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Tracey A. Overbey, Florian Diekmann & Kristi S. Lekies

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Nature-based interventions for vulnerable youth: a scoping review

Tracey A. Overbey[a], Florian Diekmann and Kristi S. Lekies[c]

[a]University Libraries, The Ohio State University, Columbus, Ohio, USA; [c]Food Agricultural, and Environmental Sciences Library, The Ohio State University, Columbus, Ohio, USA; [c]School of Environment and Natural Resources, The Ohio State University, Columbus, Ohio, USA

ABSTRACT

Nature-based interventions hold promise for vulnerable youth experiencing mental, emotional, developmental, behavioral, or social difficulties. This scoping review examined wilderness therapy, animal assisted therapy, care farming, and gardening and horticultural therapy programs to raise awareness and guide future development of research and treatment options. Studies included in this review were identified through a systematic search of the literature informed by a scoping review framework. Studies were examined by design, sample, intervention, and key findings. The majority of studies were quantitative using repeated measures designs and were conducted primarily in the United States. Sample sizes were generally small. Interventions were residential and community based with varying degrees of duration. Outcomes were largely positive across a wide range of psychosocial and behavioral measures and often maintained post-treatment. We emphasize the importance of robust empirical designs, comprehensive description of the interventions and surrounding therapies, and identification of target groups.

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Nature-based interventions; green care; nature therapy; vulnerable youth; at-risk youth; scoping review

Introduction

Contact with nature and the utilization of natural environments have been recognized to contribute to improving and promoting human health and well-being across the life span (Finlay et al. 2015; Cox et al. 2017; Frumkin et al. 2017; Aerts et al. 2018; Vanaken and Danckaerts 2018; Engemann et al. 2019; Mygind et al. 2019; Richardson et al. 2021). Researchers have investigated the relationships between natural elements, green spaces, landscapes, and outdoor activities and identified a diverse range of positive outcomes that include benefits for physical health, mental health, cognitive development, and social interactions (e.g. Abraham et al. 2010; Annerstedt and Währborg 2011; Bratman et al. 2012; Cox et al. 2017; Vanaken and Danckaerts 2018; Richardson et al. 2021). The increasing number of meta-analyses, scoping reviews, systematic reviews, and other research summaries in recent years has helped to synthesize the body of literature across outcome variables or specific populations as well as identify areas for future research (e.g. Frumkin et al. 2017; Vanaken and Danckaerts 2018; Mygind et al. 2019; Shanahan et al. 2019; Richardson et al. 2021). As the evidence base continues to grow, so has the need to identify consistencies in research findings, methodological approaches, and gaps in knowledge (Frumkin et al. 2017; Aerts et al. 2018; Vanaken and Danckaerts 2018; Richardson et al. 2021).

CONTACT Florian Diekmann diekmann.4@osu.edu Food, Agricultural, and Environmental Sciences Library, The Ohio State University, Columbus, OH

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In this paper, we focus on nature-based interventions, sometimes collectively denoted as green care activities, for vulnerable adolescents and young adults experiencing mental, emotional, developmental, behavioral, or social difficulties. Nature-based interventions and green care activities consist of a diverse range of programs and services that utilize plants, animals, and/or landscapes to create therapeutic and treatment interventions designed to address health and care needs of general populations as well as specific population groups (Sempik and Bragg 2013). A broad range of organizations have developed and employed a variety of nature-based services and therapeutic interventions to promote health and well-being in specific populations. Similarly, the diversity of target groups and the variety of behavioral, clinical and non-clinical problems is extensive. While many of the studies deal with children and young people with a mental health diagnosis, there are studies that target educational and social benefits. The latter are excluded from the present research, which focuses on therapeutic benefits rather than skill building exercises.

Increasingly, concerns have been raised about high levels of adolescents and young adults struggling with mental health problems, adjustment difficulties, problem behavior, disengagement, or disaffection (e.g. Olfson et al. 2015; Coley et al. 2018; Keyes et al. 2019; Murray et al. 2019; Mojtabai and Olfson 2020; Cybulski et al. 2021). The severity of needs, gaps in existing services, and service provision challenges have generated interest in effective treatment approaches (McGorry et al. 2013; Vyas et al. 2015; De Vries and Wolbink 2018), which include nature-based interventions. The interventions are diverse not only in their targeted groups but vary also greatly in their design and setting (Annerstedt and Währborg 2011; Moeller et al. 2018; Shanahan et al. 2019). Based on the literature, the main types of nature-based interventions can be categorized broadly into wilderness therapy (Wilson and Lipsey 2000), animal-assisted therapy (Lentini and Knox 2015; May et al. 2016; Hoagwood et al. 2017), care or social farming (Murray et al. 2019), and gardening and horticultural interventions (Sempik et al. 2014; Park et al. 2016).

Although these programs are receiving attention in the academic literature, only a small number of evidence reviews have focused on nature-based interventions solely targeting vulnerable or at-risk youth populations (e.g. Wilson and Lipsey 2000; Lentini and Knox 2015). More often, youth-focused interventions are addressed as a specific subgroup in evidence reviews on nature-based interventions across age groups (e.g. Murray et al. 2019; Shanahan et al. 2019) or based on specific conditions, such as attention deficit hyperactivity disorder (Faber Taylor et al. 2001; Faber Taylor and Kuo 2009). Furthermore, the studies can be found in a variety of disciplines, thereby limiting awareness by the larger body of literature to the community of scholars and practitioners (Harper 2017). The growing concern for adolescent and young adult populations point to the need to examine nature-based interventions and services across intervention types. Mapping the existing literature helps guide further development and application of interventions for this population and can point to areas of future research needs.

The present study

The current evidence review fills a void by summarizing the literature on nature-based interventions for a youth population that is considered vulnerable or at-risk of significant mental, emotional, developmental, behavioral, or social difficulties, or placed in out-of-home institutional care. Our specific objective is to present a summary of methodological designs, samples, interventions characteristics, and key findings of the studies on wilderness-therapy, animal-assisted therapy, care farming, and horticultural-based interventions for adolescents and young adults. We permit both quantitative and qualitative research methodologies. While the strength of quantitative methods is the empirical support for theoretical advances, qualitative studies situate the interventions in their environment which can provide a rich contextual understanding of their impacts (Deighton et al. 2010). By examining studies across different types of interventions, our study summarizes the

current knowledge on interventions and points to ways in which these interventions can be beneficial for vulnerable youth, and provides direction to researchers and practitioners who seek to advance the evidence base on this topic.

Materials and methods

Our study was informed by a scoping review framework identified as the most suitable approach to determine the extent and nature of the broad and diverse literature on the topic and to identify key areas for future research and scholarly engagement by identifying gaps in the literature (Arksey and O'Malley 2005; Levac et al. 2010).

Study eligibility criteria

Our review focused on studies targeting children, adolescents, and young adults between the ages of 10 and 24 years and who could be considered vulnerable and at-risk for poor psychosocial outcomes due to mental health diagnoses, inpatient hospitalizations, involvement in child welfare and juvenile justice systems, substance abuse, family issues, trauma, school and community difficulties, and other emotional, developmental, or behavioral concerns (Sanders and Munford 2014). We considered studies investigating a wide range of interventions aiming to utilize nature to improve and promote quality of life, human health, and wellbeing of eligible populations. With no restrictions on modes of delivery, intervention type or durations, the review included the breath and diversity of nature-based interventions. The review considered studies presenting primary data (original research) regardless of methodology, study design, publication date, or geography. Evidence-syntheses (literature reviews, meta-analyses, systematic reviews, etc.) were also eligible. If a primary data study was also included in an evidence-syntheses study, we indicated the overlap in the table that lists the evidence-synthesis studies (Table 5). Only peer-reviewed studies published in scholarly journals in English were considered. Studies without outcomes measures related to broadly defined quality of life, human health, and wellbeing categories were excluded from this review. This included studies focused primarily on educational or vocational activities, including academic instruction and learning. Likewise, studies that focused on everyday life activities or casual encounters with nature (e.g. private gardening, animal-assisted recreation, or outdoor recreational activities, such as walking, running, or cycling in nature) were excluded.

Literature search process

A comprehensive search strategy was developed and searches for relevant literature in both generic and subject-specific bibliographic databases were conducted, including Web of Science Core Collection, Scopus, CAB Abstracts and Global Health (via Web of Science), CINAHL Plus (via EBSCOhost), ERIC (via EBSCOhost), PsycINFO (via EBSCOhost), and SocINDEX (via EBSCOhost). We searched MEDLINE via the Scopus interface. Search terms were derived from initial scoping searches and reviewing the literature. The search strategy intentionally considered a broad range of nature-based interventions and was piloted to check the appropriateness of selected databases and search terms. The search string used in all databases was as follows: ("green care" OR "care farm*" OR "social farm*" OR "community farm*" OR "therap* farm*" OR "prison farm*" OR "social horticult*" OR "sensory garden*" OR "healing garden*" OR "rehabilitation garden*" OR "school garden*" OR "community garden*" OR "horticultural therap*" OR "therap* horticult*" OR "garden therap*" OR "therap* garden*" OR "forest* therap*" OR ecotherap* OR "eco therap*" OR "nature therap*" OR "nature assisted therap*" OR "nature intervention*" OR "animal assisted therap*" OR "animal assisted activit*" OR "wilderness therap*" OR "nature rehabilitation" OR "nature based rehabilitation") AND (child* OR adolesc* OR youth* OR young* OR juvenile* OR teen*).

