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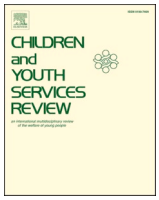

Co-production of a nature-based intervention for children with ADHD study (CONIFAS): Creating a home-based intervention with children and families with lived experience of ADHD

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ABSTRACT

Background: Attention Deficit Hyperactivity Disorder (ADHD) affects 5% of children in the United Kingdom (UK), impacting upon daily functioning and multiple health outcomes. Support for ADHD in the United Kingdom is currently insufficient, and waiting lists for specialist assessment and treatment are long. Community-based interventions are often not widely delivered although we know psycho-social interventions, such as parenting interventions, can be effective and are recommended in clinical guidelines. Nature-based interventions can support mental health and wellbeing in general populations, and recent empirical research suggests promising mechanistic support for effective use with ADHD populations. Co-production of interventions with children, adolescents and families has been recognised as a key approach for future research. The aim of this study was to co-produce a parent-led nature-based intervention, underpinned by current research, public health policy and theory, that can be taken forward to future feasibility and full trial testing to support mental health and wellbeing and symptom reduction in children with ADHD.

Method: The Double Diamond model of design was applied to structure four phases of co-production to collaboratively develop the novel intervention. The penultimate phase included a round of user-testing. The co-production group (n = 29) included children with diagnosed ADHD, their parents/guardians, and relevant professionals. The user-testing phase recruited 11 parent–child dyads who tried the intervention in their daily lives over six weeks to inform co-produced revision of the intervention in the final phase.

Results: Co-production with end-users and professionals led to a bespoke nature-based intervention for use by families for children with ADHD in the form of a box containing activity cards, psychoeducation booklets, and other play-based items. Outcome measures administered during user-testing had mixed completion rates by parents/guardians and children, but the intervention was rated highly for acceptability and accessibility by families.

Conclusion: This study demonstrated the effective use of co-production in designing a new wellbeing intervention for children with ADHD. Further testing will be beneficial for exploring whether this intervention could supplement wellbeing and symptom management services for this population.

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1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition characterised by symptoms of hyperactivity, impulsivity, and inattention (American Psychiatric Association, 2022). It is estimated to affect 5 % of children in the United Kingdom (UK) (NICE, 2018). ADHD can negatively affect functioning, sleep, quality of life, and parent/carer's emotional health and time to meet their own needs (Moen, Hedelin & Hall-Lord, 2016). This can lead to poorer family relations (Klassen, Miller, & Fine, 2004). Furthermore, ADHD is frequently comorbid with conditions including autism, conduct disorder and intellectual delay, leading to poorer health and wellbeing (Jensen & Steinhausen, 2015). ADHD is also commonly associated with depression, both within the first year after diagnosis and in later life (Riglin et al., 2021). Owing to its impact over the life course, ADHD is associated with significant economic costs at individual and societal levels including for medication, healthcare utilisation and criminal activity (Daley, Jacobsen, Lange, Sørensen, & Walldorf, 2019).

Following diagnosis, services are often patchy, unavailable, or inaccessible, leading to high levels of unmet need (Young et al., 2021). Families frequently rely on non-mainstream means of treatment for ADHD, which often have little or no supporting research evidence or clinical backing, such as homoeopathy and massage (Fibert and Relton, 2020). Psychosocial interventions have been shown to be efficacious for children and adolescents with ADHD and can include parent and guardian training and support as well as behavioural interventions (DuPaul et al., 2020); however, these are infrequently implemented due to lack of availability and perceived high costs (Young et al., 2021). Reviews have identified a need to develop an approach to supporting those with ADHD which focuses on a holistic model of care, improving quality of life whilst promoting strengths and neurodiversity (Sonuga-Barke et al., 2023).

There is consensus that better access to a broader range of non-pharmacological interventions is necessary to overcome shortfalls in ADHD service provision (Ogundele & Ayyash, 2023). One such promising area is that of interventions in nature. Increasingly, the health benefits of natural capital such as parks, woodlands and fields are being recognised by government policy makers (Public Health England, 2020). There is abundant evidence that exposure to green (publicly accessible areas with natural vegetation) and blue (outdoor water environments) spaces is associated with mental health benefits at both population and individual levels (Hartig, Mitchell, Vries, & Frumkin, 2014). Evidence suggests that health and wellbeing can be improved from relatively short bursts of nature-based activity from as little as 10 min a day (Meredith et al., 2020). A significant body of emerging research indicates the quality of connection a person has with nature can affect the extent of their mental health and wellbeing benefits (Richardson et al., 2022), and that a person's nature connectedness can be enhanced through sensory engagement with nature (Richardson et al., 2022).

There is specific evidence that children's contact with nature can be beneficial for physical activity, supporting cognition, behaviour, and mental health (Fyfe-Johnson et al., 2021). For school children aged 7–10 years with ADHD, green space playing time is associated with fewer emotional symptoms and peer relationship problems (Amoly et al., 2014). Afterschool and weekend activities in green space appear to confer greater benefits for children with ADHD than activities undertaken in built outdoor and indoor settings (Kuo & Taylor, 2004). A recent systematic review identified that it is consistently reported that exposure to nature is associated with reduced ADHD diagnoses and symptom severity (Hood & Baumann, 2024).

Hood and Baumann (2024) concluded in their systematic review that there is strong enough evidence for the positive impact of nature on ADHD to begin implementing its use in practice. The review notes that one means of achieving this is incorporating nature into behavioural interventions by recommending an increase in exposure to nature as a method of management, or by increasing the presence of nature in therapeutic spaces. Children with ADHD have specific difficulties in core areas of inattention, hyperactivity and impulsivity and emotional and social difficulties which are related to these core difficulties (NICE, 2019). Di Carmine and Berto (2020) highlighted that children with ADHD may benefit from exposure to nature and the outdoors, above and beyond neurotypical peers, as exposure to nature offers attentional recovery, where a core issue of ADHD is attention depletion. Studies have demonstrated that increased contact with green space can lead to positive improvements in the central difficulties of inattention and hyperactivity in ADHD (Kuo and Taylor 2004) and can be beneficial in reducing medication use in children with ADHD (De Vries & Verheij, 2022).

