feeders. There was an initial challenge when the feeders were beset by a flock of pigeons and one of them perched on a feeder and broke it, necessitating replacement. Eventually other bird species began visiting regularly and participants reported delight watching them. Several individuals took photos of the birds that they shared with the research assistant to send to the PI.

Additional sustainability measures included providing participants with information regarding opportunities for volunteering with local wildlife rehab facilities or participating in a citizen scientist bird count. However, at the 1 month follow up, no participants had engaged in any of these activities, despite that several had indicated a desire to do so. Several participants did indicate an expanded awareness of wildlife around them and increased knowledge about the wild animals that they saw near their homes. A post study wildlife journal activity was trialed with individuals from Cohort 1 during the Covid shutdown period. The three individuals remaining at Soldier On enrolled in this and submitted entries describing wildlife that they saw in their day-to-day lives. We also offered this option to participants in a subsequent Cohort and although they indicated interest, they did not actually submit any journal entries. Possibly the Covid shutdown period was more amenable to reflective journalling.

Discussion

The findings suggest that recruitment and retention of Veterans with PTSD in a wildlife immersion AAI program is feasible and that the activities can be administered in a manner that is safe and acceptable with appropriate supports. This includes having nonprofessionals engage in hands-on wildlife care under supervision. We were able to recruit a diverse sample that included persons from underrepresented backgrounds as well as individuals with physical challenges. The length of the program may have been difficult for some participants to complete and shorter programs may be better suited for individuals who are navigating challenging life circumstances.

Cohorts ranged from 2 to 8 participants with varying attendance. In our experience, having 4–6 participants was most manageable. Having a larger group was a bit hectic and presented challenges finding sufficient animal care experiences at the rehab center. Conversely, a group size of 2 limited social interaction and left only one participant if the other individual was absent. The social

dimension of group activities seemed to support recruitment and retention as well as contributing to building relationships among study participants that continued post study. However, it was also important to have options for individual activities for persons desiring more solitude, such as those with social anxiety. It may be helpful to examine group concordance when planning activities. Research on restorative environments suggests that social accompaniment may offer benefits such as safety, and shared discovery. However, preference for companionship varies by setting and is lower when people are experiencing attentional fatigue (45–47).

Our findings suggest that overlapping logistical and relational facilitators may enhance feasibility of a nature/wildlife immersion program. Figure 3 illustrates the facilitators supporting human-animal interactions with wildlife. The overlapping human-animal patterns in this diagram signify the occurrence of an interaction. Human-wildlife interactions include spatial, temporal, and mutually conscious dimensions (31). There are varying forms of human-wildlife interaction including physical (such as providing hands-on care) or conscious awareness (such as observation). Support needs vary with different types of human-animal interaction.

The ethical dimension of animal care was important not only for wildlife welfare but also contributed to feasibility. Animal care included both treatment and release of injured wildlife as well as sanctuary care for those that were not able to provide for themselves in the wild. Participant responses suggested that the experiences were congruent with their values about animals, and they felt that they were part of doing something good. This is consistent with studies showing that the public is increasingly concerned with captive animal welfare and many people have conflicted views towards visiting zoos (48).

FIGURE 2
Home bird feeder.

Animal sanctuaries, such as the one in this study, may offer an alternative as the animals are in captivity only because they require lifelong care (23, 49). Moreover, the findings related to animal welfare support the need to be attentive to the larger context of human-animal interactions and mutual wellbeing rather than a limited focus on human health benefits.

As participants engaged in these interactions, they began to integrate their own patterns with those of other species, study settings, and the natural world. Sometimes this involved transcending old patterns. For example, some participants described that having the wildlife activities each week "got us out of the house." Immersion in the study settings helped participants to enter the patterns of natural systems in the outdoor world through activities such as walking in the woods, and observing and caring for wild creatures. Participants described gaining insight into natural patterns such as, "learning about the forest environment in New England" and "how ecosystems worked." Patterns of wildlife care were designed to be in harmony with each animal's nature as a wild creature. For example, one participant described, "Observing wildlife such as raccoons… The habitats were designed and constructed to resemble the environments where the animals lived." Kaplan describes the natural environment as having a "special resonance" (50), (p. 174) with human inclinations and that the patterns of the natural world fulfill a variety of human purposes including observing other animals. Research with individuals participating in a wilderness immersion program suggested that participants experienced feelings of being "'at one with'" (51), (p. 182) the environment rather than feelings of control over the environment (51).

