

A Serious Game (ACE of Hearts) to Support Mental Health among Young People with Adverse Childhood Experiences: A Mixed Methods Feasibility and Acceptability Evaluation

1. Participant Flow

Participant flow is shown in Figure 2. A total of 36 young people completed baseline, of which 22 accessed AoH at least once. Reasons for a lack of uptake included difficulties with access or forgetting to download the game. Engagement levels decreased with each successive mini-game, with the proportion of mini-games played ranging from 73% (*Horse and Foal*) to 32% (*Out of My Shell*). Follow-up assessment completions were high at all timepoints.

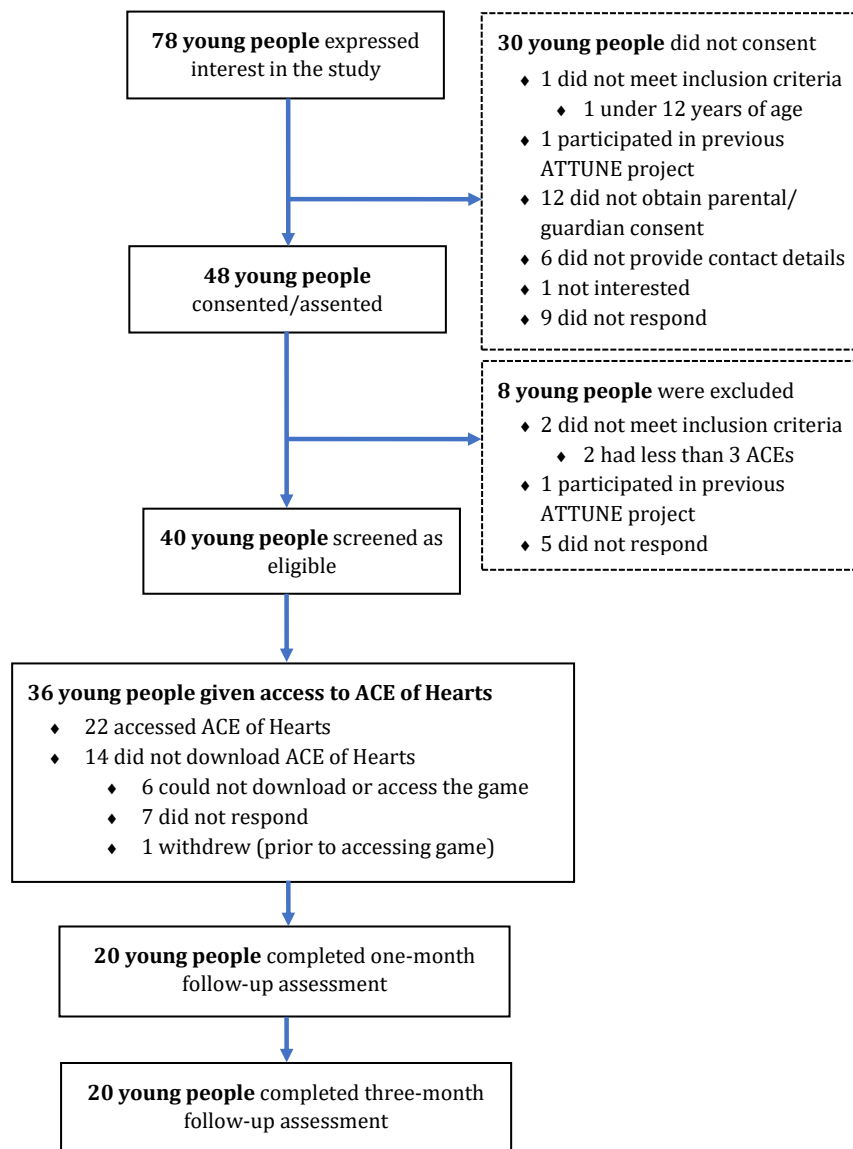


Figure 2. Participant flowchart diagram

2. Baseline characteristics

Participant baseline characteristics and PHQ-9 and GAD-7 scores are summarised in Table 2.

Participants who played AoH generally presented similar characteristics as those who did not access the game, though some small differences were observed on visual inspection of the data. A lower proportion of participants who played the game had experience of foster care (0% versus 11%) and were in school/college (50% versus 61%) compared to the total sample, respectively. In contrast, participants who played the game were more likely to identify as bisexual or pansexual (27% versus 19%) and be employed (55% versus 36%) compared with the total sample. Depressive and anxiety symptoms at clinical thresholds were similar by games access.