Set within this context and considering the strong signal that contact with nature can support children with ADHD in multiple domains (Fyfe-Johnson et al., 2021), the CONIFAS study intended to co-produce with children with lived experience of ADHD, their families, and professionals from the nature and wellbeing sector, a novel and creative nature-based parent–child intervention. At this time, to our knowledge, there did not appear to be any publicly available nature-based interventions for children and their families, which are bespoke to their needs and evidence based. This focus was selected in consultation with parents/guardians, and professionals and arose from the empirical evidence around the use of nature to support ADHD related difficulties. Empowering parents/guardians and guardians to develop skills and agency to support their children through such methods as parental support and consultation is an important focus of post-diagnostic ADHD provision, particularly for primary age children (NICE, 2019). There is also a body of evidence which indicates parents/guardians can play a crucial role in supporting their child's access to green space, but this is dependent on their own interest and orientation towards nature (Soga et al., 2018, Chawla, 2007; Cheng and Monroe, 2012). Parental confidence around supporting their children in outdoor green spaces can also mitigate risks (Truong, Nakabayashi & Hosaka, 2022). The intervention we co-produced aimed to develop healthy behaviours and support families and children with ADHD to form habits in accessing nature and the outdoors (Gardner et al., 2012). Inequality of access to green space is also a crucial issue with those living in the most deprived parts of the UK having reduced access to green space (Groundwork, 2021). We therefore needed to consider any intervention created is accessible and equitable.

Despite growing evidence, questions remain however about the practical integration of nature-based interventions into clinical settings for ADHD. This study therefore aimed to address these gaps by investigating the feasibility, efficacy, and underlying mechanisms of a co-produced, nature-based intervention specifically tailored for children with ADHD. Guided by a logic model (see Supplementary Material S2), our approach aligns with the Medical Research Council's framework on complex interventions, aiming to explore the mechanisms through which nature-based interventions affect ADHD symptoms.

2. Methods

2.1. Study design

The CONIFAS study (Armitt et al., 2022) took place across 18 months between March 2021 and August 2023. The first 12 months of the study focused on study set up, including gaining ethical approval, recruitment and the first two phases of co-production. The final six months included user testing, a final phase of co-production, and dissemination. When selecting the methodology for the study, a recent review highlighted the importance of involving individuals with ADHD in the co-design, co-production, and co-dissemination of research (Sonuga-Barke et al., 2023). This approach was utilised to bring new ideas to the current evidence base. Co-production has been described as a partnership where everyone works towards a mutually agreed aim, plays an active part, and existing skills, experience, and knowledge are valued (Pettican et al., 2022).

The study aimed to draw from current theoretical understanding of how green space can support children with ADHD alongside looking at public health campaigns encouraging increased access and engagement with nature and practical resources already available for use with children with ADHD. It was recognised that this is a complex area of intervention development with multiple factors to consider. The Medical Research Council guidance on complex intervention development was utilised (Skivington et al., 2021), particularly when considering programme theory development and stakeholder engagement. A logic model was developed during the study (Supplementary material S2) which incorporates theory and possible mechanisms of action. This was open to modification throughout the study and is still considered a working document as we seek to take this study forward to further testing.

Co-production workshops were informed by The Design Council's (2005) Double Diamond process model. As seen in Fig. 1, this model comprises four phases – Discover, Define, Develop, and Deliver – offering a creative, user-centred, and iterative approach to co-designing a product or intervention. The Discover phase offers the means to understand the problem by engaging with people with lived experience. This first phase is twinned with the Define phase which reformulates the problem from the vantage point of those with lived experience. The final two phases of Develop and Deliver focus on creative solution focused activities, testing these, and refining them. The model provided an overall linear structure for the creation and appraisal of the bespoke intervention, but the day-to-day process was iterative, circular, and responsive to the wants and needs of all co-producers and the creative process (see Fig. 2).

2.2. Objectives

Our main objectives map onto these four phases with co-production workshops structured around the Double Diamond Model.

1. Phase one – Discover: Create a co-production team of parent/guardian-child dyads with lived experience of ADHD, voluntary organisations working in green spaces, NHS professionals, clinicians, education professionals, and researchers. Investigate the strengths and difficulties associated with an ADHD diagnosis in children and how nature can be used to support affected children.
2. Phase two – Define: Create an appropriate and acceptable intervention for families of children and young people with ADHD through workshops, using existing campaigns (such as the five 'Ways to Wellbeing' and Wildlife Trust's 30 Days Wild) and resources for inspiration (e.g. Aked, Marks, Cordon, & Thompson, 2008; Wildlife Trusts, 2023).
3. Phase three – Develop: Recruit a further 10 families to conduct a user testing trial to test the usability, acceptability, and accessibility of the created intervention.
4. Phase four – Deliver: Refine the intervention with co-production participants from phases one and two using feedback from the user testing. Finalise the intervention ready for small-scale feasibility testing in health services.

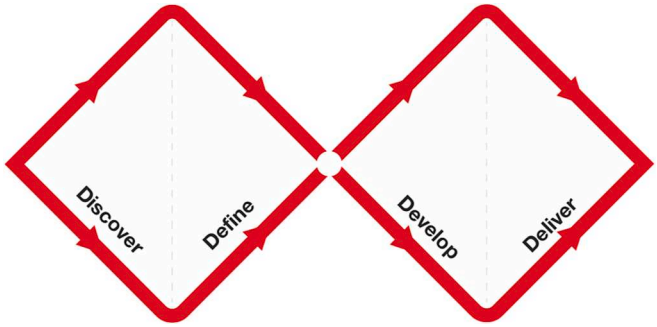

Fig. 1. Double diamond model.

