

Human-horse interactions as complementary strategies for mental health promotion

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Abstract

Background. Animal-assisted interventions (AAI) represent complementary rehabilitative approaches designed to address a range of physical and mental health conditions. Among these, Equine-assisted interventions (EAI) offer structured opportunities for engagement through diverse activities conducted within naturalistic settings, thereby integrating therapeutic processes with ecological contexts.

Methods. Over the past years, our group has developed and implemented standardized AAI methodologies that are now embedded within comprehensive intervention planning. This overview summarizes the application of different rehabilitative programs based on EAI.

Results. Our findings suggest that EAI can be effectively implemented across a heterogeneous spectrum of psychiatric disorders, contributing to recovery processes and social integration across the lifespan, from childhood to old age.

Conclusions. EAI represent innovative, ecologically grounded interventions with promising clinical potential. Further research involving larger, well-characterized samples is warranted to strengthen the evidence base and to expand the applicability of these promising complementary interventions.

Key words

- human-animal interactions
- horses
- rehabilitation
- mental health
- complementary therapies

INTRODUCTION

During the past 20 years, growing attention has been directed toward the contribution of companion animals to individual well-being and mental health [1-3], promoting their introduction into a variety of social, educational, and, in some cases, therapeutic contexts [4]. Indeed, pets can be a source of emotional stimuli, offering opportunities for social engagement and physical activity relevant both in daily life and in institutionalized settings [4-9]. Interaction with animals can promote affiliative behaviors and reduce arousal, as documented in clinical and non-clinical populations (e.g., patients with mental disorders, animal owners, and non-owners) [10-12]. As for the underlying mechanisms, physical contact with a companion animal activates physiological systems specifically involved in emotional/affiliative behaviors, and arousal (e.g., beta-endorphin, cortisol, oxytocin, dopamine) [8, 11].

Collectively, this scientific evidence has been used as the basis to develop Animal-assisted interventions (AAI), which represent recreational, educational, or therapeutic activities in which companion animals are intentionally engaged to promote the physical and mental health of individuals [4-7, 13-18]. Structured and goal-oriented AAI have proven to be an effective integrative approach that can complement traditional pharmacological and non-pharmacological treatments [4, 6, 14, 18]. Grounded in the biopsychosocial model, AAI exert their effects through integrated biological, psychological, and social pathways [3, 8]. This multidimensional approach is also reflected in the distinction of AAI into three areas: Animal-assisted activities (AAA), Animal-assisted education (AAE), and Animal-assisted therapies (AAT) [19-21].

In Italy, the Ministry of Health's National Guidelines define the planning and monitoring of AAI, as well as

the role and specific training of clinical professionals, and of the veterinarians and the experts in animal management and behavior, which are part of the multidisciplinary team managing these interventions [4, 20, 21]. The multi-professional background of the team is essential to managing the complexity of the AAI and ensuring the well-being of the participants involved, both humans and animals [21, 22]. The choice of the clinical professionals involved depends upon the objectives to be achieved, which may be recreational (AAA), educational (AAE), or therapeutic (AAT) [4, 20, 21]. According to the Italian National Guidelines on AAI, the intervention team must also include animal experts (veterinarians and handlers). In every AAI program, veterinarians assess the animal's suitability for participation through a multimethod evaluation of health status, living conditions, workload, and equipment requirements [22]. Moreover, the handler is responsible for regularly monitoring the animal's well-being during intervention sessions through direct observation of its behaviors. The animal's characteristics should always be matched to the rehabilitation goals [21, 23-26]. The animal species primarily involved in AAI are those that have undergone a long process of domestication by humans (e.g., dogs, horses, donkeys, cats, and rabbits), which has led to the selection of physical and behavioral characteristics that are best suited to human needs, such as temperament traits, communicative and cognitive skills [4, 21]. Dogs share a long history of co-evolution with humans and have developed a highly complex system of nonverbal communication with our species. As a result, they are currently recognized as one of the most versatile species for AAI across a wide range of mental health conditions and settings [4, 6, 7, 22]. Regular interactions with dogs can provide significant benefits in both clinical and educational contexts, contributing to the reduction of symptoms such as anxiety, depression, and loneliness at both young and older ages. Small companion animals, like cats and rabbits, are becoming popular in AAI targeting institutionalized older adults, such as individuals diagnosed with dementia living in nursing homes. Although the evidence is still limited, interacting with cats appears to improve mobility, interpersonal relationships, and daily activities such as personal hygiene and self-care [22]. In addition, AAI implemented in natural and de-medicalized environments, primarily involving horses and donkeys, might be a good addition to conventional therapies. In this regard, horses are particularly well-suited as they demonstrate significant cognitive and interspecific abilities that allow them to discriminate human communicative behaviors and emotional states [27]. For instance, horses respond to humans pointing at food, indicating that they can associate gestures with relevant situations and develop encoding and interpretation strategies based on human cues [28]. Horses are likewise capable of distinguishing human emotional cues – such as vocal tones, posture, and, more generally, nonverbal communication – and modulating their behavior through mechanisms of emotional transfer [23, 24, 26, 29-33]. Additionally, horses form long-term memories about humans based on previous experiences and the quality of interactions,