The natural environment is a dynamic system. An intervention based on immersion into a dynamic system is not a discrete fixed activity in a laboratory setting but rather an interaction within a changing environment. Some of the changes in the environment reflect rhythmical patterns such as seasonal changes. But other changes are neither regular, nor predictable (such as acorns falling or the Covid pandemic). Thus, a science of natural immersion and human-animal interaction must be able to encompass this dynamic emergence. It was interesting that when we developed an activity survey question to assess stresses in the environment, we were worried about big things like gunfire, not acorns and children. Unexpected occurrences could also make the experience extra special, such as when a large tortoise in the wildlife hospital delighted participants by unexpectedly approaching them. Immersion experiences are one possible approach to AAI in natural settings as they allow for both consistency and flexibility.

There was some variation in participant comfort level regarding engaging with particular animals. This is consistent with literature showing that humans have varied attitudes toward different species (52, 53). Emotions are an important dimension of human responses to wildlife and feelings such as fear likely have an evolutionary basis (54). Therefore, it was important to inform participants what different experiences might entail so they could choose whether or not to participate depending upon their comfort level. There was also a suggestion of developing comfort levels over time such as a participant who initially was afraid to hold the snake but, after encouragement, was able to hold it and had a meaningful experience. This is consistent with research showing that exposure to different species within a safe context can increase positive valuation of that species (23).

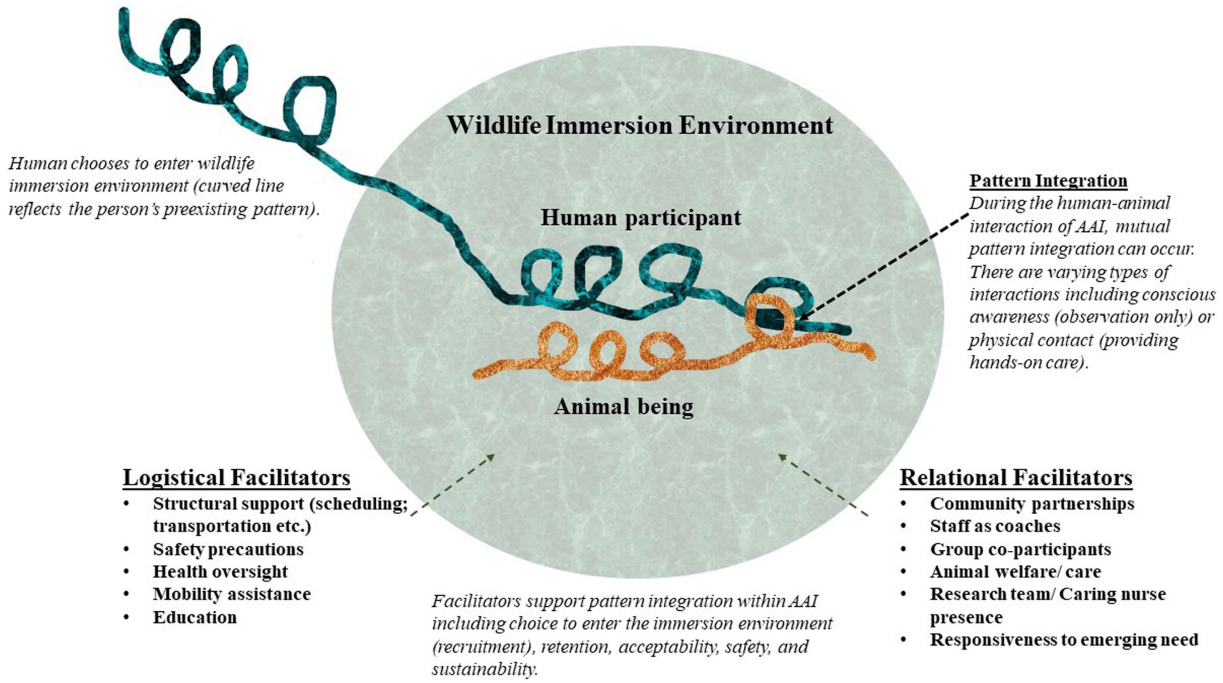

FIGURE 3
Pattern integration feasibility facilitators in AAI.

Intervention development can be an important aspect of pilot study work because interventions with human persons are complex and dynamic, influenced by unexpected events, and have varying meanings for participants. Hoddinott (55) notes that such studies sometimes need "further tinkering" (p. 3). Being responsive to the needs of participants and community partners reflects our theoretical framework of transcendent pluralism in which choices for the human good, or dignity, are viewed as part of a mutually evolving process. This approach is consistent with community-academic partnerships in which the expertise and needs of all partners are considered (53).