Fig. 2. Outputs from the professional's discovery workshop.

2.3. Ethics

The co-production phases of the study were submitted for ethical review by the The University of York Health Sciences Research Ethics Committee (REC) and were approved on the 23rd of May 2022. The user-testing phase was submitted to the same REC and approved on the 12th of December 2022 (DEGERC/Res/01122022/1).).

2.4. Participants

2.4.1. Co-producers – phases one, two and four

Twenty-nine participants including primary school-aged children (n = 9), parents/guardians (n = 10), and professionals (n = 10) were recruited to form the co-production group (Phases one, two and four). Demographic details were not collected for these participants. Families were recruited across North, East, and West Yorkshire, thus providing a broad scope of nature access across a wide geographic region. Professionals were drawn from a variety of occupational and volunteer roles including clinical psychology, education, early years and nature and outdoor providers. The number and type of co-producers attending each workshop can be found in Table S1 in supplementary materials.

2.4.2. User testing phase

Eleven parent/guardian-child dyads were recruited to the user-testing phase and asked to use the intervention over a 6-week period. Table S2 in supplementary material shows the demographic characteristics of parent/guardian and child participants, along with key clinical characteristics of child participants. The majority of families lived in the least deprived Index of Multiple Deprivation (IMD) deciles, but four families lived in the most deprived deciles (IMD ranks between 2 and 4). All children were drawn from year groups in Key Stage 2 and the majority (73 %) were boys.

2.4.3. Eligibility criteria

Eligible children were aged between 5–11 years and had a clinical diagnosis of ADHD as reported by parents/guardians (this was considered sufficient evidence for inclusion). Both children and parents/guardians were required to have sufficient understanding of English to participate in the study. This was decided upon due to lack of provision for live translation services. Children who posed a risk of harm to themselves or others, and children unable to participate due to profound additional difficulties as determined by parents/guardians were also ineligible.

2.5. Recruitment

Physical posters and social media were used to advertise the study. Existing research networks, schools, local authorities and known community groups were used to reach a diverse group of families. Interested participants contacted the research team directly and a phone/virtual call was organised to check eligibility and introduce the aim and nature of the study. They were given REC-approved participant information sheets via email or post with sufficient time to review and ask any questions. All adult participants in both parts of the study provided informed consent for their participation and that of their child. Children were given the option of providing assent, though this was not required.

2.6. Procedures and analysis

2.6.1. Co-production phases (one, two, & four) procedures

In phases one and two, a total of seven separate workshops (three in phase one, four in phase two) were held to explore co-producer views on ADHD and nature and to understand factors to consider, including potential underlying theory and policy, when developing an intervention to support engagement with nature. Further details about formatting of the workshops can be found in the published study protocol (Armitt et al., 2022).

The workshops were held at a nature reserve to allow children and families to actively engage in set activities or take breaks as needed. It was intended that the workshops would be engaging, fun, and allow for adjustments to support individual needs. To offer a sense of structure to the workshop, the research team encouraged the children to take part in games using what are known as 'sensory circuits' (Griffin, 2023). A sensory circuit begins with a physical activity, then an 'organising' task where children are encouraged to connect their mind with their body (e.g., vestibular action via balancing games), and finishing with a calming activity. The use of sensory circuits developed from the professional workshop and provided a link to potential underlying mechanisms of action for supporting children with ADHD.

A key aim of these workshops was to gain sufficient information from participants about the content, look, feel and delivery of the intervention to allow the research team to build a prototype for testing. Naturalistic play featured heavily with both children and parents/guardians being offered the chance to take part in a wide range of activities to identify which activities and formats were most popular. There was also an emphasis on how activities could be 'gamified' to make them more appealing to children who gravitated towards more game-like play. Phases one and two also aimed to develop a logic model to enable the development of psychoeducational booklets to support parents/guardians, guardians, children, and professionals in understanding how and why nature can be beneficial.

Phase four (deliver) occurred after user-testing of the prototype intervention in phase three. It consisted of two in-person workshops at the same Nature Reserve as phases one and two with the original co-producers from these phases. Participants were given visual and written summaries of the feedback from the user-testing phase to encourage engagement with refining intervention components.

2.6.2. Analysis

Due to the flexible and dynamic nature of the workshops it was not possible to gather detailed transcripts of the workshops for qualitative analysis. Several research team members and a graphic designer were scheduled to attend each workshop to take field notes in a naturalistic way. The graphic designer produced live visual notes which were more accessible to children and other neurodivergent group members. All notes were shown to participants at each stage, allowing for iterative cycles of reflection and adjustment.

2.6.3. User-testing phase (three) procedures

2.6.3.1. Procedures. The small user-testing phase allowed a separate set of 11 families to try out the co-produced intervention in their day-to-day lives, in varied environments across Yorkshire, UK. Families provided qualitative feedback about their experiences of its use which was collected via phone calls and free text questionnaire and diary responses that were logged on an Excel sheet. Several outcome measures were also collected at baseline and six-weeks after baseline to assess the feasibility of using these measures for future intervention testing, as opposed to testing intervention efficacy (this is planned for a future trial). We wanted to measure the acceptability and accessibility of the co-produced nature-based intervention for families as well as understand what outcome measures might be best suited to capture hypothesised improvements in children's symptomatology and mental health and wellbeing.

With the support of our patient and public involvement lead and stakeholder engagement with local neurodevelopmental services within CAMHS, we administered outcomes for ADHD symptoms, anxiety and depression and nature connectedness to test for feasibility and acceptability of use in a larger trial. The outcomes included were Parent-completed demographics questionnaire, Conners-3 Global Index parent version (Conners 3GI-P, Conners et al., 1998), Revised Children's Anxiety and Depression Scale (RCADS, Chorpita et al, 2000) (parent), Nature Connectedness Index (NCI), Parent/guardian acceptability and accessibility questionnaire, and a Child acceptability questionnaire.