extending those memories to new contexts or unfamiliar subjects [27]. In educational and therapeutic contexts, donkeys represent a valuable resource: their calm temperament and reduced size help mitigate the fear commonly elicited by horses, supporting their employment in AAI targeting individuals with cognitive and psychiatric disorders [22].

From a clinical/rehabilitative perspective, Equine-assisted interventions (EAI) integrate the beneficial effects of the emotional relationship with an animal with the opportunity to engage in physical activity, ultimately activating multiple functional domains. Participation in equestrian activities, in fact, provides a significant degree of motor stimulation, which improves coordination, balance, agility, and flexibility, at the same time providing cognitive enrichment and opportunities for the development of social skills [34-40]. This approach is in line with a large body of scientific evidence highlighting the benefits of prescribing sports and physical activities to promote mental health [1, 41-43]. Such benefits are further enhanced by the recreational and natural environment in which EAI are provided, which places the individual away from standard medicalized settings, increasing motivation for intervention adherence [39].

EAI IN DIFFERENT REHABILITATIVE SETTINGS

EAI are an extremely versatile approach that can be tailored to specific individual needs [5, 39, 44-48]. A recent scoping review has distinguished EAI programs into two major categories: unmounted EAI, which includes exclusively ground-based activities (grooming, stable work, and horse-handling exercise), and mounted EAI (riding, driving, or vaulting), which borrows technical elements of equestrian sports, adapting them to the rehabilitative goal [39]. Ground-based activities involve a predefined sequence of actions affecting neurobehavioral components. These are aimed at caring for the horse, facilitating skill development, cooperation, and teamwork. In addition, grooming activities can help to build trust and confidence between the horse and the rider, and to strengthen their mutual relationship over time. Horse handling and stable management activities further enhance confidence in interacting with the animal while supporting the development of self-esteem, autonomy, and self-efficacy. Neuromotor components are mostly engaged during horseback riding, the rhythmic movement of the horse inducing pelvic motions in the rider that closely resemble those of human gait. This neuromotor input contributes to the normalization of muscle tone, including reductions in spasticity, and supports overall improvements in motor function. Concurrently, mounted activities engage key cognitive neurobehavioral processes, such as attention, memory, executive functions, and spatial-temporal perception, while fostering self-regulation and effective coping strategies.

A correct balance between ground-based and mounted activities should be an integral part of the intervention methodology and should be matched with the behavioral characteristics of the rider-horse dyad

to ensure well-being and the achievement of tailored rehabilitation goals [49]. Equestrian activities offer a wide range of tools that can bring broad multifunctionality to the intervention methodology and influence the outcome of the rehabilitative process (Table 1). Over the years, our group has developed standardized protocols and methodologies that have become an integral part of the rehabilitation of children, adolescents, and adults with mental and/or neurodegenerative disorders (Table 2).

Applying EAI in children and adolescents

A substantial number of mental disorders have their onset in childhood or adolescence and can influence growth trajectories and social functioning [50]. Several studies have demonstrated that EAI can be effective in supporting young people facing mental health challenges [39, 44, 47]. Particularly with children and adolescents, the non-judgmental and calming presence of the horse within the setting is an important support for health professionals seeking to improve social behavior and address emotional problems [47, 51]. During EAI,

young people are facilitated in taking an active role in the healing process, with an improvement in their communication, cognitive, and social skills, also reducing the stigma associated with mental health conditions [44, 52]. Regular interactions with the horse promote positive attitudes towards another living being, fostering a sense of care and attention and providing a valuable opportunity to nurture self-esteem and enhance one's sense of responsibility [47]. Lastly, the recreational approach and the nature-based environment of EAI can elicit positive emotions and interest, thereby promoting adherence to the intervention plan [39, 51].

Children with autism spectrum disorder

Autism spectrum disorder (ASD) constitutes a heterogeneous diagnostic category of neurodevelopmental disorders [53]. Characteristic features include persistent difficulties in the social use of verbal and non-verbal communication, impairment in social interactions (social-emotional reciprocity; development, maintenance, and understanding of relationships), as well as restricted and repetitive patterns of behavior [53].