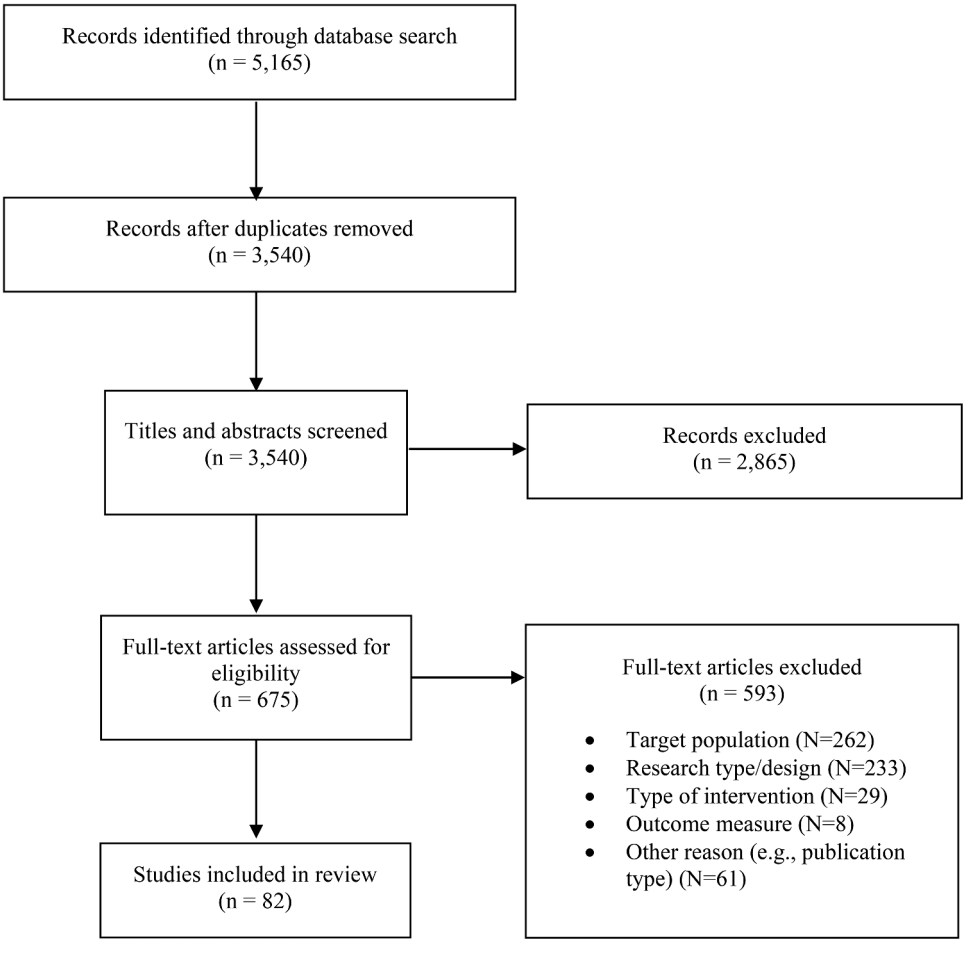

Figure 1. Study selection flow chart.

Database searches were conducted on 17 December 2018. The search was repeated on 8 July 2020 to identify studies published since the original search date. Search results were de-duplicated to remove redundant citations identified from multiple sources. All records were reviewed at the title and abstract level for studies that potentially met the a priori inclusion criteria. In the next step, full-texts of all records were obtained and assessed by two independent reviewers for eligibility. Potential discrepancies in screening were resolved by consensus. Following full-article screening, standardized descriptive data such as bibliographic information and descriptive study metadata, including sample populations, study type, intervention characteristics, outcome measures, and narratively summarized key findings were documented for each study. The final analysis consisted of tabulating and grouping the studies by intervention types. Because of the wide range of interventions and the variety of methods and study designs considered, study validity assessment (critical appraisal) was outside the scope of the review. Figure 1 summarizes the study selection process and indicates the number of articles excluded at each phase of screening.

Results

Studies on wilderness-therapy interventions

Wilderness therapy programs, also referred to as outdoor behavioral healthcare, utilize the natural environment, generally in remote areas, as the setting for an intensive therapeutic process under the direction of skilled leaders. These programs consist primarily of residential programs ranging in length from a few weeks to several months or longer but also can include shorter intensive periods of three to 10 days that are incorporated into in-patient hospital, outpatient mental health, traditional residential treatment, or specialized treatment programs. Components include learning outdoor skills, hiking extensive distances, overnight camping, being away in remote areas, and individual and group therapy sessions. There may also be a family component, in which parents participate in therapy while their child is in care separately or as part of the wilderness therapy program. Additionally, parents may participate in outdoor activities with their child for a short period of time. Youth are placed in small groups with 6–8 other youth, with group process, trust, and cooperation essential components. Programs serve youth with severe mental health, behavioral, and social difficulties, including substance dependence or abuse. Prior to placement, youth typically have participated in other types of treatment modalities such as outpatient or inpatient mental health services which were unsuccessful in remedying the underlying issues (Russell 2001, 2003; Bettmann et al. 2016; Fernee et al. 2017).

A total of 35 studies of wilderness therapy were identified which included 31 original studies and four evidence-synthesis reviews. Of the 31 original studies, 18 used quantitative methods, one used mixed methods, and 12 used qualitative methods (Tables 1 and Table 5). Samples ranged from 14 to 816 in the original quantitative studies and from four to 148 in the original qualitative studies. The sample of the original mixed methods study was 32 adolescents. In addition to the original intervention studies, four evidence-synthesis studies met inclusion criteria and consisted of two meta-analyses (Bettmann et al. 2016; Gillis et al. 2016), one scoping review (Harper 2017), and one qualitative review (Fernee et al. 2017). The two meta-analyses included 2,399 and 2,667 participants. The review of qualitative studies examined a total of 102 adolescents.

Ages of youth in the treatment programs ranged from 12 to 34 years of age. In the 31 original studies, data were obtained from youth in treatment programs (N = 29), parents or caregivers (N = 9), and/or staff members (N = 3) (Table 1). Most of the studies examined youth in programs that served males and females, but five studies examined programs exclusively for males (Lambie et al. 2000; Russell 2000; Gillespie and Allen-Craig 2009; Somervell and Lambie 2009; Margalit and Ben-Ari 2014) and two studies examined programs exclusively for females (Caulkins et al. 2006; Pryor et al. 2006). Almost all programs indicated they served youth with severe mental health, behavioral, and social difficulties, including substance abuse and dependence or focused on specific groups such as youth who have committed sex offenses or delinquent acts, or experienced trauma.

The original studies took place primarily in the United States (N = 19, Table 1) with other locations including Australia (N = 3, Pryor et al. 2006; Gillespie and Allen-Craig 2009; McIver et al. 2018), Norway (N = 3, Gabrielsen et al. 2019a, 2019b; Fernee et al. 2020), New Zealand (N = 2, Lambie et al. 2000; Somervell and Lambie 2009), Canada (N = 1, Harper et al. 2019), Israel (N = 1, Margalit and Ben-Ari 2014), Ireland (N = 1, Conlon et al. 2018), and the United Kingdom (N = 1, Paquette and Vitaro 2014). The two quantitative meta-analyses (Bettmann et al. 2016; Gillis et al. 2016) and scoping review (Harper 2017) examined studies exclusively or predominantly from the United States; the qualitative review article included only studies from the United States (Fernee et al. 2017) (Table 5).

The majority of the 31 original intervention studies examined stand-alone wilderness therapy programs (N = 18) that lasted between three and 22 weeks (Table 1). Other studies examined hiking, camping, or other wilderness components that were integrated into inpatient hospital, specialized mental health care, or drug treatment programs (N = 5, Berman and Anton 1988; Pryor et al. 2006; Harper 2017; Gabrielsen et al. 2019a, 2019b; Fernee et al. 2020), residential treatment

Table 1. Original intervention studies on wilderness therapy.

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Quantitative studies								
Bandoroff and Scherer (1994)	Adolescents with substance abuse, behavioral problems, poor school performance, and delinquent activity and their parents	66 (27 participating and 39 non-participating families in family therapy component, 65% male, 35% female, 90% White)	13–18	USA	One group repeated measures (pre, post, 6 week post treatment) with comparison group of nonparticipating families	21-day (3-week) wilderness therapy program followed by 4-day wilderness family therapy program	Overall program satisfaction, family functioning, delinquency, problem behavior, self-concept	At post-test and 6-weeks post, family functioning moved from clinical to within normal range; ratings of delinquency and problem behavior decreased; and self concept improved for both groups
Berman and Anton (1988)	Adolescents in acute psychiatric hospitals with symptoms of impulsive, acting out behaviors, or withdrawn, inhibited behaviors; two groups of youth appropriate for wilderness therapy and experimental group with more severe difficulties	14 (57% male, 43% female)	13–17	USA	One group pre-post test plus some measures at discharge from hospital	1 backpacking trip of 7 or 9 days into wilderness areas	Behavioral, mental well-being, locus of control	Improvement in locus of control, treatment plan objectives, peer interaction, behavior, and mental health indicators noted across measures, particularly for youth not engaging in aggressive or highly distractible behaviors
Bettmann et al. (2017)	Young adults with mental health, substances use disorder, and multiple diagnoses	157 (65% male, 35% female, 95% White)	18–28	USA	One group pre-post test	8-week wilderness therapy program, average of 63.5 days, range of 28–106 days	Attachment, global mental health functioning, psychological individuation	Improvements across almost all measures related to mental health, attachment with parents, interpersonal relationships, and symptom distress with medium to large effect sizes; many improvements clinically significant

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Bettmann et al. (2013)	Adolescents with substance use disorders, mental health, and behavioral diagnoses	41 (34% male, 66% female, 82% White)	Average: 15.8	USA	One group repeated measures (pre-post test and 6 month post treatment)	8-week wilderness therapy program with strong family component	Intrapersonal distress, somatic distress, interpersonal relations, critical items, social problems, behavioral dysfunction	Improvement in psychological, social, and behavioral functioning with medium to large effect sizes; gains maintained or improved at 6-month follow up social functioning; reduction in symptoms
Bettmann and Tucker (2011)	Adolescents with oppositional defiant disorder, depression, substance use disorder, attention-deficit /hyperactivity disorder, anxiety	96 (62% male, 38% female, 90% White, 3% Hispanic, 2% Native American, 1% Asian, 4% Other)	14–17	USA	One group pre-post test	7-week wilderness therapy program including family component	Attachment	Study examined attachment to parents and peers; mixed findings related to attachment to parents; differences noted by age and diagnosis
Clark et al. (2004)	Adolescents with severe mental health and behavioral problems comparable to those in psychiatric hospitals	109 (62% male, 38% female)	13–18	USA	One group pre-post test (youth pre and post treatment; parents pre and 2 months after treatment)	21-day (3 week) wilderness therapy program	Defense styles, personality patterns, expressed concerns, clinical syndromes, behavior	Treatment had impacts on all dysfunctional personality patterns and clinical syndromes scales, many with medium to large effects
Combs et al. (2016)	Adolescents with significant levels of emotional and behavioral dysfunction, especially mood, substance abuse, and anxiety disorders	659 (71% male, 29% female)	Average: 16	USA	One group repeated measures (pre, weeks 3 and 5, and post treatment and at 6 and 18 month post-treatment)	7-week wilderness therapy program	Interpersonal distress, somatic symptoms, interpersonal relations, critical items, social problems, and behavioral dysfunction	Youth made improvements throughout treatment and were discharged at normal level of functioning on measures of psychological, social, and behavioral functioning; improvements maintained at 6 and 18 months; some differences noted by gender