2.6.4. Analysis

For the qualitative feedback, the research team used summative content analysis to identify and gauge the presence and relevance of feedback about use of the intervention (Hsieh & Shannon, 2005). This summary was translated into an easy-read, visual format then shared with co-producers in the final phase to refine the intervention for future testing.

No inferential statistical analyses were planned for the outcome measures completed in this study. Descriptive statistics and t-scores are reported in the results section to demonstrate functioning of the scales and whether responses corresponded with published values for these measures; no tests of significance were performed.

3. Results

3.1. Co-production phases of intervention development: Phases one and two

Results are defined as key outcomes at each stage of the research cycle which led to the production of the intervention.

3.1.1. Phase one – discover

Phase one consisted of three workshops with the co-production group. The first was with professionals only, the second with parents/guardians and children, and the third was held virtually with just parents/guardians.

In workshop one, professionals identified a range of core principles and approaches to which the intervention should adhere. There was consensus that it should be child-led, with an emphasis on promoting purposeful enjoyment, empowerment, movement, positive but safe risk taking, and sensory activities. There was an understanding that parents/guardians were likely to play an important role in supporting long-term engagement with the intervention. Professionals felt that supporting families to understand *why* nature can be beneficial using current research would be critical. These concepts informed development of a logic model detailing important theory including child led activities promoting opportunities for movement, sensory engagement and activities to promote attention, nature connection and strengthening the

parent child relationship.

Children in workshop two were asked to describe their favourite and least favourite activities in nature to generate a list of activities that might be included in the intervention. Importantly we focused on understanding barriers to engaging with nature (e.g., bad weather) and exploring options to overcome these barriers. Some candidate activities, such as sensory exploration of the woodlands and constructing nature treasure boxes, were tested with the children and their parents/guardians during the workshops. During these exploratory tasks, the research team collected feedback from children in groups and on a 1:1 basis and recorded any notes regarding why activities were liked/disliked, any adaptations that could be made, and collected consensus on which activities should or should not be included in the intervention. Whilst there were some clear group preferences, it was also evident that the children had varying interests, and so a range of activities and activity types should be included.

In workshop three, parents/guardians highlighted that nature offers children with ADHD freedom to express themselves where there is an abundance of space and fewer concerns about rule-based play. We were able to map this to our logic model linking to existing evidence around parents/guardians and carers often feeling anxious and risk averse of their children playing outdoors (Truong, Nakabayashi & Hosaka, 2022). Parental confidence was discussed as a potential barrier, with the need to understand safe ways for children to explore and engage with nature, building competencies as confidence increases. Parents/guardians communicated that the intervention should include an educational component about the role of health and nature presented using a mix of text, video, and graphical formats (Fig. 3). Other considerations focused on practical steps such as offering the intervention at the right time during a family's diagnostic/post-diagnostic journey and fitting it into