Table 1

Description of ground and mounted activities in Equine-assisted intervention sessions

	ACTIVITY	DESCRIPTION	OBJECTIVE AND CLINICAL IMPLICATION
GROUND	Grooming and rewarding	It involves a predefined sequence of actions aimed at caring for the horse and requires the use of specific tools (e.g., curry comb, soft brush, mane and tail brush, hoof pick). Observation of the horse's behaviour and reactions. When mounted activities are scheduled, the horse is also harnessed according to the type of activity (riding, vaulting, driving). Reward the horse with snacks at the end of the session (e.g., carrots, sugar, hay)	Facilitate non-verbal (tactile, visual, olfactory) contact and communication with the horse. Facilitate metacognitive understanding of the horse. Promote affiliative behaviours and the opportunity to exhibit prosocial behaviour. Promote emotional connection and trust. Learn the importance of being grateful
	Horse handling	Use a rope attached to the horse's halter to get the horse to move with clients. Learn the basic elements of leading a horse, such as stopping, turning, walking, tension and the proper way to hold the rope. More complex activities consist of hand leading the horse inside an arena following a maze with pre-determined elements (e.g., leading the horse over barriers, around poles and cones) and longing the horse in a circle	Experience the horse's responsiveness and make requests properly. Increase the comfort level with the horse. Gain confidence, self-esteem, self-efficacy and mastery
	Stable work	It includes stable management activities such as box and paddock cleaning, feeding and minor facility maintenance activities	Strengthen autonomy and self-efficacy. Promote responsibility, routine and reliability. Facilitate skill development, cooperation, teamwork and social growth
MOUNTED	Horse riding	More sophisticated communication with the horse based on physical contact that involves riding the horse, independently or assisted by a handler, inside and/or outside an arena. Learn and perform basic riding figures (e.g., circles, vaults, half vaults, serpentines). More complex activities include riding independently in an outdoor arena or completing gymkhana and dressage exercises	Improve motor skills (muscle strength, balance and coordination), cognitive skills (memory, attention, problem-solving executive functions and spatial-temporal perception), behavioural and emotional skills (modulate physiologic arousal levels, self-regulation behaviours, coping strategies). Enhance self-esteem, independence and self-efficacy
	Carriage driving	This modality facilitates access for people unable to ride due to weight, balance and physical limitations (e.g., severe obesity, lower limb disabilities, spinal cord injuries, back injuries, spina bifida) and consists of driving a carriage	
	Equestrian vaulting	More sophisticated communication with the horse is based on physical contact and involves performing gymnastic exercises to the rhythm of music and coordinating body movements with the horse, which is led in a circle by an experienced equestrian trainer. It also includes warm-up exercises and body-awareness exercises. Vaulting sessions are usually group-based	Improve motor skills (muscle strength, coordination, balance, agility and rhythm), cognitive skills (memory, attention and executive functions) and interpersonal skills through group-based activities. Promote creativity, body awareness and expressiveness

Table 2
Examples of standardised Equine-assisted intervention (EAI) methodologies and monitoring applied to populations with different clinical conditions

Population and clinical condition	INTERVENTION METHODOLOGY				MONITORING	
	Grooming and rewarding	Horse handling	Horse riding	Equestrian vaulting	Quantitative evaluation (outcome)	Qualitative evaluation (outcome)
Children with autism spectrum disorder	X		X	X	TOL (executive functioning and problem-solving) VABS (adaptive functioning) Video recording (problem behaviours, spatial relationships, social interactions, and communication displayed by the child toward the horse)	
Adolescents with eating disorders	X			X	BMI and BIA (body weight and composition) EDI-3 (eating disorder symptoms) SCL-90-R (psychopathological dimensions) STAI (anxiety)	Observation (participants' attitudes, emotionality, behaviour during the EAI sessions, and relationship with horse and team members)
Adolescents at risk for psychopathologies	X	X	X	X		Observational schedules (participants' socialisations, attitudes, emotionality, behaviour, and motor performance during the EAI sessions)
Adults with stress-related disorders	X	X	X		HAM-D (depression) SCL-90-R (psychopathological dimensions) STAI form Y (anxiety) WEMWBS (psychophysical well-being)	Observation (participants' attitudes, emotionality, behaviour during the EAI sessions, and relationship with horse and team members) Group discussions guided by a psychiatrist (psychological themes elicited by the EAI)
Adults with schizophrenia	X	X	X		BPRS (negative symptoms) PANSS (positive symptoms)	
Adults with Parkinson's disease	X		X		AES (apathy) Gait analysis and UPDRS (motor assessment) GDS (depression) PD-39 (quality of life) STAI form Y Stroop test (cognitive performance)	