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Davis-Berman and Berman (1989)	Adolescents in outpatient mental health counseling, with family, relationship problems, depression, anger and impulse control difficulties	23 (65% male, 35% female)	13–18	USA	One group pre-post test	1.5–2 week backpacking trip	Locus of control, self-efficacy, self-esteem, behavior symptoms	Improvements in all outcome measures
Gabrielsen et al. (2019b)	Adolescents in specialized mental health care program with severe mental health concerns including social anxiety, depression, behavioral disorders, adjustment disorders and fatigue	33 (30% male, 70% female)	16–18	Norway	One group repeated measures (data collected each day of final 6–7 day trip)	Half day, full day, and 3–7 day trips for a total of either 12 or 18 days of wilderness trips	State anxiety	Decrease in state anxiety for majority of participants with medium effect size; as demands of program increased, anxiety levels remained stable
Gillespie and Allen-Craig (2009)	Adolescents experiencing psychosocial and family difficulties and at risk of significant mental health problems	19 (100% male)	14–16	Australia	One group repeated measures (pre, post and during the program)	5-week program that included simple pioneer living, community involvement, activities, and a 10-day wilderness experience followed by 2-year mentoring program	Resilience	Participants' resilience and 6 of 10 protective factors increased with moderate to large effect sizes

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Harper et al. (2007)	Adolescents with emotional, behavioral, and substance abuse problems and parents	221 (62% male, 38% female, 92% White) and 124 parents	13–18	USA	One group repeated measures (pre, 2 months post, and 12 months post)	21-day wilderness therapy program	Family functioning, behavior, mental health, school success, social engagement	Improvements in behavior, mental health, social engagement, and school performance; some decreases in family functioning particularly from pre to 2 months post; medium to large effect sizes; most changes maintained at 12 months; some gender differences
Hoag et al. (2013)	Young adults with substance abuse, mood, and other personal difficulties	297 (73% male, 27% female, 88% White)	18–34	USA	One group repeated measures (pre, weeks 3, 5, and post, with 6 and 12 month follow-up)	Wilderness therapy program of at least 5 weeks; average of 9.8 weeks	Subjective discomfort, interpersonal relationships, social role performance, life skills, cognitive distortions	Improvements in mood, interpersonal relationships, social and life skills, and behavioral difficulties from intake to discharge and throughout the program; large effect sizes
Johnson et al. (2020)	Adolescents with trauma and stressor-related disorders, reactive attachment, depressive, and anxiety disorders; substance use; or disruptive behavior	816 (69.2% White, 5.0% African American, 7.6% Asian, 8.6% Hispanic/ Latinx, 1.0% Native American, 8.6% other) and 189 caregivers	13–17	USA	One group repeated measures (pre-post, 6 month and 1 year post-treatment)	Trauma-informed wilderness therapy program 10–12 weeks, average of 80 days	Psychological functioning, family functioning, Psychophysiological functioning	Improvements in family functioning and psychological functioning with large effect sizes at discharge; mixed results at 6 and 12 months; improvement in psychophysiological functioning pre to post with small to moderate effect size

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Margalit and Ben-Ari (2014)	Adolescents from low-income families experiencing behavior, social educational difficulties	93 (100% male, in boarding school for 1.5 years)	14–16	Israel	Non-randomized repeated measures design with 3 groups: full program, partial program, and control group (pre, post, and 5 month follow up)	12 group sessions that included 10 prep sessions on outdoor skills, a 4-day backpacking trip, and 2 closure meetings (full program) or participation in prep sessions only (partial program)	Cognitive autonomy, self-efficacy	Improvements in cognitive autonomy and self-efficacy compared to controls; gains persisted at 5 months
Paquette and Vitaro (2014)	Adolescents and young adults on probation or ordered to do community service work	220 (87% male, 13% female)	16–30 (majority under 25 years of age)	UK	One group repeated measures (pre-post 3 and 6 months after treatment)	Wilderness therapy program of either 8–10 days or 17–20 days	Antisociality, interpersonal skills, accomplishment motivation, socio-professional status	Improvements in behavior and socio-professional status (employment, school attendance, or volunteering), interpersonal skills with larger effect size for longer program. Gains maintained or improved 3–6 months post treatment; improvements in interpersonal skills and achievement motivation from pre to post with larger effect size for longer program
Roberts et al. (2017)	Young adults with mood disorders, substance use disorder, anxiety disorder, pervasive development, behavior and attachment disorders	186 (82% male, 18% female)	18–32 (majority 18–23)	USA	One group repeated measures (pre, weeks 3 and 5 during the program, post, and 6 and 18 months post-treatment)	Outdoor behavioral health program between 5 and 22 weeks with an average of 10 weeks	Psychosocial functioning, symptom distress, interpersonal relationships, social role performance	Improvements in overall psychosocial functioning, symptom distress, interpersonal relationships, and social role performance from pre to post with gains maintained at 6 and 18 months post-treatment

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Russell (2003)	Adolescents with a variety of disorders including oppositional defiant, substance use, and depression	523 (69% male, 31% female), 372 parents	16–18	USA	One group repeated measures (pre, post, and 12-month post treatment)	7 outdoor behavioral health programs 3 weeks, 6 weeks, 8 weeks, or 24 weeks; average of 45 days	Interpersonal distress, somatic symptoms, interpersonal relations, critical items, social problems, and behavioral dysfunction	Improvements in psychological, social, and behavioral functioning; outcomes maintained or improved at 12 months; improvements across all groups and treatment lengths particularly for longer treatment program; some differences based on age of youth
Tucker et al. (2016)	Adolescents with mental health, substance abuse, and behavioral disorders	516 (70% male, 30% female, 79% White, 7% Hispanic, 2% Asian, 1% African American, 1% Native American, 10% Other)	13–18	USA	One group pre-post test	Wilderness therapy program average of 79.8 days	Interpersonal distress, somatic symptoms, interpersonal relations, critical items, social problems, and behavioral dysfunction, body mass index	Improvements in healthy weight, body mass, and psychological, social, and behavioral functioning
Mixed-methods studies								
Gabrielsen et al. (2019a)	Adolescents participating in a specialized mental health care program diagnosed with depression, social anxiety, behavioral disturbance, adjustment disorders, mental fatigue	32 (34% male, 66% female)	16–18	Norway	One group repeated measures (pre-post and 12-month post treatment); participant observation and semi-structured interviews with participants within 6 weeks post treatment or at 12 month follow up	Eight single days and 2 overnight trips of 3 and 6 days within an 8–10-week period	State anxiety	Few changes on numerous mental health measures pre to post but more differences from pre to 12 months follow up. Participants reported varying degrees of change; benefits were not immediately apparent to participants and may take time to process
Qualitative studies								

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Caulkins et al. (2006)	Adolescents with a range of psychological symptoms including clinical depression, suicidal, received treatment previously	6 (100% female)	15–16	USA	Participant observation, document analysis, and semi-structured interviews with participants and staff shortly before end of program	6–12-week wilderness therapy program	General impacts (reflection, perceived competence, accomplishment), substantive impacts (self-efficacy, awareness, timelessness)	Study examined impacts of backpacking component which included reflection, perceived competence, sense of accomplishment, and an increase in self-efficacy, and awareness of self, others, and surroundings
Conlon et al. (2018)	Adolescents in foster care and referred from the care system, immediate residential care, or mental health professionals and not experiencing substance abuse problems	11 (90% male, 10% female)	12.7–18.4	Ireland	Semi-structured interviews with participants at end of program	Wilderness experiences incorporated into other therapeutic programming; 1 full day per week of outdoor activities and overnight camping trips every other week; participation ranged from 3 days to 10 months with an average of 5.3 months	Social skills, self development, anger management, trust, life changes	Participants reported increases in social skills, self-esteem, self-efficacy, anger management, and more positive world views
Fernee et al. (2020)	Adolescents with mental health diagnoses that included anxiety, depression, post-traumatic stress disorder, and chronic fatigue and had one or more adverse childhood experiences	10 (60% female, 40% male)	16–18	Norway	Semi-structured interviews with participants 12 months post treatment	10-week program that included 8 single day and two overnight trips of 3 and 6 days duration incorporated into hospital outpatient mental health program	Mood, emotional regulation, self-acceptance, self-confidence, and social interaction	Participants continued to use nature as a remedy and reported improvements in mood, emotional regulation, self-acceptance, self-confidence, and social interaction