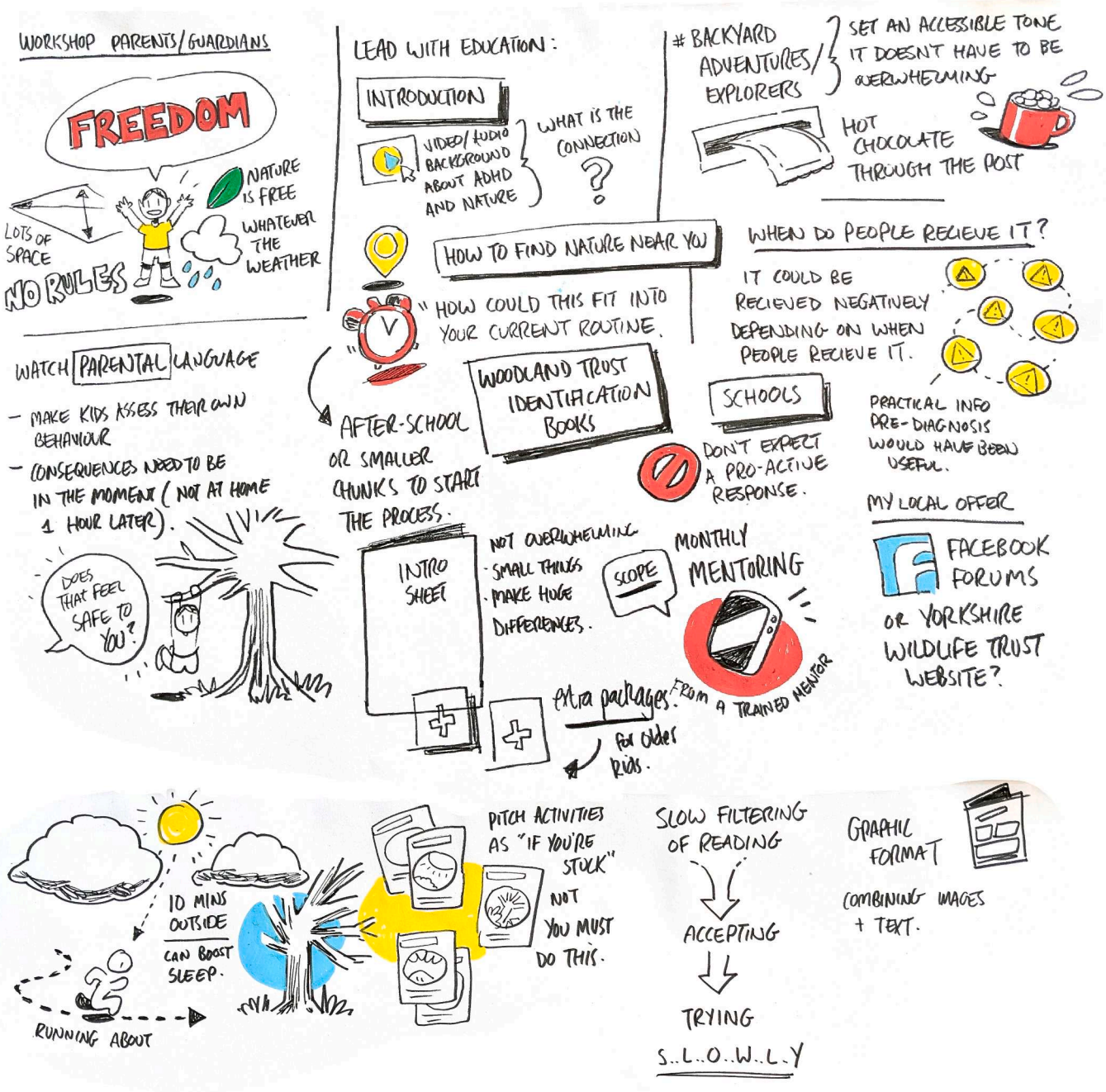

Fig. 3. Output from parent/guardian discovery workshop.

existing routines.

3.1.2. Phase two – define

Phase two consisted of a further four workshops. The first three of these were set up in the same way as the phase one workshops, but an additional final workshop was held with all participants together.

With the focus for this phase on defining what the intervention should be and creating it, co-producers in each of the first three workshops discussed what it might look like and consist of. Several options were discussed within the context of the important discussions in phase one. The candidate content, approach, and options for supporting engagement with the intervention which came from discussions in all workshops and are shown in Table 1.

Prior to the final Define-phase workshop, the research team worked with a graphic artist to produce a prototype intervention that captured the core elements shown in Table 1. Some components including the induction sessions and facilitation by existing community groups could not be included for pragmatic reasons (e.g., budget restrictions). The prototype intervention included:

- A physical box containing all items
- A contents list and initial activity instructions
- 'Can you find something…' cards
- A parent/guardian education and support booklet
- A child education and support booklet
- Activity cards
- An activity calendar with stickers

At the final Define-phase workshop, the families and professionals were teamed up with a researcher to look through and use the prototype intervention materials. Feedback about how to improve accessibility and usability of the intervention ready for the user-testing phase was collated by the research team (see Fig. 4).

Several of the suggested modifications were then actioned by the research team. These included:

- Affix the contents list on the inside of the box lid to guide which activities to undertake first
- Weatherproof the activity and 'finder' cards
- Include additional scaffolding information in the parent/guardian's booklet to support families to engage with nature (e.g., where to go, what to bring)
- Adopt a more graphical, less text-based design for the child booklet
- Make the offer more exciting and special by including more fun items (e.g., wooden name badge, hot chocolate).

Fig. 4. Co-producer suggested changes to intervention at the final Define-phase workshop.

3.2. User-testing phase: Phase three

3.2.1. Accessibility and acceptability

The feedback from families in the user-testing phase indicated that overall, parents/guardians found the intervention to be an acceptable and feasible means of facilitating their child to engage with nature. Creative tasks that involved building dens, making clay models, and using phone cameras to take pictures of nature finds were popular ways to manage inattention. Physical activities such as night walks, climbing, and running were perceived to be useful for managing impulsivity, emotion, and sleep regulation. Parents/guardians consistently reported

Table 1
Candidate intervention components.

Content
Psychoeducation for parents/guardians about ADHD, health and other benefits of nature; what to expect from nature activities.
Scaffolding information about what natural spaces look like nearer to home, accessibility, and fitting activities into existing routines.
Guidance about setting boundaries and talking about positive risk taking.
Physical pack or box that includes 'creature comforts' (e.g., hot chocolate for cold days).
Nature activity ideas that can be done in bad weather and out/inside the home (e.g., leaf art).
Signposting and links to existing resources to support outdoor activity (e.g., 30 Days Wild, The Wildlife Trusts).
Approach
10-minute blocks of nature activity (e.g., using 5 senses on the walk to school) with option for more challenging and longer activities.
Child-led and flexible approach to choosing activities with visual learning aids for children.
Support
Induction session for families to introduce the intervention.
Involve community leaders with a strong track record of working with children outdoors (e.g., Scout leaders).
Social contact with other families engaging with the intervention (e.g., online platform).
Weekly or fortnightly check-in phone calls to support knowledge exchange and upskilling to boost confidence.
Situate the intervention within a service (e.g., CAMHS).

finding the activity cards to be a useful device to trigger engagement in bite size outdoor activities that could be feasibly achieved, even in bad weather. There was also consensus that the intervention offered constructive ways to establish risks and boundaries, allowing children to enjoy outdoor play.

Families also reported finding it tricky to fit in the ten minutes of engagement with nature every day due to things like busy schedules, bad weather, and their children having low energy. Some parents/guardians did not initially engage with their psychoeducation booklet until prompted and some children found their psychoeducation booklet similar to schoolwork and not engaging enough. It was also reported that the boxes could be more immediately engaging in their contents, for example if more fun materials or games were included.

To assess acceptability of all outcome measures planned for use in future trials, we considered the survey completion rates at baseline and follow-up for both parent/guardian and child participants (Table 2).

Parent/guardian acceptability and accessibility questionnaire responses were captured from 10 out of 11 parents/guardians with a mean score of 36.2 out of 45 (SD = 3.4) for acceptability and 23.2 out of 30 (SD = 4.4) for accessibility. Six out of 11 children completed the acceptability questionnaire, with a mean score of 31.8 out of 40 (SD = 4.6).