TOL: Tower of London test; VABS: Vineland Adaptive Behavior Scale (VABS); BMI: Body Mass Index; BIA: Bioimpedance Analysis; EDI-3: Eating Disorder Inventory-3; SCL-90-R: Symptom Checklist-90-Revised Scale; STAI: State-Trait Anxiety Inventory; HAM-D: Hamilton Depression Rating Scale; WEMWBS: Warwick Edinburgh Mental Well-Being Scale; BPRS: Brief Psychiatric Rating Scale; PANSS: Positive and Negative Syndrome Scale; AES: Apathy Evaluation Scale; UPDRS: Unified Parkinson's disease Rating Scale; GDS: Geriatric Depression Scale; PD-39: Parkinson's Disease Questionnaire-39.

ASD affects more than 78 million people in the world, and approximately 1 out of 100 children receives a diagnosis [54, 55]. The complex nature of ASD calls for a multidimensional treatment approach, and EAI can complement traditional treatments, including educational/behavioral interventions and pharmacotherapy [51, 56, 57]. It has been shown that EAI can have a positive effect on the social and behavioral skills of children with ASD, as well as on the well-being of their caregivers, reducing parental stress and improving family functioning [51, 52, 58, 59].

The distinctive characteristics of ASD highlight the importance of tuning the intervention protocol to promote the child's optimal adaptation and involvement during the sessions. Individuals with ASD do not cope

well with abrupt changes and intense multisensory stimulation. Indeed, in the initial stages of EAI, it may be appropriate to plan short sessions with a maximal duration of 30 minutes, and then gradually lengthen the activities to around 60 minutes. This approach promotes a gradual adaptation to non-familiar situations, removing an excessive burden coming from multiple novel sensory and emotional inputs. According to the evidence gathered from our projects, each session should incorporate an initial ground-based activity, including horse grooming (i.e., brushing the horse's coat, mane, and tail with a comb or brush), during which children are educated on basic safety rules and learn the practical aspects necessary for a positive interaction with the animal [58, 60, 61]. Images and drawings depicting

grooming tools (comb, brush, and hoof pick) and horse facial expressions are commonly used as visual aids to further facilitate the child during this phase [58].

Subsequently, sessions can include mounted activities, such as equestrian vaulting (EV) or riding. EV is a valuable initial approach, which is particularly well-suited to younger children and those with difficulties with impulse control. Indeed, during vaulting activities, the child does not have to deal with the responsibility of leading the horse and is therefore able to focus more on the tasks proposed by the therapist. Furthermore, vaulting activities facilitate collaborative learning in small groups, allowing therapists to integrate children with ASD into peer-based activities. This approach has the additional benefit of creating a supportive relational network and improving opportunities for social interactions. By contrast, riding activities are designed to facilitate cognitive rehabilitation through the acquisition of essential skills for independently managing a horse within an arena. The setting can be further enriched with appropriate stimuli (music in the case of EV; letters, cones, barriers, cup games in the case of horseback riding), increasing involvement and promoting treatment adherence. At the end of each session, the intervention typically entails a further ground-based phase, which represents an opportunity for children to engage in prosocial and affiliative behaviors by providing the horse with rewards (e.g., carrots, sugar, hay), as well as verbal and non-verbal expressions of gratitude and farewell [58, 62]. When developing an intervention program for children with ASD, it is important to adapt the activity to their individual functional levels. As mounted activities require concentration and compliance with professional instructions to ensure safety, they may be less suitable for individuals with low-functioning ASD. In these cases, grooming, horse handling exercises, and stable work are generally preferred, as they offer greater adaptability and fewer safety constraints.

To reliably assess the efficacy of the EAI, a multi-method approach is suggested, which incorporates different tools, such as caregiver questionnaires, standardized tests, and video recording and coding (see Table 2) [63, 64]. Quantitative tools can be used to evaluate the effects of EAI, monitoring improvements in adaptive and executive functioning and problem-solving skills. Additionally, quantitative evaluation can be complemented with direct observation and analysis of child behavior through video recordings [61]. This method, which relies on an ethological approach, is considered the best way to assess the quality of human-horse interaction in children with ASD.