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Harper et al. (2019)	Adolescents in residential treatment with addictive behavior, mental health issues, and behavioral difficulties	148 (67% male, 33% female)	13–19	Canada	Analysis of written surveys completed by participants after wilderness experience	Wilderness therapy component of 6–9 weeks followed by 8 months in residential treatment program	Psychosocial skills, hard skills, self-efficacy, perspective, self-esteem, Physical and mental improvements	Youth perceived improvement in psychosocial well-being, communication, leadership, emotional regulation, physical health, sobriety, outdoor skills, and increases in self-esteem and self-efficacy
Lambie et al. (2000)	Adolescents who had committed sexual offenses	14 (100% male) and 12 parents	13–19	New Zealand	Semi-structured interviews after completion of program with participants and parents; examination of child protective service records	1–2 year community treatment program with 3 wilderness experiences of 10 days total throughout the program; family therapy and follow up therapy for up to 18 months post treatment	Social relationships; empathy; cognitive distortions, safety plans, coping with high-risk situations, offending cycle behavior, perceived level of risk, intimacy, sexual relationships	Youth reported the ability to avoid high-risk situations, taking responsibility for behavior, victim empathy, appropriate social relationships, and improvement in self-esteem; none had reoffended two years post-treatment
Liermann and Norton (2016)	Adolescents with poor family relationships and high-risk behaviors	9 (primarily White)	Not provided	USA	Pre and post questionnaires (1 month prior and 1 week and 6 months post treatment) and telephone interviews with parents 3 months post treatment	28-day wilderness program and 3-day parent/guardian seminar at the end	Communication, trust, course components	Reported improvement in family relationships, communication, and trust
McIver et al. (2018)	Young adults recovering from significant mental health conditions	19 and 9 staff members (58% female, 42% male)	18–25	Australia	Semi-structured interviews with participants and staff 10 days after final session	9–11 wilderness program sessions including 3-day trip for youth in 12-month residential treatment and community program	Relationship to staff, self, nature, peers	Youth reported an increased awareness of self and peers, self-confidence, self-esteem, healthier behaviors

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Pryor et al. (2006)	Young adults in a drug treatment intervention program and who had experienced adverse childhood events, self-harm, and mental health difficulties	7 (100% female)	17–24	Australia	Semi-structured interviews with participants pre and post wilderness trip, and at end of 6-week program	6-week program with 12-day wilderness trip	Contextual issues, physical health, drug/alcohol misuse, mental health, social connection, economic participation	Participants reported improvements in physical and mental health, social relationships, social skills, economic participation, more positive body image, greater resiliency, less risk taking, less drug and alcohol abuse and better stability of treatment; better management of mental health symptoms
Russell (2000)	Adolescents with substance use dependency and mental health disorders	4 (100% male) and their parents	Not provided	USA	Client case studies consisting of participant observation, interviews and focus groups with staff, interviews with participants immediately after treatment and interviews with participants and parents at 4 months post treatment	4 different wilderness therapy programs ranging from 21–52 days	Family relationships, abstinence, academic achievements	Participants reported better relationships with family, abstinence from alcohol and drugs, and desire to complete school; Some relapse was noted at 4 months
Russell (2005)	Adolescents with a variety of disorders including oppositional defiant, substance use, and depression	47 (67% male, 33% female) and 88 parents	16–18	USA	Semi-structured interviews with participants and parents 24 months post treatment	7 outdoor behavioral health programs 3 weeks, 6, weeks, 8 weeks, or 180 days; average of 45 days	Well-being, program effectiveness, family communication, school	Almost all felt the program was effective; the majority of youth were doing well but had transitional difficulties post-treatment especially with friends and substance abuse

(*Continued*)

Table 1. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Russell and Phillips-Miller (2002)	Adolescents with severe behavioral problems	12 and parents and staff	13–17	USA	Client case studies consisting of participant observation and interviews post-treatment	4 wilderness therapy programs, average of 38 days	Relationships with counselors, peer dynamic, facilitated reflection on life, challenge and structure of process, behavioral awareness, abstinence, becoming better person	Participants reported program was effective in helping to motivate behavioral change, desire to abstain from substance use, and self-improvement; increase in self-confidence and self esteem
Somervell and Lambie (2009)	Adolescents from various cultural backgrounds who have committed sexual offenses and were living with family/whānau, in foster care, or in residential treatment	7 (100% male) and 4 therapists	13–18	Not provided	Participant observation, semi-structured interviews	Wilderness therapy experience of 4–6 days on 2–3 occasions incorporated into 12–24-month community-based sexual offender program	Enhanced relationships, view of self, intensity of the experience, disclosure	Participants reported enhanced relationships with peers and a more positive view of self

programs (N = 3, Gillespie and Allen-Craig 2009; McIver et al. 2018; Harper et al. 2019), outpatient counseling (N = 1, Davis-Berman and Berman 1989), boarding schools (N = 1, Margalit and Ben-Ari 2014), or foster care, community-based treatment programs or other types of therapeutic care (N = 3, Lambie et al. 2000; Somervell and Lambie 2009; Conlon et al. 2018). These experiences lasted a total of four to 20 days over an extended period of time.

The 18 original quantitative (Table 1) and one original mixed methods studies (Gabrielsen et al. 2019a) used well-established measures and repeated measures designs to assess psychological, social, and behavioral functioning from pre to post treatment, as well as family functioning (N = 5, Bandoroff and Scherer 1994; Russell 2000, 2005; Harper et al. 2007; Johnson et al. 2020), attachment to parents (N = 2, Bettmann and Tucker 2011; Bettmann et al. 2017) and body mass index and weight (N = 1, Tucker et al. 2016). Measures such as the Youth Outcome Questionnaire or Youth Outcome Questionnaire-Self Report (Burlingame et al. 2004) have indicators of clinical significance that allow for differentiating clinical and non-clinical samples. Thus, clinical as well as statistical significance was often reported.

Overall, positive change was indicated across studies on a broad range of measures from pre to post treatment that included symptom distress, self-esteem, self-efficacy, locus of control, problem behaviors, substance use, social interaction, school attendance, recidivism, and other psychosocial and well-being indicators, often with medium to large effect sizes (Table 1). Additionally, positive change was maintained upon completion of treatment to later follow up periods ranging from six weeks to 18 months later (N = 12, Bandoroff and Scherer 1994; Russell 2003; Clark et al. 2004; Harper et al. 2007; Bettmann et al. 2013; Hoag et al. 2013; Margalit and Ben-Ari 2014; Paquette and Vitaro 2014; Combs et al. 2016; Roberts et al. 2017; Gabrielsen et al. 2019a; Johnson et al. 2020). Change was often noted by *t*-tests with more recent use of regression analysis and hierarchical linear modeling (Paquette and Vitaro 2014; Combs et al. 2016; Bettmann et al. 2017; Roberts et al. 2017; Johnson et al. 2020). Some studies included analyses by gender, age, or diagnosis with mixed program impact findings based on subgroup (Berman and Anton 1988; Russell 2003; Harper et al. 2007; Bettmann and Tucker 2011; Combs et al. 2016). Findings were also mixed on measures of family functioning or attachment to parents (Harper et al. 2007; Bettmann and Tucker 2011).

The 12 qualitative studies (Table 1) all utilized interviews with participants with the exception of one study that analyzed open-ended survey responses (Harper et al. 2019) and one study that interviewed parents only (Liermann and Norton 2016). Additionally, five studies used participant observation, focus groups, and document analysis along with interviews (Lambie et al. 2000; Russell 2000; Russell and Phillips-Miller 2002; Caulkins et al. 2006; Somervell and Lambie 2009). These methods were used to gain greater insights into the treatment process, including beneficial components, allowing youth a greater voice in outcomes assessment, and gaining multiple perspectives from youth, parents, and staff. Four studies included interviews with parents (Lambie et al. 2000; Russell 2000, 2005; Liermann and Norton 2016) and three studies included interviews with staff (Russell 2000; Caulkins et al. 2006; McIver et al. 2018).

Most interviews were done immediately at post-treatment with five studies conducting interviews at three to 24 months post-treatment (Russell 2000, 2005; Pryor et al. 2006; Liermann and Norton 2016; Fernee et al. 2020). The studies examined impacts from participation in the wilderness therapy program as a whole, although one study specifically examined the family therapy component (Liermann and Norton 2016) and one study examined the backpacking component (Caulkins et al. 2006).

Confirming the quantitative studies, the qualitative research noted positive impacts on a range of psychological, social, and behavioral outcomes, as well as relationships with parents and peers. Most gains were maintained post treatment. Going beyond the insights gained from quantitative studies, two qualitative studies, and the qualitative component of the mixed methods study (Gabrielsen et al. 2019a) noted transition difficulties after treatment and youth needing more time to process the changes that occurred through treatment (Russell 2000, 2005). Also unique to qualitative research,

most of these studies included discussion of key components of wilderness therapy that contributed to positive outcomes, such as the role of nature, peer and staff relationships, being in a new environment, physical rigors, and other challenges.

Studies on animal-assisted interventions

Animal-assisted interventions represent a broad category of structured interventions that include or incorporate animals in health, education and human services with the goal of reaching therapeutic gains in humans (IAHAIO 2018). Animal-assistant interventions are aimed at improving behavioral, social, emotional, cognitive or physical functioning and typically include defined goals and measured outcomes (Maber-Aleksandrowicz et al. 2016). Of the 37 studies on animal-assisted therapy, 29 are original intervention studies with 15 quantitative, five mixed-methods, and nine qualitative designs (Table 2). An additional eight studies present evidence-synthesis studies, including four systematic reviews (Maber-Aleksandrowicz et al. 2016; Hoagwood et al. 2017; Jones et al. 2019; White et al. 2020), two literature reviews (Lentini and Knox 2015; May et al. 2016), one meta-analysis (Wilkie et al. 2016) and one systematic map (McDaniel Peters and Wood 2017) (Table 5).

The sample ranged from 29 to 138 participants in the 15 original quantitative studies (Table 2); the one meta-analysis examined 377 children and adolescents. The sample of the original mixed methods studies ranged from seven to 28 study participants and the sample size of the qualitative studies ranged from five to 80 children and adolescents. Ages of study participants ranged from two to 22 years of age. Most of the 37 studies on animal-assisted therapy examined male and female participants; four studies focused on males (Mallon 1994; Conniff et al. 2005; Williams and Metz 2014; Boshoff et al. 2015; Hemingway et al. 2015) and three studies focused on female children and adolescents (Conniff et al. 2005; Carlsson et al. 2015; Carlsson 2018; Naste et al. 2018). Overall, the majority of this literature examined youth with mental health difficulties, including several studies that focus on populations with specific conditions, such as autism, post-traumatic stress syndrome, and attention deficit hyperactivity disorder. Many of the 37 studies targeted specific samples, such as children and adolescents in foster care, adolescents living in residential care, incarcerated adolescents, and hospitalized children and adolescents.