3.2.2. ADHD symptomatology, mental health, and nature-connectedness descriptives and t-scores

After six weeks of using the CONIFAS intervention, there was a three-point reduction in mean scores on the Conners 3GI-P restless-impulsive subscale, but *t*-scores showed little change in concerns typically reported, with one child moving from very elevated to elevated scores. Raw scores of emotional lability were also reduced at six weeks compared with baseline, and four children transitioned from very elevated at baseline to elevated *t*-scores at follow-up; one child reported an average *t*-score at follow-up. There was little change on the total subscale for the Conners 3GI-P, where all but one child reported very elevated scores at 6 weeks. There was considerable variance in reported symptoms of anxiety and depression, with raw scores on the RCADS ranging from 19 to 107 at baseline. At six weeks, the variance of raw scores had reduced, ranging from 20 to 76. The narrowing of scores on the RCADS at six weeks was reflected in a more normal distribution of *t*-scores, with three children reporting scores in the clinical range, two children reporting borderline and normal scores respectively (Table 3).

The intervention has been well-received on a small scale, with positive experiences reported regarding a range of common ADHD symptoms such as sleep. Children with ADHD have increased prevalence of parent-reported sleep disturbances compared with healthy controls, and management strategies should consider how best to address co-morbid sleep problems (Owens, Maxim, Nobile, McGuinn, & Msall, 2000). Qualitative feedback from parents/guardians suggested that night-time walks, for example to star gaze, were helpful in regulating sleep among those children with sleep disturbances, signalling that the intervention could offer a behavioural alternative to pharmacological solutions such as melatonin.

Table 2
Completion rates for baseline and 6-week follow-up surveys in the User-testing phase.

	Baseline		6 weeks	
	n	%	n	%
Parent/guardian				
Demographics	11	100	N/A	N/A
Connors 3GI	11	100	9	82
Revised Childhood Anxiety and Depression Scale (RCADS)	11	100	10	91
Parent Acceptability & Accessibility	N/A	N/A	10	91
Diaries returned	N/A	N/A	4	36
Child				
NCI	10	91	6	55
Child Acceptability	N/A	N/A	6	55

3.3. Final co-production phase: Phase four

3.3.1. Phase four – deliver

User testing feedback was shared with the co-producers in phase four. They recommended key changes for the nature activity box intervention which are detailed in Table 4. One key change was the recommendation to utilise smaller bite size activities and increase the novelty of activities to sustain engagement and increase the potential for exploration. This suggestion fits well with strengths focused theories of ADHD which posit that individuals have heightened levels of novelty-seeking and exploratory behaviours, manifesting as symptoms labelled as distractibility and impulsivity in modern environments (Le Cunff, 2024).

3.4. Outcome of all four stages: Intervention overview and structure

The CONIFAS intervention aims to support children and families with ADHD to engage with nature-based activities to support their health and wellbeing and reduce ADHD symptoms. It is designed to be delivered by families at home, with an emphasis on supporting daily activity that can help manage ADHD symptoms. The logic model for the CONIFAS intervention is included as supplementary material (S3.

When developing the intervention, about a significant focus was put on accessibility and the need for the intervention to meet the needs of a diverse group of families including those with minimal access to large local green spaces. Activities were co-produced with families that could be completed indoors or in small green or urban outdoor areas, but which still provided opportunities to connect with nature, burn off energy and develop skills. This approach was taken from the literature considering the need to ensure accessibility for those with limited access to green space (McEwan et al., 2020) and was well-informed by the lived experiences and perspectives of the co-production group.

The intervention pictured in Fig. 5 is presented in a cardboard box that maximises portability and sustainability of the materials. Included in the box are: 1) a pack of 30 laminated'10-minute challenge' activity cards, colour coded by category (active, body and senses; creative; discovering; relaxing; exploring); 2) a pack of 36 'Can you find something' cards; 3) a psychoeducation booklet for parents/guardians; 4) a psychoeducation and activity booklet for children. The intervention box also includes two sachets of hot chocolate, modelling clay, a wood 'cookie' to draw or paint on, and a daily challenge calendar with star stickers.

The activity cards serve as the lynchpin of the intervention and offer tips and ideas to prompt engagement with a range of different outdoor activities that will appeal to a broad cross section of children with ADHD. These cards also include guidance about difficulty level, skills needed (or to be developed), and recommendations about what resources might be needed to complete each task.

The underpinning principles for the intervention are described in the psychoeducation booklets for parents/guardians and children, which are supported as audio versions accessed via QR codes. The parent/guardian booklet includes a section explaining the scientific premise and evidence for why contact and engagement with nature is beneficial for health and wellbeing, especially for children with ADHD. An overarching ethos of the intervention is that each child has different strengths and engagement with activities that play to these strengths supports celebrating individuals' diversity. Additionally, parents/guardians are encouraged to gradually build trust and confidence through daily use and establishing rules and boundaries. The booklet also includes practical advice about how to access outdoor activity and

Table 3
Baseline and 6-week follow-up scores for CGI and RCADS.

	Baseline				6 weeks			
	Raw score	Mean SD	t-score	Mean SE	Raw score	Mean SD	t-score	Mean SE
Conners 3GI-P: Restless-Impulsive	18.4	2.2	88.0	0.9	15.4	3.8	82.5	3.2
Conners 3GI-P: Emotional Lability	6.2	2.5	78.9	4.0	4.7	2.4	71.2	4.8
Conners 3GI-P: Total	24.7	4.5	86.9	1.6	20.2	5.8	80.3	3.4
RCADS Total Anxiety and Depression	53.0	28.3	65.4	4.3	43.4	18.7	61.9	4.1

Note. SD – standard deviation; SE – standard error.
The mean score at baseline on the NCI for the ten children who completed this questionnaire was 47 (SD = 24.4). At 6-weeks the mean NCI score was 58.1 (SD = 17.8). However only six of the 11 children completed the NCI at follow-up.

Table 4
Changes recommended to nature activity box following final Deliver-phase workshop.