Results from multiple projects show that, starting from the grooming phase, the presence of the horse contributes to creating a rehabilitative space in which the child learns to relate with adults and peers and performs specific tasks that stimulate cooperation, attention, and memory skills [58, 60, 61]. Additionally, the soothing influence of equine interaction and the proprioceptive input elicited during mounted activities – both equestrian vaulting (EV) and riding – allows modulation of the levels of sensory and affective arousal [62], as well as positively influencing problem-

solving abilities and executive functions [52, 58, 65]. Horse stimulation can also improve gross motor skills such as balance, coordination, and posture [66]. Lastly, the unspoken communication with the horse enables children with ASD to establish and gradually reinforce an emotional connection with the animal, overcoming the communication and social skills difficulties [52, 61]. From a psychotherapeutic perspective, the child's relationship with the animal can catalyze the expression of internal states and experiences, thereby creating a foundation for therapeutic work [60].

Adolescents with eating disorders

Eating disorders (ED) are mental health disorders characterized by persistent disturbances in eating or feeding behaviors that significantly impair physical health or psychosocial functioning [53]. ED typically have a chronic course with long-term remission rates and an increased risk of suicide; among these, anorexia nervosa (AN) has limited recovery and the highest mortality [67, 68]. Individuals with AN exhibit an intense fear of gaining weight or a persistent pattern of behavior that interferes with it, as well as disturbances in body weight or shape perception [53]. Treatment plans require the intervention of a multidisciplinary team, and they may include individual, group, or family psychotherapy, nutritional counselling, and medical care [69]. As treatment failure and relapses are common after completion of therapy [70], developing supplementary rehabilitative interventions to enhance the efficacy of established treatments is a specific unmet need [71].

Our group has recently developed a pilot project named "Horses and Butterflies", to test the feasibility and effectiveness of an EAI based on EV that exploited the physical and emotional synergy between horse and participant for the psychosocial rehabilitation of young patients with AN [72, 73]. The intervention included a grooming phase designed to shift participants' attention from obsessive thoughts about their own bodies toward the care of another living being, thereby fostering the development of a positive relationship with the horse [73]. This was followed by warm-up and vaulting exercises aimed at restoring bodily awareness. The movement is no longer used to sustain anorexic symptoms related to weight reduction but instead becomes a means of expression and interaction, initially with the horse and subsequently with other participants, promoting social engagement. EV involves a substantial physical effort, encompassing muscular strength, postural control, and coordination. Access to EV-based programs for individuals with AN should therefore be conditional upon a multidisciplinary clinical evaluation, aimed at ensuring participant safety and an appropriate risk-benefit balance. In particular, it is essential to confirm that body mass index (BMI) is not critically low (e.g., BMI < 16) and that sufficient skeletal and muscular integrity is present, considering the increased risk of osteoporosis and reduced muscle mass commonly associated with the disorder.

Seven girls (aged between 13 and 20 years old), in outpatient treatment for anorexia, were enrolled in the project and randomly assigned to two groups: 3 to the

EV group and 4 to the control group. The intervention lasted 3 months and comprised 10 weekly sessions (each 60-90 minutes long) carried out in small groups [72].

Longitudinal evaluations of anthropometric indices and body composition were complemented by psychological tests (Table 2) [74-78]. Participants' attitudes, emotions, and general behaviors were observed by a psychologist during the session, as well as their relationship with the horses and the other team members. This intervention has shown good feasibility and a high level of acceptability by the participants and their families [72]. Preliminary results indicate a promising improvement in some of the core psychological symptoms associated with anorexia (e.g., perfectionism, interoceptive deficits, overcontrol, and affective problems), anxiety management, and physical condition (an increase in fat mass and a reduction in lean mass weight) [72, 73] suggesting that it can be employed effectively as an integrative approach to promote recovery of body awareness and social reintegration in AN.

Vulnerable adolescents

As many mental disorders have their onset during adolescence, a proactive approach is needed to prevent mental illness and to promote the well-being of individuals in this vulnerable age group [79-81]. Adolescents in residential treatment facilities often fail to adapt and exhibit strong opposition to social norms, showing difficulties in social relationships, reduced school attendance, a propensity towards self-harm, and an inability to regulate their emotions and behavior effectively in the face of frustration or competition [82].

Previous studies have shown the potential for EAI on the socio-emotional functioning of at-risk adolescents in residential care [82, 83]. We have set up the pilot project *Horses & Friends* to evaluate the suitability and potential benefits of an EAI program as a complementary tool to promote the psycho-physical well-being and socio-emotional functioning of adolescents undergoing psychiatric treatment in a therapeutic residential setting [84]. The project was conducted over five months, with weekly sessions lasting 70 minutes. The intervention was led by a multidisciplinary team of qualified professionals in mental health and EAI. Each session included a 1st ground activity phase (grooming and horse handling), a 2nd mounted activity phase (both riding and vaulting activities), and a 3rd ground activity phase (final grooming and rewarding of the horse). The psychologists involved in the project employed qualitative evaluations through observational schedules to monitor participants' socializations (interactions with horses, peers, and team members) and progress in terms of attitudes, emotionality, behavior, and motor performance during the activities.