The majority of the 37 studies examined equine-facilitated interventions (N = 23), followed by canine-facilitated interventions (N = 11) involving trained therapy dogs and pets or shelter animals. Three studies involved farm animals. The activities consisted of structured sessions offered over period of nine to 12 weeks with weekly sessions between 60 and 180 minutes with few original studies describing interventions with durations longer than three months (N = 3, Burgon 2011, 2013; Bachi et al. 2012). Six evidence-based synthesis studies include interventions longer than three months with the longest being 18 months (Maujean et al. 2013; Kemp et al. 2014; Saggers and Strachan 2016; Tsantefski et al. 2017; Dunlop and Tsantefski 2018). Studies are located primarily in the USA (N = 14), Australia (N = 5, Maujean et al. 2013; Kemp et al. 2014; Saggers and Strachan 2016; Tsantefski et al. 2017; Dunlop and Tsantefski 2018), and European countries (N = 8, Burgon 2011, 2013; Balluerka et al. 2014, 2015; Carlsson et al. 2015; Hemingway et al. 2015; Stefanini et al. 2015, 2016; Muela et al. 2017; Carlsson 2018).

Key findings of the 37 studies addressed psychological, social, and behavioral outcomes. Studies that examined psychological outcomes addressed these at different levels. The literature indicated the associations of animal-assisted interventions with global psychological measures, especially stronger psychological well-being, better internal regulation and cognitive functioning, higher emotional states, fewer emotional problems, and lower levels of post-traumatic stress disorders. With regard to individual differences measures, animal-assisted interventions were associated with several personality measures, including higher levels of self-image, self-control, trust, self-confidence, self-esteem and self-efficacy, as well as measures of life satisfaction, calmness, and

feeling of safety. Additionally, the studies documented the association of animal-assisted interventions with lower levels of mental health disorders, such as irritability, self-stigmatization, anxiety, and depression, as well as better management of emotions, especially anger and fear.

Social outcome measures that were found to be related to animal-assisted interventions included global measures of better overall social functioning and higher levels of social cognition. In addition, the research documented the association of animal-assisted interventions with interpersonal skills in social interaction, including empathy, respect, humor, and patience in treating others. Studies also reported higher engagement, bonding, attachment formation, helping others, and steps toward taking leadership. A number of studies pointed to communication-related outcomes, such as use of communication strategies and better coping with teasing and bullying.

Behavior-related outcome measures that were found to be related to animal-assisted interventions included global constructs of a lower number of negative, disruptive, and difficult behaviors, lesser behavioral dysregulation and hyperactivity. A positive association of animal-assisted interventions and attendance of school and treatment sessions was also reported.

Studies on care farming interventions

Care farming interventions, also described in the literature as social farming or green care farming interventions, are provided primarily through agricultural farms and landscapes. They utilize structured programs of farming-related activities to deliver health, social, and educational services to adolescents and young adults (Sempik and Bragg 2013; Murray et al. 2019). Care farms typically complement traditional social support services. Well established in many European countries (Hassink and Van Dijk 2006; Hassink et al. 2014), adolescent-focused care farming interventions vary markedly based on the type of farming enterprise, farming activities involved, support services provided, service user groups engaged, and other factors (for examples of care farming programs, see Murray et al. 2019). While overlapping in some aspects, the farming component of care farms typically involves a broader range of activities than the more narrowly focused horticultural- and animal-based therapy interventions (Murray et al. 2019), distinguishing care farming interventions and characterizes the related literature.

Four studies in the final dataset investigate adolescent-focused care farming interventions based on our inclusion criteria. Three studies are original research located in Europe (Kogstad et al. 2014; Schreuder et al. 2014; Leck et al. 2015, Table 3). Of those three studies, two studies employed a qualitative, semi-structured interview methodology to retrospectively analyze experiences and observations and semi-structured interviews (Kogstad et al. 2014; Schreuder et al. 2014). The third study used a mixed-method design included 216 baseline and 137 follow-up survey responses as well as 33 semi-structured interviews with a subsample of survey respondents (Leck et al. 2015). Adolescents struggling in mainstream education comprised the principal subpopulation (N = 30). In addition to the three original intervention studies, the fourth study in this sample was a systematic review, which assessed studies based on a logic model that examined the studies' settings, intervention components, mechanisms linked to theoretical concepts, proximal outcomes, and outcomes (Murray et al. 2019, Table 5). Four studies on disaffected adolescents were included in the systematic review, including the above three studies.

The two qualitative studies had nine and 11 study participants (Kogstad et al. 2014; Schreuder et al. 2014), the mixed methods study had 30 study participants (Leck et al. 2015), and the systematic review included studies with a total of 112 children and adolescents (Murray et al. 2019). The care farming interventions with residential programs varied in length from about three months to over a year, where this information is provided.

Key findings across the three original intervention studies point to three main components of successful care farming. The first component is the farm setting, the farmer, and the farming environment that is conducive to recovery. The second effective component is the variety of tasks and the environmental engagement that allow for a gradual increase in adolescents' self-efficacy.

Table 2. Original intervention studies on animal-assisted interventions.

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Quantitative studies								
Bachi et al. (2012)	Adolescents with severe personal and adaptive needs in residential treatment facility	29	14–18	Israel	Controlled trial, pre-post test, one year follow up	Equine-facilitated psychotherapy, weekly sessions (50 min) for 7 months (14–26 sessions in total)	Self-image, self-control, trust, life satisfaction	Data indicate no significant effects but showed trends of positive effects on all outcome measures
Balluerka et al. (2014)	Adolesents with childhood trauma and mental health problems (behavioral, depressive, anxiety disorders) in residential care	46 (30% female, 70% male)	12–17	Spain	Controlled trial, pre-post test	Animal-assisted psychotherapy with dogs and horses at a local farm, additional guided interactions with cats and other farm animals, 2 consequtive days with overnight stay for 12 weeks (34 sessions in total)	Attachment (secure, preoccupied, avoidant, disorganized attachment), family functioning	Data indicate increase in secure attachment and decrease in preoccupied attachment (high effect sizes) but no significant differences in other attachment dimensions
Balluerka et al. (2015)	Adolesents with childhood trauma and mental health problems (behavioral and anxiety disorders) in residential care	63 (38% female, 62% male, 68% from Basque Country, 32% migrants from Northern Africa)	12–17	Spain	Controlled trial, pre-post test	Animal-assisted psychotherapy with dogs and horses at a local farm, additional guided interactions with cats and other farm animals, 2 consequtive days with overnight stay for 12 weeks (34 sessions in total)	Psychosocial adaptation (clinical symptoms, personal adjustment, adaptive skills, and school adjustment)	Data indicate increase in school adjustment and improvement of social skills and leadership, decrease in hyperactive behavior and less attention problems but no significant differences in other clinical symptoms or personal adjustment scores
Boshoff et al. (2015)	Adolesents in treatment at youth care facility for problem behaviour	39 (100% male, 69% Black, 31% White)	14–18	South Africa	Controlled trial, pre-post test	Equine-assisted therapy, 8 sessions in total, no further details reported	Subjective well-being, coping (problem focused, emotion focused, dysfunctional coping)	Data show modest improvements in psychological wellbeing, including improved subjective wellbeing, problem-focused and socio-emotion-focused coping but no effect on dysfunctional coping

(*Continued*)

Table 2. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Gabriels et al. (2015)	Children and adolesents with Autism Spectrum Disorder	116 (87% male, 13% female, 18% Hispanic 79% White, 3% Indigenous, 3% Asian, 1% Black, 10% Multiracial and other)	6–16	USA	Randomized controlled trial, pre-post test	Therapeutic horseback riding, weekly sessions (45 + min) for 10 weeks	Irritability, hyperactivity, social cognition, social communication	Data indicate significant improvements in all measures
Hartwig (2017)	Children and adolesents in treatment at community counseling clinic for grief, loss, anxiety, depression, and self-concept issues	29 (55% female, 45% male; 45% White, 38% Hispanic, 7% African-American, 10% Other)	10–18	USA	Randomized controlled trial, pre-post test	Canine-assisted therapy, weekly sessions (50 min) for 10 weeks (10 sessions in total)	Anxiety, depression, disruptive behavior, self-concept, anger	Data indicate significant decrease in anxiety, depression, and disruptive behavior for both treatment and comparison groups but no significant change in self-concept and anger
Kemp et al. (2014)	Children and adolesents experiencing sexual- and/or physical abuse	30 (80% female, 20% male, 27% Indigenous, 63% Non-indigenous)	8–17	Australia	Controlled trial, pre-post test	Equine facilitated therapy, weekly sessions (90 min) for 9–10 weeks	Trauma symptoms, psychopathology, depression, behavior, anxiety	Data showed improved state of psychological distress and depression for all gender and age groups
Muela et al. (2017)	Adolescents with mental health problems and childhood trauma in residental care	87 (39% female, 41% male)	12–17	Spain	Randomized controlled trial, pre-post test	Equine-facilitated psychotherapy, 34 sessions, no further details provided	Clinical symptoms, personal adjustment, and adaptive skills	Data suggests improvements in depression and sense of inadequacy but improvements in social skills and positive attitides toward teachers were not significant
Mueller and McCullough (2017)	Children and adolesents with post-traumatic stress syndroms	54 (83% male, 17% female)	10–18	USA	Randomized controlled trial, pre-post test	Equine-facilitated psychotherapy, weekly sessions (120 min) for 10 weeks	Intrusion, avoidance, arousal symptoms associated with post-traumatic stress, human-animal bonding	Findings indicate that intervention may be an effective additional treatment modality but not significant more effective than traditional therapeutic services

(*Continued*)