Nature activity box
Change the name
Make the materials less like 'schoolwork' (e.g. star stickers)
Make easier and harder box contents for different abilities
Have certificates available either online or posted
Create a way to 'level up' or unlock more and/or harder activities once a month or so
Create an induction element for parents/guardians to make them feel more confident and prepared to use the intervention
Child booklet
More pictures or comic strips, less text-based
Make it feel less like 'schoolwork' and have clearer instructions
Activity cards
Make these smaller and spread information from the fronts out onto back
Remove time extensions on the back
Split cards into groups by degree of difficulty, send out or open every X weeks
Include more activities (ideas provided)

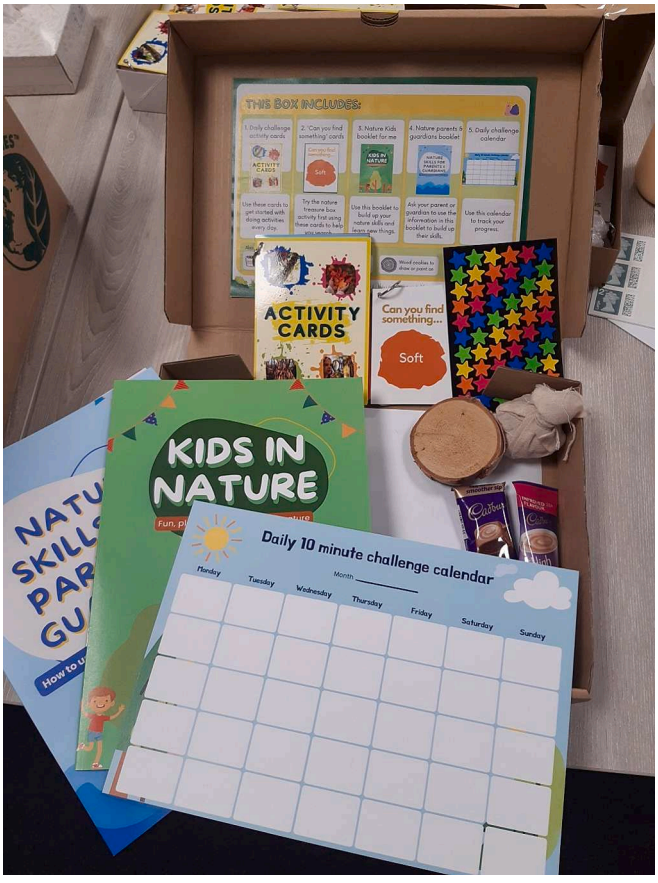

Fig. 5. The nature activity box intervention.

the types of clothing and food to bring.

The children's booklet is designed to be an age-appropriate companion to the parent/guardian booklet. It combines playful graphics with information about why nature can be fun and good for health. The children's booklet emphasises strengths rather than difficulties associated with ADHD, captured by encouraging children to draw or write about something they have achieved or felt good about while being in nature and to share this with others. The booklet also explains how the activity cards work, and rules and boundaries are discussed in the context of three games to build trust and confidence with outdoor play.

4. Discussion

To our knowledge, CONIFAS is the first study to co-produce a bespoke nature-based intervention with children with ADHD, their families, and professionals in relevant fields. Our aim was to create a positive and neuro-affirming intervention that is both accessible and acceptable for a broad range of families.

4.1. Intervention development

The logic model for the intervention distinguishes several mechanisms that might underpin its utility. Parents/guardians and professionals identified the need for the intervention to have a relational and supportive component. It was not felt to be enough to expect parents/guardians to carry out the intervention in a self-guided manner. Parents/guardians identified low confidence around engaging in nature. This fits with existing literature which indicates that it is important to encourage parents/guardians to allow their children to play in nature by mitigating their anxiety and concerns around perceived risks (Truong, Nakabayashi & Hosaka, 2022). This was an important focus in our workshops.

The intervention was geared towards goal oriented and gratifying, bite sized activities of 10 min or more, with a view to maintaining focus and attention. Evidence suggests that health and wellbeing can be improved from relatively short bursts of nature-based activity from as

little as 10 min a day (Meredith et al., 2020). Of possible importance here is the restorative quality of engaging with nature, which can help maintain and restore capacity for directed attention (Berto, 2005). Attention restoration theory proposes that the ability to concentrate on a task requires directed attention which is finite and more likely to be used up in urban and high stress environments. Time spent in natural environments that afford opportunities for 'softly fascinating' activities can bring about involuntary or effortless attention, restoring directed attention capacities, including decision making. However, this experimental evidence has yet to be translated to child populations with ADHD.

A further underpinning concept of the intervention is nature connection which was seen to increase among participants in the user-testing phase. Nature connection captures a more active state about an individual's subjective sense of their relationship with the natural world and is known to be associated with hedonic and eudemonic wellbeing and lower levels of anxiety and depression (Capaldi, Dopko, & Zelenski, 2014). Mindful engagement with nature that included game-based activities has been shown to be associated with higher nature connection and positive affect among school children aged 9–11 years (Barrable, Booth, Adams, & Beauchamp, 2021), suggesting that greater nature connection might be implicated in improved mental health in children with ADHD.

The use of creative and physical activities (e.g., running, climbing, and den building) that promote proprioceptive responses is a key feature of the intervention. Proprioception (or kinaesthesia) is the conscious and unconscious awareness of location and movement of the body and body position (Ayres, 2005). Approximately 50 % of children with ADHD have difficulties with motor skills or motor coordination, affecting daily life and self-esteem (Skinner & Piek, 2001). These active physical tasks are seen as a central aspect of supporting hyperactivity (burning off energy) and allowing children to practise motor coordination (Griffin, 2023).