The sustainability bird feeding feature allowed participants to engage with wildlife after the study concluded, which was positively received. However, participants did not choose to engage in other post study activities, such as volunteering at rehab facilities, despite expressing strong interest and being provided with information. This suggests that providing a concrete structure for activities, as was done during the study, might be needed for some individuals to engage in wildlife pursuits. This is consistent with previous research by the PI which found that when individuals have a desire for transformative action, the desire may remain latent until a supportive structure for the activity is found (24). In post study interviews, participants described application of knowledge to interactions with wildlife in their daily lives suggesting that education is a helpful feature for sustainability.

Limitations and strengths

Recruitment was substantially affected by the Covid pandemic. Target enrollment had been 5 cohorts with 50 total participants. However, after a 1.5-year hold, we resumed the study, and by applying safety precautions, were able to provide the intervention safely with no Covid transmission. Although recruitment from one organization greatly enhanced logistics and participant support, there were some limitations in having a more transient study population that affected retention. Sample size and recruitment from one organization also limits generalizability of the findings.

Nature is variable and sometimes unpredictable. The outdoor activities placed seasonal restrictions in a New England setting. However, future studies could explore winter wildlife activities such as finding animal tracks in snow. Additionally, the activities were based upon animal availability and needs, which meant that experiences varied. This presented some limitations in terms of ability to strictly control the intervention. However, this was also a strength in terms of a real-world evaluation. Having the PI immersed in the field with participants allowed us to be responsive to needs and capture extensive feasibility data. An additional strength was that all the interventions were conducted in settings open to the public and thus are amenable to testing with different populations and future translation. Further research is needed to extend these findings and to test results with larger sample sizes and different populations.

Conclusion

Our study findings suggest that animal-assisted activities with wildlife, including wildlife care, are feasible for Veterans with PTSD/PTSD symptoms and concomitant physical and psychiatric conditions. Immersion in the natural world and interaction with its many species offers potential benefits to the human person. However, the natural world is a dynamic system. Research with AAI must be able to encompass dynamic emergence and complexity. An AAI involving wildlife is not an isolated prescriptive activity but influenced by

multidimensional phenomena. Logistical as well as relational facilitators are important for the safe and fulfilling implementation of AAI in the natural setting. Animal welfare is an important consideration and guidance by persons knowledgeable about wildlife is critical so that human benefits do not come at the expense of other species. It is also important to consider sustainable features of AAI in order to provide individuals with ways to integrate the natural world within their daily lives. As humans learn to interact with wildlife ethically and safely, we can build a sustainable future toward the advancement of both human and wildlife wellbeing.

Data availability statement

The datasets presented in this article are not readily available because the data are not publicly accessible. Requests to access the datasets should be directed to DonnaJ.Perry@umassmed.edu.

Ethics statement

The studies involving humans were approved by UMass Chan Medical School Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DP: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. SC: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. JM: Writing – review & editing, Project administration. JA: Writing – review & editing, Data curation. DS: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

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

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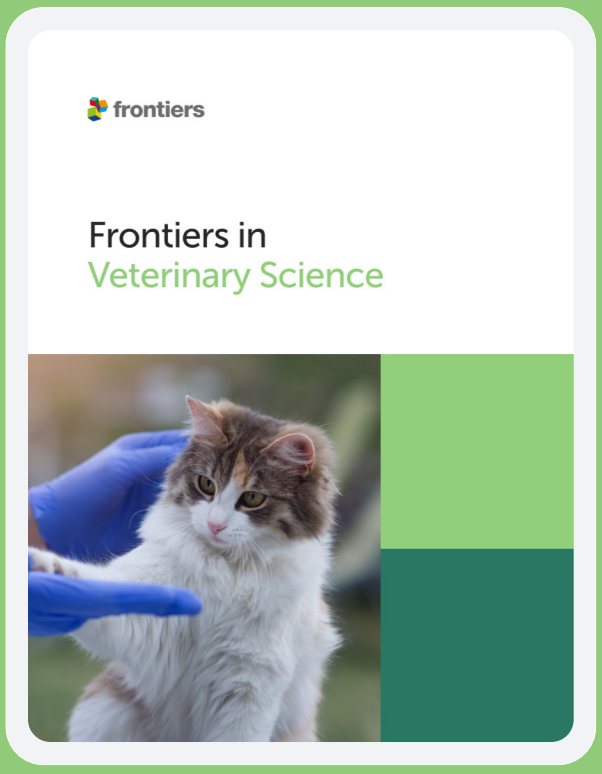

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