Table 2. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Seivert et al. (2018)	Incarcerated youth with psychological disorders and psychiatric diagnoses	138 (70% male, 30% female; 46% White, 44% Black, 4% Hispanic, 6% Other)	13–18	USA	Randomized controlled trial, pre-post test	Animal-assisted therapy as experiental learning with shelter dogs in detention facility, twice weekly sessions (120 min) for 10 weeks	Internalizing (depression, anxiety, and somatization), externalizing (aggression, conduct problems, and hyperactivity/ impulsivity) behaviors, emphathy	No significant increase in empathy, impact on behavioral problems was inconslusive
Stefanini et al. (2015)	Children and adolesents hospitalized with acute mental disorders	34 (53% male, 47% female)	11–17	Italy	Randomized controlled trial, pre-post test	Animal-assisted therapy with dogs, conducted in hospital garden, weekly sessions (45 min) for 3 months (10 sessions in total)	Global functioning, hospital care format, school attendance, observation of animal-assisted therapy	Results show significant improvements in global functioning, reduction in hospital care format, and increase in school attendance
Stefanini et al. (2016)	Children and adolesents hospitalized with acute mental disorders	40 (45% male, 55% female)	11–17	Italy	Randomized controlled trial, pre-post test	Animal-assisted therapy with dogs, conducted in hospital garden, weekly sessions (45 min) for 3 months (10 sessions in total)	Global functioning, tnternalizing and externalizing behavior	Results indicate decrease in internalizing symptoms and increase in total competence, and improvements in global functioning
Trotter et al. (2008)	Children with high risk for academic and/or social failure	164 (67% male, 33% female, 83% White, 7% African-American, 7% Hispanic, 3% Others)	Grades 3–8	USA	Non-randomized trial, pre-post test	Equine-assisted counselling at a horse ranch, weekly sessions (120 min) for 12 weeks	Global functioning, psychosocial behavior	Results indicate significant improvements, with increases in positive behaviors and decreases in negative behaviors
Trujillo et al. (2020)	Adolesents with psychiatric and substance use disorders	31 (65% male, 35% female, 94% Hispanic, 3% Black, 3% White)	12–17	USA	Quasi-experimental design, pre-post test	Animal-assisted therapy with therapy dogs, weekly sessions for 12 weeks	Treatment participation, clinical outcomes (overall well-being, school engagement), sobriety	Data indicate intervention increased attendance of substance use treatment sessions and overall wellbeing
Tsantefski et al. (2017)	Children exposed to parental substance abuse	41 (58% female, 42% male)	7–13	Australia	Non-randomized trial, pre-post test, survey	Equine-assisted therapy, weekly sessions (120 min) for 12 weeks	Child behavior (prosocial, hyperactivity, conduct disorder, emotional sensitivity, peer problem behaviour)	Data indicate a significant decrease in difficult behaviors, emotional problems, and hyperactivity
Mixed-methods studies								

(*Continued*)

Table 2. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Conniff et al. (2005)	Adolesents with conduct disorders at medium secure residential facility	23 (100% female, 48% White, 35% African American, 17% Other)	13–17	USA	Randomized controlled trial, pre-post test, survey (qualitative)	Unstructured animal-assisted activies (pet visitation program) within residential facility, weekly sessions (60 min) for 8 weeks	Global behavior (anxiety, depression, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, aggressive behavior	No significant differences on behavior or emotional state but positive evaluation of program by participants
Ewing et al. (2007)	Youth with emotional disorders, behavioral conduct disorders, learning disabilities	28	10–13	USA	Pre-post test, case study	Equine-facilitated psychotherapy, twice weekly sessions (120 min) for 9 weeks	Self-esteem, empathy, locus of control, depression, loneliness	Quantitative results indicate no significant effects on self-estem, empathy, internal locus of control, and feelings of depression and loneliness but case studies results indicate positive changes
Hanselman (2001)	Adolescents with emotional, behavioral disorders	7 (100% White)	14–17	USA	Pre-post test, observational study	Pet therapy with dogs, weekly sessions for 12 weeks	State and trait of anger, human-animal bonding, mood, depression	Data indicate significant decrease in state and trait of anger, increase in animal bonding, tension, confusion, anger and depression; observations indicate significant positive behavioral change and acceleration in therapy
Naste et al. (2018)	Youth with complex trauma exposure	3 (100% female)	10–13	USA	Empirically-driven clinical case study (observational study), longitudinal data	Equine-facilitated psychotherapy for complex trauma, varied length of times	Biological regulation, affect regulation, dissociation, behavioral control, cognition, self-concept, attachment, post-traumatic stress symptoms, dysregulation, depression, somatic awareness, alexithymia	Study results indicate evidence of reduced internalizing problems, improved interpersonal skills, communication strategies, and overall social functioning, also improved internal regulation and organization, cognitive functioning, development of positive coping skills

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Table 2. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Perkins (2018)	Adolesents in foster care, living in a group home	7 (86% female, 14% male; 86% White, 14% African-American)	No information provided	USA	Pre-post test, observational data	Equine-assisted learning, weekly sessions (45 min) for 8 weeks	Engagement, confidence, respect, communication, work ethic	Results suggests improvements in emotional regulation, communication, confidence, and respect, indicating intervention contributes to development of specific life skills
Qualitative studies								
Burgon (2011, 2013)	Adolesents and young adults displaying complex social, emotional, and behavioural coping strategies, including attention deficit, hyperactivity, autistic spectrum diagnosis	7	11–21	UK	Ethnographic case study, semi-structured and unstructured open interviews	Equine-assisted therapy and learning, participants enroll into program for periods up to 2 years with weekly or bi-weekly sessions	Confidence and self-esteem, sense of mastery and self-efficacy, empathy, opportunities	Results indicate psychosocial benefits, including improvements in confidence, self-esteem, self-efficacy, emphathy, and opening of positive opportunities
Carlsson et al. (2015); Carlsson (2018)	Adolesents and young adults in residential care, self-harming	9 (100% female)	15–21	Sweden	Observational case study, semi-structured interviews	Equine-assisted social work, weekly sessions (40–90 min), no further details provided	Doing & performing and being & feeling with the horse as an object/subject	Data suggests positive effects in countering self-stigmatisation and lowering barriers to change
Dunlop and Tsantefski (2018)	Children experiencing problematic parental substance use and adverse family events	33 (55% female, 45% male)	7–13	Australia	Semi-structured interviews at conclusion of program	Equine-assisted group therapy, weekly sessions (120 min) for 9 weeks	Safety and security, personal and social development	Results suggests that participants experience a sense of safety, feeling understood, and having a sense of the horses' behaviour as predictable and therefore manageable; participants also reported developing mastery over fears, feeling good about their new ways of treating others.
Hemingway et al. (2015)	Young adults incarcerated with disruptive behavior and disengaged	20 (100% male)	18–21	UK	Semi-structured interviews, observational study (start and end sessions)	Equine-facilitated learning, 7 sessions (150 min) over a 4-day period	Calm assertivness, confidence, focus, practicality, facilitation	Results indicate that participants felt that they developed and increased confidence, control of body language, and communication with horses

(*Continued*)

Table 2. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention	Outcome measures	Results
Lange et al. (2007)	Adolescents participaing in anger management group	5	13–16	USA	Explorative study, semi-structured interviews	Animal-assisted therarpy with a dog, no further details provided	Calming, humor relief, safety, empathy	Results indicate beneficial effects, including calming state, humor relief, feelings of safety, experiencing empathy, and motivation to complete program
Mallon (1994)	Children and adolesents with behavioral, emotional and academic difficulties in residental treatment center (farm)	80 (mostly male)	7–16	USA	Exploratory study	Animal-assisted therarpy with farm animals	Healing and therapetic effects, animals as metapher, comfort/ nurturing responses, communication, abuse/ aggression	Results indicate that intervention has positive impact on behavioral and emotional state
Maujean et al. (2013)	Disengaged children and adolescents	16 (69% male, 31% female)	12–22	Australia	Pilot study, semi-structured interviews, pre-post	Equine-facilitated psychotherapy, weekly sessions for 10 weeks	Enjoyment, psychological and social benefits, engagement, transferable skills, mechanisms of change	Results indicate positive improvements in psychosocial outcomes, including developing of life skills, confidence and engagement, suggesting that treatment may provide alternative to traditional interventions
Saggers and Strachan (2016)	Primary school students at risk of school failure	11 (55% female, 45% male)	10–13	Australia	Explorative study, semi-structured interviews, pre-post	Equine-facilitated social-emotional learning, weekly sessions for 8 weeks	Horsemanship, developing resilience	Results suggests positive impact on improving social-emotional wellbeing and developing resilience, including gaining confidence, developing communication skills, coping with teasing and bullying, learning to relax and manage stress, and developing attending skills and task perseverance
Williams and Metz (2014)	Adolescents in residential care	5 (100% male)	15–17	USA	Photovoice study, semi-structured interviews and focus groups	Animal-assistant intervention involving training rescue dogs, twice-weekly (120 min) seesions for 12 weeks	Gaining patience, attachment, wanting to better themselves, helping others, teaching, relating to the animal	Results suggest possible therapeutic benefits; six themes emerged, inlcuding gaining patience, forming an attachment, wanting to better themselves, helping others, teaching, and relating to the animal

Experiences with farm animals provide comfort for adolescents lacking trust in people and life in nature to recover a positive sense of self. The role of routine in farming provides structure to the recovery of adolescents. Third, successful interventions provide opportunity for personal development and the development of social interactions to improve physical and mental health and well-being. The systematic review pointed specifically to the findings that care farming increased the quality of life and decreased depression and anxiety for disaffected youth (Murray et al. 2019). The three original studies and the single evidence-synthesis study indicate weak associations between mechanism and outcomes and point to the need for robust analysis of the pathways through which care farming interventions affect the proposed outcomes.

Studies on gardening and horticulture-based interventions

Gardening and horticulture-based interventions examine whether programs that teach gardening and horticulture skills, for example, how to grow and maintain a community garden, are associated with youth's mental, psychological, and behavioral health. We identified six studies, including five original intervention studies (Table 4) and one literature review (Table 5). Three of the original studies used mixed-method approaches (Twill et al. 2011; Sonti et al. 2016; Chiumento et al. 2018) and two used qualitative designs (Allen et al. 2008; Delia and Krasny 2018). The sample sizes in the mixed-methods studies ranged from nine to 50 study participants. The samples in these studies included males and females, where reported. The ages ranged from six to 25 years, with four of the studies focusing on specific age groups, including age ranges of up to seven years. The single evidence-synthesis study was a literature review that summarized 133 studies, but did not list sample sizes of the individual studies; demographic information is provided in summary statistics (Park et al. 2016, Table 5).