During the sessions, the participants established a strong emotional connection with the horses, which was a motivating factor and a catalyst for interpersonal relationships. This is relevant as rehabilitation work with adolescents living in a residential facility is largely focused on positively redirecting aggressive behavior, replacing alienation and hostility with feelings of trust,

safety, and acceptance [82]. When implementing EAI for vulnerable adolescents, it is crucial to address motivation from the outset to foster active engagement and reduce the risk of dropout. The interaction with the horse was perceived as fun, stimulating, and engaging, promoting good adherence to the intervention and improvements in the adolescents' attitudes and behavior during the session. Moreover, a social gathering was organized after each session, which proved to be a valuable experience, facilitating deeper connections between participants and reinforcing the interpersonal relationships established during the project.

The integration of two distinct sporting activities, such as horse riding and vaulting, has been particularly beneficial for adolescents, enabling them to simultaneously develop a range of functional competencies. Autonomous horse riding fostered an empowering process, strengthening self-esteem and anxiety management. Additionally, vaulting exercise improved physical skills, including coordination, balance, and agility, as well as concentration, attention, and courage. These qualitative findings are in line with recent evidence about the positive effects of physical activity as a rehabilitative tool for young people with mental disorders [85].

Applying EAI in adults with mental and neurodegenerative disorders

Mental health disorders in adulthood have been associated with an increased prevalence of unhealthy lifestyles, including smoking, weight gain, sedentary behaviors, and decreased physical activity. Additionally, social withdrawal and the impoverishment of emotional relationships can contribute negatively to mental health and quality of life in at-risk individuals [86, 87]. In this overview, we report some examples of EAI applied to adults with stress-related (e.g., military veterans), psychotic (e.g., schizophrenia), and neurodegenerative (e.g., Parkinson's disease) disorders.

EAI in adults with stress-related disorders

In the last decade, EAI has emerged as a promising treatment opportunity for trauma and stressor-related disorders [88, 89]. Most studies on the topic focus on the population of military veterans who, compared with the general population, have a higher risk of being challenged with acute or chronic stressors [90-92]. A recent systematic review and meta-analysis on EAI for military veterans underlines the great heterogeneity of the intervention protocols, emphasizing the need for standardized procedures and tools that may allow evaluation of the effectiveness of this type of intervention [88]. In a preliminary study, Arnon *et al.* [91] developed a standardized EAI protocol for a sample of US military veterans, which appears promising, particularly in terms of short-term symptomatic benefits, improved quality of life, acceptance, and satisfaction with the type of intervention.

Over the past two years, our group has developed an evidence-based, standardized EAI program to support the mental health of military veterans. The intervention's primary focus was on the promotion of effective coping strategies, the alleviation of psychological

symptoms associated with adjustment difficulties, and the enhancement of socio-emotional skills. Additionally, the intervention sought to facilitate a re-evaluation of one's military identity [93]. Longitudinal evaluations were carried out using standardized psychological scales to measure anxiety and depressive symptoms, psychopathological dimensions, and psychophysical well-being (Table 2) [74, 77, 94-96]. The progress of the participants was also assessed through qualitative observations of their attitudes, behaviors, and emotional responses during the EAI sessions.

The project revealed a high degree of adherence by veterans who enjoyed the activities proposed, a relevant result considering the resistance toward traditional therapies and the high dropout rate among this population [91, 97]. During the project, participants had the opportunity to enjoy contact with the natural environment and to challenge themselves with activities they had never tackled before, such as horse handling and riding, which require leadership, benefiting veterans by allowing them to regain their autonomy and sense of agency in a safe and less stressful natural environment [93]. In addition, the activity with the horse brought out relevant identity issues that were shared by the entire group of participants during discussions guided by a psychiatrist. Given the considerable heterogeneity of stress-related and physical conditions observed among military veterans, it is essential to adapt both the intervention and the associated assessment methods through personalized treatment plans. In our experience, the overall intervention included the successful adaptation of the rehabilitation protocol to integrate two participants with physical disabilities, one veteran in a wheelchair and another with blindness, into the EAI sessions, modulating the activities to their specific needs [93].