4.2. Outcome measures

The outcome measures selected for use in this study were identified as those routinely used in clinical practice within local neurodevelopmental services (RCADS and Conners-3) and in research into nature connection (NCI). Whilst there was indication that some of the measures were acceptable and accessible for parents/guardians at both time points (RCADS/Conners), the high completion rate of child questionnaires dropped at follow-up, potentially indicating a need to consider alternative measures or provide additional support to children to allow them to complete these. The diaries which we implemented for parents/guardians to record observations and notes day-to-day were not well completed. Further discussion with participants taking part in both phases of the study indicated that quality of life for the child was of just as much importance as a reduction in the clinical scales related to ADHD and mental health. This more holistic viewpoint is explored in a recent review by Sonuga-Barke et al (2023) who identified that some individuals with ADHD find a focus on symptom reduction to be stigmatising and that a broader focus on wellbeing and quality of life for those with ADHD may be of benefit. Further patient and public involvement work has indicated that quality of life and reductions in symptoms and mental ill health are often equally valued by parents/guardians. The inclusion of a quality-of-life measure in a future feasibility study will be considered further for example the Child Health Utility questionnaire (CHU9-D).

4.3. Strengths

4.3.1. Methodology

A major strength of our study was the use of co-production methods that embraced core principles of power sharing and inclusion of the perspectives and skills of all participants. Increasing the use of co-production with those with ADHD has been recommended in recent reviews (Sonuga-Barke, et al., 2023). Co-production workshops were facilitated by professionals from the Yorkshire Wildlife Trust to ensure that the workshops were informed by knowledge of nature and children's activities in it. The research team studied co-production methodology to ensure that the research process was jointly owned by all participants rather than dominated by the research team, and that all voices would be heard equally. Furthermore, equal participation was promoted by holding initial workshops separately to cater for the needs and perspectives of different stakeholder groups. Where in-person attendance was a barrier, we used virtual workshops to boost inclusivity. Our approach also adhered to best practice for making outputs accessible (e.g., using visual summaries).

The intervention itself, created through co-production, was well-informed by lived experience and reflects the perspectives of a diverse group of children, parents/guardians, and professionals. Sensory circuits were used in both the co-production workshops and as part of the final intervention to support children in connecting their mind with their body through vestibular actions. These methods were helpful in ensuring that there was a diverse variety of activities for children to engage in that met individual needs.

5. Limitations

We aimed to recruit children aged 5–11 years old; however, all participating children were aged $\geq$ 7 years. It is likely that this was a function of long waiting times for ADHD diagnoses. We were also unable to record and collect full demographic details of our co-producers due to ethical and practical constraints. We recognise that this impacts the level of clarity around whose views were represented in the creation of the tool but hope that the included user-testing phase, following refinement, and continued developmental work will enable us to ensure that the intervention is accessible and acceptable for a wide range of families. Despite efforts to ensure workshops were flexibly organised, including provision of food and refreshments, some of the workshops had low attendance, suggesting flexibility of engagement and offering individual sessions is a critical feature of sustaining engagement in co-production work, particularly when working with families, neurodivergent children, and busy professionals. Further reflections on the co-production process are detailed in Armitt et al. (2024)

5.1. Future directions

It should be acknowledged that intervention development within this area is complex and we need to undertake further work to investigate the theory of change underpinning the intervention. At present we have a logic model which was developed iteratively as the study progressed. The MRC guidance clearly highlights the role of theory in intervention development and understanding programme theory (Skivington et al., 2021). In a further study we will seek to review the intervention package to identify proposed behaviour change techniques (BCTs). BCTs are the smallest active, replicable and observable components of an intervention, e.g., self-monitoring of behaviour (Michie, Atkins & West, 2014). BCTs will be mapped onto the proposed theoretical mechanisms of action within the Theory and Technique Tool (Michie et al., 2021). We will use this mapping to support an initial programme theory utilising the Theory of Change (De Silva et al., 2014).

An important next step will be considering the context for implementation of the intervention. Professionals indicated that support for parents/guardians is limited pre and post ADHD diagnosis although services are trying to address this gap in provision (Young et al., 2021). There was a consensus that this type of supportive parent/guardian led intervention could be of great value both when children are waiting for diagnosis and post diagnosis. Whilst we considered that the intervention would be utilised by those with existing diagnoses of ADHD there are societal and individual imperatives to invest in early identification and

treatment. Evidence-based treatments are recommended, such as parent/guardian education and support programmes, group and individual psychological treatment, and drug treatments (NICE, 2018). However, ADHD is under-identified, under-diagnosed, and under-treated in the UK, where the average waiting time for an initial ADHD screening through NHS Child and Adolescent Mental Health Services (CAMHS) is 16 months, three times longer than other CAMH services (House, 2023). Furthermore, following diagnosis, services are patchy, unavailable, or inaccessible, leading to high levels of unmet need (Young et al., 2021).

We aim to test the feasibility and acceptability of this intervention on a larger scale. We have met with a wide variety of stakeholders as part of our dissemination plan including voluntary and community agencies, children's social prescribing services and NHS Neurodevelopmental teams. We have received positive support for the CONIFAS intervention as a post diagnostic support tool alongside existing NICE (2019) recommended modalities of support such as parent training. Services have highlighted the importance of supporting parents/guardians to feel empowered to support their children in neuro-affirming ways which is a key focus of the CONIFAS intervention. Following this engagement work we intend to explore whether the intervention can be feasibly and acceptably delivered in two NHS neurodevelopmental service contexts to support the wellbeing of these children. We would then aim to test effectiveness and cost-effectiveness of the intervention in a large-scale randomised control trial. Parents/guardians also highlighted that the chance to meet other families and for their child to enjoy peer interactions within natural spaces was hugely beneficial. We intend to consider whether we can integrate a peer support component into the intervention or whether this is a separate focus.

6. Conclusion

We used an inclusive and participatory approach to co-produce a nature-based intervention that aims to meet the needs of and be acceptable and accessible for families and their children with ADHD. The CONIFAS intervention represents a novel approach to fill an existing gap in service provision to support the wellbeing of children with ADHD at a family-directed community level utilising a fun and non-pharmacological approach. We aim to further test the intervention's capacity to impact the reduction and/or management of ADHD symptoms and improve mental health in an appropriate service context.

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Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.childyouth.2024.108042.

Data availability

Data will be made available on request.

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