All interventions were based on community gardening, including specializations such as urban farming (N = 2, Allen et al. 2008; Delia and Krasny 2018), school gardening (N = 1, Chiumento et al. 2018), neighborhood beautification (N = 1, Allen et al. 2008), and gardening in juvenile rehabilitation (N = 1, Twill et al. 2011). The literature review study further identified interventions that included indoor planting, craft-making, and flower arrangements (Park et al. 2016). The interventions ranged from three to nine months, typically spanning the growing season; intervention hours were not reported.

The three mixed-methods studies provided mixed findings about the role of horticulture-based interventions for youth mental health (Twill et al. 2011; Sonti et al. 2016; Chiumento et al. 2018). For example, one set of findings did not support a relationship between the intervention and self-concept, emotional, and behavioral management (Twill et al. 2011). Another set of findings pointed to positive associations with food, health, and environmental behaviors (short-term) and communication and decision-making skills (longer-term) (Sonti et al. 2016). One study did not provide statistical analysis (Chiumento et al. 2018). The two qualitative studies emphasized the association of horticulture-based interventions with social and leadership skills (Allen et al. 2008; Delia and Krasny 2018), thus providing additional perspective to the empirical findings. Finally, the literature review indicated that the relationship of intervention and outcome is dependent on the type of mental disorder of the targeted youth (Park et al. 2016).

Discussion

This study contributes a summary of the literature for the specific population of vulnerable youth experiencing mental, emotional, developmental, behavioral, or social difficulties across four types of nature-related interventions: wilderness-therapy interventions, animal-assisted interventions, care-farming interventions, and gardening and horticulture-based interventions. The literature includes quantitative, qualitative and mixed-methods study designs, with the majority being quantitative studies. Commonly used methodological approaches are repeated measures, control or comparison

Table 3. Original intervention studies on care farming.

Reference	Population	Participants	Age	Country	Study design	Intervention duration	Outcome measure	Key findings
Mixed-methods studies								
Leck et al. (2015)	Adolescents struggling in mainstream education	30 (14% of total sample)	No information provided	UK	Survey of standardized health and wellbeing measures, semi-structured interviews	Care farming, adolescents working at 13 different farm enterprises, varied length of stay (<3 months to >1 year), clients worked 1 day, 2 days or 5 days per week	Positive experience, personal development, environmental engagement, social interaction, physical health and well-being, mental health and well-being	Results indicate that intervention had positive effects on farm experience, personal development, environmental engagement, development of social interactions, improved physical and mental health and well-being; effects were positively associated with duration of intervention
Qualitative studies								
Kogstad et al. (2014)	Young adults at-risk for school-dropouts, substance-abuse, self-destructive behavior	9	17–27	Norway	Observational study, semi-structured interviews, 2–4 interviews, conducted over 2-year period	Care farming, adolescents working full-time at 3 mixed-farm enterprises offering employment scheme, duration not reported	Leader and the group atmosphere, building of self-efficacy through individually-adapted meaningful tasks, animals and nature	Data indicate that intervention can be considered supplemental; effective factors were supportive group atmosphere, diversity of tasks increasing self-efficacy, farm animals providing comfort, nature helping recovering a positive sense of self
Schreuder et al. (2014)	Young adults with severe social and mental health problems	11 (82% male; 18% female)	17–22	The Netherlands	Semi-structured interviews	Care farming as experiential outdoor education, 6 months stay	Comprehensibility, manageability, meaningfulness	Results showed that richness and diversity of the farm setting was conducive to learning: factors were ease of comprehending farm environment, ability to manage resources, and a high level of meaning assigned to farm environment

Table 4. Original intervention studies on gardening and horticultural therapy interventions.

Reference	Population	Participants	Age	Country	Study design	Intervention duration	Outcome measures	Key findings
Mixed-methods studies								
Chiumento et al. (2018)	Children with behavioral, emotional and social difficulties	32 (61% male, 67%)	9–14	UK	Qualitative assessment via a mental wellbeing impact Assessment toolkit; quantitative pre-post evaluation	2-hour session per month, for 6 months; social and therapeutic horticulture to explore the natural environment	Mental well-being (enhancing control, increasing resilience and community assets, participation and social inclusion)	Quantitative results scores worsened post intervention for 5 of 7 items (statistical means difference tests not calculated), qualitative results indicate higher scores for emotioal wellbeing and self-help
Sonti et al. (2016)	Young adults enrolled in urban farming youth internship program	50 (58% female, 42% male, 56% Black, 20% mixed race, 16% Latino, 8% Asian)	18–25	USA	Online and mailed survey with closed and open-ended questions, conducted 1 years after completion of intervention	Internship of 3 to 9 months with training and work at urban farm, community and backyard gardens; 5 to 25 hrs./week	Environment, self, communication, decision-making, community, learning experiences, perceived benefits	Regression results indicate association of curriculum with food, health, and environmental behaviors; and longer program participation with communication and decision-making skills Qualitative responses indicate learning by at least 50% of respondents in gardening/ food and communication/ social skills
Twill et al. (2011)	Adolescents in juvenile rehabilitation center	19 (79% male, 21% female, 79% White, 5% African-American, 16% other)	13–17	USA	Two semi-structured interviews at week 8 and week 17 of the intervention	Limited detail on intervention; focused on landscaping and horticulture activities; duration during growing season	Positive self-concept, emotional and behavioral management	Quantitative evaluations were similar in first and second interview; responses to open-ended questions indicate positive self-concept, emotional and behavioral management
Qualitative studies								

(*Continued*)

Table 4. (Continued).

Reference	Population	Participants	Age	Country	Study design	Intervention duration	Outcome measures	Key findings
Allen et al. (2008)	Children and adolescents in neighborhood-based community garden program	16 (100% African-American)	6–16	USA	Case studies including observations, photography, semi-structured interviews	Work in community gardens, including clearing lots, removing trash, planting, weeding, watering, harvesting, mowing lawns and planting flowers in the neighborhood, street cleaning; about 9-month duration from growing season to the end of the year	Constructive activity, community contributions, relationships/ interpersonal skills, social control, cognitive and behavioral competencies	Work was perceived as constructive activity, positive contribution to community, relationship and interpersonal skills, informal social control, cognitive and behavioral competencies, nutrition knowledge
Delia and Krasny (2018)	Adolescents from under-resourced communities	9 (88% female, 22% male, White, African and African-American; Hispanic)	15–18	USA	One-on-one interviews; appreciative inquiry process	Internship program at urban farm including growing and selling food, environmental education, and team leadership; about 9-month duration from March to November	Belonging, expectations, complexity, leadership practice, becoming self	Results indicate that intervention contributes to positive youth development, authentic career settings, critical consciousness and leadership, change agents

Table 5. Evidence-synthesis studies.

Reference	Intervention	Study type	Number of studies	Age	Intervention details	Outcome measures	Results
Wilderness therapy interventions							
Bettmann et al. (2016)	Wilderness therapy	Meta-analysis	36[a]	Average 17.4	2399 private-pay adolescents receiving treatment, 1982–2004, 1 week to 2 years of treatment, average of 7.04 weeks	Self-esteem, locus of control, behavioral observations, personal effectiveness, clinical measures, and interpersonal measures	Improvements across all areas, medium effect sizes
Fernee et al. (2017)	Wilderness therapy programs	Qualitative review study (realist synthesis)	7[b]	12–18	102 adolescents receiving treatment, 2000–2014, 10 days to 1 year	Wilderness therapy outcomes and processes related to psychosocial outcomes	Positive impacts including increase in self-confidence, self-esteem, and self-awareness; sense of accomplishment, social skills, and trust; emotional control; desire to change including finishing school and improving relationships with family; few or no negative findings noted
Gillis et al. (2016)	Wilderness therapy (residential, inpatient, and outpatient programs)	Meta-analysis	21[c]	Average 15.62	1458 participants, 1998–2013, average age 14.34 years	Interpersonal distress, somatic symptoms, interpersonal relations, critical items, social problems, and behavioral dysfunction	Large effect sizes for treatment outcomes; effect sizes higher for Y-OQ in wilderness programs and lower for Y-OQ-SR in non-wilderness therapy programs
Harper (2017)	Wilderness therapy, therapeutic camping, and adventure education	Scoping review	63[d]	Not provided	January 1997-March 2017 (20 years)	Wilderness and adventure therapy, therapeutic camping, adventure education & physical activity	Strong support for wilderness therapy as a treatment for youth with mental health and behavioral issues
Animal-assisted interventions							
Hoagwood et al. (2017)	Animal-assistet therapy	Systematic review	24[e]	3–20	1,308 children and adolescents with mental health problems ages 3–20 years, weekly sessions (10–180 min) for 8–26 weeks	Emotional and behavioral issues, trauma and post traumatic stress disorder, autism spectrum disorder, attention deficit hyperactivity disorder	Results indicate that animal assistat therapies can provide a complementary and integrative approach; scientific evidence base is limited but growing

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Table 5. (Continued).

Reference	Intervention	Study type	Number of studies	Age	Intervention details	Outcome measures	Results
Jones et al. (2019)	Canine-assisted psychotherapy	Systematic review	7[f]	10–19	134 adolescents with mental health problems, weekly sessions (45–180 min) for 10–12 weeks	Post-traumatic stress disorder, depression, anxiety and internalising problems, anger and externalising problems, Engagement, socialisation & connection	Results indicate positive impacts for internalising disorders, post-traumatic stress disorders and equivalents effects for anxiery, anger, and externalising disorders; also positive impact on engagement and socialization behaviors and reductions in disruptive behaviors within treatment sessions
Lentini and Knox (2015)	Equine-assisted psychotherapy	Literature review	66[g]	3–22	672+ at-risk children and adolecents receiving mental health treatments, mostly weekly sessions (30–120 min) for 3–12 months	Quantitative review (at-risk youth, autism spectrum disorder), qualitative review, conceptional and theoretical review	Results indicate that evidence base for equine-assisted psychotherapy for children and adolescents is increasing, particular for at-risk youth with ASD, overall positive effects for assessed constructs
Maber-Aleksandrowicz et al. (2016)	Animal-assisted therapy	Systematic review	10	6–19	Most (= 9) studies targeting mostly male children and adolescents ages with intellectual disabilities, mostly weekly sessions (20–240 min) for 2–18 months	Social, cognitive, emotional, behavior outcomes	Positive improvement reported from studies for all assessed psychosocial outcomes but only some reaching statistical significance
May et al. (2016)	Animal-assisted therapy	Literature review focusing on empirical methodology	45[h]		1,694 youth with physical and mental health concerns, age not reported, 1–116 sessions	Study design, procedures, assessment and measures, outcome analysis	Data indicate that research on animal-assisted therapy is guided by principles of evidence-based practices (study quality average: 1.04/2.00); study quality is found to be moderately and positively correlated with study date

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Table 5. (Continued).