EAI in adults with schizophrenia

Schizophrenia is a complex psychopathological condition, and the combination of positive (e.g., delusions and hallucinations) and negative (e.g., blunted affect, alogia, social withdrawal, anhedonia, and avolition) symptoms contributes to significant alterations in individual's functioning [98, 99]. In addition, cognitive deficits lead to difficulties in understanding the mental states of others (e.g., beliefs, intentions) and using this information to interpret and predict their behavior [100]. Therefore, the intervention should focus not only on reducing psychotic symptoms but also on promoting social functioning.

Over the past 20 years, many studies have supported the benefits of EAI as an integrative rehabilitative approach for the mental and physical health of patients with psychotic disorders [5, 35, 46, 101, 102]. The multicenter *Pindar* project is an example of good practice demonstrating the effectiveness of a year-long EAI that followed a structured methodology designed for 24 patients diagnosed with schizophrenia [5]. Involving individuals with psychotic disorders in EAI can present significant challenges: acute positive symptoms can interfere with safe interaction with the horse and the therapeutic environment. For this reason, the EAI

should be implemented when positive symptoms are in remission or adequately stabilized through pharmacological treatment. Under these conditions, EAI can be effectively oriented toward relapse prevention, functional recovery, and the targeted improvement of negative symptoms.

In the *Pindar* project, a total of 40 EAI weekly sessions were held for 24 months, after a few introductory meetings planned to help the participants gradually familiarize themselves with horses. Each session included a ground phase, during which participants learned about horses (behavior and body parts) and equipment (saddle and bridle), as well as horseback riding activities aimed at developing nonverbal communication strategies for interacting with the animal [5].

To evaluate the improvements in positive and negative psychiatric symptoms, psychological scales were administered at the beginning and the end of the project (Table 2) [103, 104].

Overall results indicate that EAI allowed patients to take an active role in their rehabilitation process, with significant improvements in negative symptomatology (social isolation and apathy), pharmacological compliance, and hospitalization rates [5]. In particular, the grooming and horse handling activities have allowed participants to experience the animal's calming presence, which became a starting point for simplified interaction and to regain contact with the external world [5]. In this regard, the horse acted as a facilitator by fostering communication: horse-related activities help divert attention away from the disease and provide a topic of conversation within and outside the intervention setting, helping participants in social integration and overcoming self-stigmatization [35, 101]. In addition, observing horses' behavior and reactions during ground activities favored the rehabilitation of cognitive abilities [105].

The rehabilitative work set up during ground activities can be strengthened by horse riding [105]. During riding activities, the communication process is mediated by bodily contact, which allows concretely tackling the difficulties of perception and management of reality; the correct use of reins and legs allows the patients to interact directly with the animal, and body balance adjustments allow the exchange of information between horse and rider. Moreover, horse riding contributes to increasing interest in physical activity, leading to improvements in motor skills and counteracting obesity, a highly common condition in these patients, mainly due to side effects of pharmacological therapies [105].

In conclusion, the integration of EAI into usual care is particularly suited for patients with schizophrenia, showing the potential to foster disease remission, social contact, and the acquisition of skills transferable to other areas of the participant's life [5].

EAI in adults with Parkinson's disease

Parkinson's disease (PD) is a progressive and neurodegenerative disease affecting motor function. This condition is also accompanied by a range of non-motor symptoms, including mood and cognitive disorders [106], impacting patients' quality of life. Current treat-

ment involves a combination of pharmacological and rehabilitative therapies. Patients with PD usually attend highly medicalized treatment programs, whereas the natural context that characterizes EAI may favor higher compliance with the intervention [107, 108]. Indeed, EAI is a suitable approach to tackle PD as it allows synergistic intervention on motor (e.g., balance, posture, gait, rigidity, and involuntary movements), cognitive, and socio-emotional functioning [107, 108].

We report an example of EAI that has followed a standardized 5-week protocol, including weekly sessions of 60 minutes [108]. Several challenges may occur when including individuals with PD in EAI. Motor symptoms raise safety concerns and may increase the fear of falling, negatively affecting confidence and participation. Grooming was planned at the beginning and the end of each session to progressively help patients with PD work on gross-motor and coordination skills. Riding activities constituted the core component of the intervention methodology, given the strong stimulation of the patient's proprioception skills by the horse's gait, which closely resembles that of human walking. This is of particular benefit to patients with difficulties in ambulation [108]. The execution of exercises on the horse (rotation, flexion, extension of the upper arms, and bending/torsion of the trunk) facilitated the stimulation of the vestibular system, thereby assisting in the enhancement of balance maintenance, both in the saddle and following dismount [108]. During mounted activities, reduced tolerance to fatigue should be carefully considered, modulating the intensity of exercises to maintain physical exertion throughout the session. These difficulties are often compounded by depressive states and anhedonia, which are common in this population and can further reduce motivation. However, the interaction between humans and horses has been observed to elicit positive emotional responses that may have a beneficial impact on mood disturbances and quality of life [108]. Gait analysis, motor assessment, and psychological evaluations of cognitive performance, depressive symptoms, apathy, and quality of life were conducted before and after the EAI (Table 2) [95, 109-115]. A comparison of the pre- and post-intervention scores revealed a general improvement in motor skills, as well as a positive change in gait, including an increase in stride length and a decrease in stance and double stance rates [108]. Cognitive and psychological assessments indicated improvements in attention, quality of life, and a reduction in anxiety and apathy levels [108]. These results have been further confirmed by a more recent study [107], indicating that a structured EAI methodology can be integrated with other protocols in the rehabilitation of PD individuals.