Reference	Intervention	Study type	Number of studies	Age	Intervention details	Outcome measures	Results
McDaniel Peters and Wood (2017)	Equine-assisted interventions	Systematic map	33[(i)]	2–16	633 children and adolescents with Autism spectrum disorder, 1–30 weeks (15–120 min), 1–40 sessions in total	autism spectrum, post-traumatic stress and attention deficit disorder, equine-assisted interventions characteristics and components, therapeutic goals and measured outcomes, state of scientific development	Data indicate improvements in behavior, social interaction, communication, motor control and self-care, 45% of outcomes were statistically significant, 22% positive, 33% negative
Wilkie et al. (2016)	Equine therapy	Meta-analysis	7[(j)]	8–19	377 at-risk children and adolesents, treatment 5–26 weeks	Only studies with quantitative data amendable to meta-analysis considered, study uses random effects model	Study finds medium effect sizes and indicates that intervention is a viable alternative to conventional strategies among at-risk youth
White et al. (2020)	Equine-assisted therapy	Systematic review	10	6–14	118 children and adolesents with attention deficit/hyperactivity diagnosis, 1–3 weekly sessions (45–90 min) for 4–32 weeks	Behavioral symptoms, psychological symptoms, physical symptoms, body of evidence framework	Data suggests positive trends in behavioral, psychological, and physical outcomes for children with attention deficit/hyperactivity, but few studies with significant results
Care farming interventions							
Murray et al. (2019)	Care farming	Systematic review	31 (4 in target population)[(k)]	9–27	4 studies with 112 disaffected/excluded youth, varied length of stay	Quality of life, depression, anxiety	Results suggests that care farming increased quality of life, decreased depression and anxiety for disaffected youth
Gardening and horticultural therapy interventions							

(*Continued*)

Table 5. (Continued).

Reference	Intervention	Study type	Number of studies	Age	Intervention details	Outcome measures	Results
Park et al. (2016)	Horticultural activity interventions for youth from general populations, with developmental disorders, emotional and behavioral disorders, and mental illnesses	Literature review	207 (133 studies with children, 74 studies with adolescents)	Children age 8 to 13; adolescents age 14 to 19	Varying length (under 10 to more than 31 sessions, duration 30–120 min) and group sizes (less than 11 to more than 30), Activities: gardening outdoors, planting indoors, making crafts with live plants, arranging flowers, making crafts with artificial or pressed flowers, other activities related to horticulture	Psychological, emotional, social, behavioral, cognitive, educational factors	Interventions for general population children and adolescents were related to physical, psychological/emotional, cognitive, social, educational, and behavioral outcomes; interventions for adolescents with developmental disorders were related to the six outcome categories, interventions for adolescents with emotional and behavioral disorders were related to 5 outcomes, interventions for adolescents with mental illness are related to psychological/ emotional outcomes

Notes:
(a) Includes original intervention studies Harper et al. (2007) and Hoag et al. (2013)
(b) Includes original intervention studies Caulkins et al. (2006), Russell (2000), Russell (2005), and Russell and Phillips-Miller (2002)
(c) Includes original intervention studies Bettmann et al. (2013) and Harper et al. (2007)
(d) Includes original intervention studies Bettmann and Tucker (2011), Combs et al. (2016), Harper et al. (2007), Russell (2003), and Russell (2005)
(e) Includes original intervention studies Bachi et al. (2012), Balluerka et al. (2015), Conniff et al. (2005), and Gabriels et al. (2015), and Trotter et al. (2008)
(f) Includes original intervention studies Hanselman (2001), Hartwig (2017), Lange et al. (2007), Stefanini et al. (2015), and Stefanini et al. (2016)
(g) Includes original intervention studies Kemp (2014), Maujean et al. (2013), and Trotter et al. (2008)
(h) Includes original intervention studies Bachi et al. (2012), Balluerka et al. (2014), Ewing et al. (2007), Hanselman (2001), Kemp et al. (2014), and Lange (2007)
(i) Includes original intervention study Gabriels et al. (2015)
(j) Includes original intervention studies Bachi et al. (2012), Kemp et al. (2014), and Trotter et al. (2008)
(k) Includes original intervention study Leck et al. (2015), Kogstad et al. (2014), and Schreuder et al. (2014)

groups, and post-treatment assessment. The majority of sample sizes is small with only 13 original studies including more than 100 study participants. Interventions vary in their focus, ranging from broadly designed, multi-faceted tasks in care farming and horticulture-based interventions to highly specific activities in animal-assisted interventions. The key findings reflect the nature of the interventions, in particular, the most robust findings can be associated with the more narrowly defined animal-assisted interventions. Outcomes were largely positive across a wide range of psychosocial and behavioral measures and often maintained post-treatment. The psychosocial and behavioral measures that the nature-based intervention contributed to the most include mental health measures, such as hyperactivity, anxiety, depression etc., social measures, such as relationship building, interpersonal skills, etc., and measures of personal development, such as self-concept, meaningfulness etc.

This scoping review identifies several avenues for future research. A first avenue for future research that emerged from the analysis of the *study designs* is the need for a greater emphasis on the use of methodologically robust empirical designs, to achieve a higher degree of external validity. The majority of studies in this scoping review are based on pre-post evaluation-type repeated measures. The approach is often justified with the special nature of the intervention which makes a comparison group difficult to obtain, a challenge that is particularly evident in wilderness-therapy interventions (Russell 2003; Clark et al. 2004; Roberts et al. 2017). To some extent, the animal-assisted interventions literature can serve as a role model here, with its larger number of statistically robust research designs that often include larger sample sizes and randomized approaches with control groups. Alternatively, newer statistical approaches, such as intent-to-treat designs (Gupta 2011), or staggered research designs, such the step-wedge designs (Hemming et al. 2015), deserve greater attention in this literature.

A second avenue for future research comes from the analysis of the *interventions* covered in this review and points to a continued need for evaluating youth-based interventions. In particular, knowing of the large number of interventions targeting adolescents and young adults with mental health difficulties, future research should examine how well the literature reflects the breadth of the field. This analysis could be beneficial for identifying additional research needs and initiate a discussion of best practices in areas that are better understood. Ideally, this research should be approached from an international perspective, to increase the understanding of effective interventions from a cultural lens (e.g. Levinger et al. 2021). A second, intervention-related observation is the often limited amount of information on the actual intervention in the research studies. On the one end are the highly-focused studies that list the exact number of hours of each intervention within a therapy plan, while on the other end of the spectrum are studies that provide a list of interventions but lack detailed information that would facilitate a better understanding of which components were particularly effective (e.g. Caulkins et al. 2006). A third, related observation is the challenges with establishing causality and demonstrating which part of an intervention has beneficial effects for which group of users. Although beyond the scope of this review study, our evidence synthesis suggests a greater need for critical engagement with the reported benefits that takes into account issues, such as self-selection bias or negative outcomes and challenges, that are typically not reported in original studies. For this reason, it is difficult to assess the factors for successful interventions and groups (e.g. with more severe clinical depression or disabilities) for whom nature-based therapy is not a viable option.

A third avenue for future research emerged from the analysis of the *study participant* samples in this scoping review. Future research should identify the subgroups more clearly for whom the treatment is most effective, i.e. by age group, gender, or diagnosis (Berman and Anton 1988; Gillis et al. 2016). In particular, more understanding is needed how well the treatment modalities work for the variety and severity of psychosocial, behavioral, clinical, and non-clinical issues experienced by youth in the short and long-term. For example, some of the wilderness therapy studies have examined target groups, but typically with mixed results and not enough consistency across the studies to make strong recommendations (Berman and Anton 1988; Harper et al. 2007; Bettmann

and Tucker 2011; Combs et al. 2016). A related topic for future research is disparities in nature-based interventions due to a program's funding structure. Whether self-paid, government funded, or a combination of both, the financial foundation of an intervention can determine participant composition and quality of an intervention (Frankford 2007). Information on the funding structure and its implications would provide additional transparency in this literature and also will help eliminate biases in who participates in the different programs (Bettmann et al. 2016).

A fourth avenue for future research emerged from the analysis of *key findings* for this scoping review. Few studies acknowledge the fact that nature-based interventions are generally used after other treatment modalities have been tried or can be part of an integrative treatment model (e.g. Compitus 2019). Yet the literature does not control for the impacts of this prior treatment. Furthermore, few studies have included discussion of aftercare plans. Future research should examine the best placement of nature-based intervention within a holistic assessment of treatment models. In a related perspective, many nature-based interventions, especially care farming, have an integrative function which aims to reconnecting youth with the community. This aspect could be more widely investigated in the literature.

Several limitations should also be noted for this study. First, we excluded reports and other gray literature, to keep the focus on the peer-reviewed studies. Second, the context of most of the studies is often highly location specific, which limits their generalizability. For this reason, we describe rather than measure differences and similarities in the literature. Third, we excluded the miscellaneous categories of nature-based interventions from this review, such adventure therapy, green exercise activities, challenge programs, therapeutic camping and other outdoor experiential programs that may include youth participating for recreational rather than therapeutic reasons (Wilson and Lipsey 2000; Gillis et al. 2008). Difficult to categorize, these interventions should be examined in a separate study that focuses on this diverse array of approaches to working with youth. Fourth, our understanding is also limited by the publication of findings from only a small percentage of all possible programs that exist. Increased attention to nature-based interventions by scholars across disciplines can increase the potential for collaborative research efforts and help build capacity of residential and community-based programs to implement research studies, disseminate findings, and add to the evidence base (Cunningham et al. 2015; Thompson et al. 2017; Wainberg et al. 2017).

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ORCID

Florian Diekmann http://orcid.org/0000-0002-7961-6769

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