DISCUSSION AND CONCLUSIONS

EAI are professional-led interventions aimed at enhancing health and well-being by actively involving individuals in structured and nature-based experiences, stimulating multiple functional domains at the same time (social, emotional, and physical). The interaction between motor, cognitive, and socio-emotional skills has been a particular area of interest for researchers

studying both typical and atypical development across the lifespan [116]. Motor functioning has been demonstrated to have clear associations with the development of communication and object knowledge; moreover, training motor skills and acquiring additional patterns of actions (e.g., those related to different sports techniques) have been proven to have a positive impact on socialization and interpersonal relationships in both children and adults [117, 118]. As evidenced by the experiences presented in this overview, incorporating riding or vaulting activities into EAI enables targeted intervention to improve balance, coordination, and agility. Concurrently, these activities foster the development of cognitive abilities (executive functions, memory, and attention), social skills, and emotional regulation strategies, underscoring their multifaceted benefits [34-40, 119].

From a mechanistic perspective, the rehabilitation process can have important effects on brain plasticity by activating those brain circuits that are dysfunctional as a consequence of the disease, especially after a chronic phase [120]. Another fundamental notion is the existence of periods of vulnerability/opportunity in which the brain can be influenced by stimuli that can promote plasticity of brain areas affected by the pathology. Among the periods of greatest vulnerability to mental illness, we can list the perinatal stages and adolescence [120]. These considerations point to the need to carry out early interventions for greater functional and behavioral recovery.

It has also been proposed that EAI can impact physiological mechanisms underlying emotional regulation and arousal, which are dysfunctional in affective disorders. Tactile contact and direct eye contact with dogs during human-animal interaction are associated with increased oxytocin release, which plays a central role in the regulation of affiliative behaviors within intraspecific relationships [11, 121]. Preliminary data on human-horse contact indicate a significant increase in oxytocin during the first and seventh week of intervention, and a recent study investigated changes in human plasma oxytocin levels after engaging with cows, hypothesizing that interactions with equine and farm animals can elicit the same physiological response [122, 123]. It is widely recognized that the physical contact experienced during grooming activity represents a significant aspect of the EAI. Such contact can facilitate relaxation, a calming response in the participants, and the human-horse emotional connection, thereby contributing to the overall rehabilitation outcome.

In addition, the non-judgmental and welcoming presence of the horse can facilitate the acquisition of a greater awareness of the emotional internal states and the external world [93]. The horse can represent a powerful motivational stimulus and can act as a bridge in establishing trust with the mental health professional [93] who should support the individual in identifying emotions, memories, thoughts, and representations related to their personal experience.

Notwithstanding the promising findings reported in this overview, further research is needed to improve knowledge on the effectiveness of EAI, particularly as

it relates to the underlying mechanisms. Future studies should involve larger samples, appropriate control groups, balanced gender representation, and standardized assessment tools tailored both to the clinical characteristics of the target population and to the specific components of the intervention. A recent paper highlighted the importance of harmonizing the terminology, proposing the umbrella term of Animal-assisted services (AAS), to increase transparency about the key features of the different approaches in the field [124]. In this project's collection, we have maintained the Italian standard terminology as requested by the Italian Ministry of Health [20]. As the field progresses, a common terminology must be agreed upon by health institutions and scientific societies. Nonetheless, strengthening methodological rigor is crucial to allow AAI, or AAS, to be upscaled to "best practices" which are fundamental to innovate the mental health sector (<https://ja-mentor.eu/>).

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Declaration of artificial intelligence (AI) use

During the preparation of this work, the Authors used ChatGPT to revise the English language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Authors' contributions

BC, CC: conceptualization, writing – original draft, writing – review and editing; NF: review and editing; SC: writing – review and editing; FC: conceptualization, writing – review and editing.

Conflict of interest statement

The Authors declare that they have no conflict of interest.

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