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Table 2. Characteristics of the sample by all participants who completed the baseline assessment (n=36) and participants who accessed the serious game (n=22)

Characteristics	All participants (n=36)	Participants who accessed the game (n=22)
Age (years), M(SD)	16.86 (3.62)	17.91 (3.68)
Age group, n (%)		
12-15 years	15 (41.7)	7 (31.8)
16-17 years	9 (25.0)	4 (18.2)
18-24 years	12 (33.3)	11 (50.0)
Gender, n (%)		
Woman/girl	16 (44.4)	9 (40.9)
Man/boy	16 (44.4)	10 (45.5)
Non-binary	2 (5.6)	2 (9.1)
Other/Prefer not to say	2 (5.6)	1 (4.5)

Ethnic background, n (%)

Black, African, Caribbean or Black British	6 (16.7)	3 (13.6)
Asian (various) or Asian British	1 (2.8)	1 (4.5)
Arab	2 (5.6)	2 (9.1)
White (various) or white other	19 (52.8)	13 (59.1)
Irish	2 (5.6)	2 (9.1)
Mixed or multiple (various)	6 (16.7)	1 (4.5)

Sexual orientation, n (%)

Heterosexual/straight	18 (50.0)	10 (45.5)
Gay or Lesbian	3 (8.3)	2 (9.1)
Bisexual or pansexual	7 (19.4)	6 (27.3)
Asexual	3 (8.3)	2 (9.1)
Don't know/Prefer not to say	5 (13.9)	2 (9.1)

Neurodevelopmental condition diagnosis received, n (%)

None	25 (69.4)	15 (68.2)
One diagnosis	5 (13.9)	4 (18.2)
2 diagnoses	4 (11.1)	1 (4.5)

3+ diagnoses	2 (5.6)	2 (9.1)
Geographical area, n (%)		
Urban	22 (61.1)	14 (63.6)
Rural	11 (30.6)	6 (27.3)
Coastal	1 (2.8)	1 (4.5)
Don't know	2 (5.6)	1 (4.5)
Depression symptom severity (PHQ-9), n (%)		
None/minimal Depression	7 (19.44)	5 (22.73)
Mild Depression	9 (25.0)	4 (18.18)
Moderate Depression	9 (25.0)	7 (31.82)
Moderate-Severe Depression	11 (30.56)	6 (27.28)
Anxiety symptom severity (GAD-7), n (%)		
None/minimal Anxiety	8 (22.22)	4 (18.18)
Mild Anxiety	11 (30.56)	9 (40.91)
Moderate Anxiety	7 (19.44)	3 (13.64)
Severe Anxiety	10 (27.78)	6 (27.27)

3. Outcome Measures

Feasibility

Feasibility outcomes are summarised in Table 1.

Table 1. Feasibility outcomes of ACE of Hearts

Outcomes	Participants
Number of young people expressed interest in the study, n	78
Rates of young person consent and assent, n (%)	48 (61.5)
Rates of eligibility	40 (83.3)
Rates of enrolment (baseline assessment completed), n (%)	36 (90.0)
Rate of uptake (serious game accessed), n (%)	22 (61.1)
Rates of assessment completion, n (%)	
One-month follow-up	20/22 (90.9)
Three-month follow-up	20/22 (90.9)
Rate of retention (all assessments completed), n (%)	19/22 (86.4)
Rates of engagement (mini-games played), n (%)	
Mini-game 1: Horse and foal	16/22 (72.7)
Mini-game 2: Hard times	12/22 (54.5)
Mini-game 3: Dial it back	10/22 (45.5)
Mini-game 4: Out of my shell	7/22 (31.8)

Acceptability

Among participants who accessed AoH, 20 (out of 22; 91%) completed the acceptability questionnaire (see Supplementary Material 4). Most participants reported that they enjoyed using AoH (85%), found it simple (70%) and easy to use (85%), and felt it could help them to think about their own life experiences (80%) and acknowledge difficult experiences they had been through (80%). Just over half of participants (55%) understood how to use the game features, while 65% reported feeling confident using AoH without reminders.

Mental health outcome measures

Although this study was not designed to assess the efficacy of the serious game, no harms or unintended outcomes were reported. While not suitable for formal statistical testing, the observed patterns provided preliminary indications of positive trends in anxiety, depression, and mental wellbeing, and importantly no worsening.

Deleted: Supplementary Material 5 shows the pre-post scores for the mental health outcome measures at baseline, one- and three-month follow-up.

Qualitative process evaluation of the serious game

Fifteen participants (75%; of 20 invited) completed an interview. Most were aged 18-24 years (60%), from a White background (73%), and identified as women/girls (40%), men/boys (40%) or non-binary (13%). Thirteen interviews were conducted online with a researcher and two were completed independently by participants in written format. Eight (67%, out of 12 invited) participants verified that their data were accurate and complete. Analysis resulted in four overarching themes: (1) Design features, style and customisability, (2) User experience and accessibility, (3) Characters, stories and content, and (4) Perceived impact. Illustrative quotes and researcher notes are presented in Table 3.

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1. Design features, style, and customisability

Overall design, feel and appearance: Participants suggested the game was fun, unique, and helpful to consider mental health and ACEs (*note 1*). They generally liked the visual design, arts content, and interactive elements (*note 2*). However, for some people, the mini-games (e.g. *Horse and Foal*), were considered too lengthy and slow, leading to drifting attention or boredom (*quote 3*). Others enjoyed the slower pace, as calmer and more relaxing than 'overstimulating' games.

Interactive elements and customisation: Many participants liked the personalisation features, particularly the *cosy den* (*note 4*). They suggested ways to support engagement and reduce cognitive effort (e.g., through puzzles), expand the range of topics covered, and include guided activities (e.g., journaling, breathing, meditation) (*quote 5*). Some participants said they had limited control over predetermined storylines. Allowing choice over which mini-game to play first might tailor experiences.

2. User experience and accessibility

User experience, navigation and ease of use: Several participants wanted clearer signposting and guidance (*note 6*), and notifications to prompt engagement (*note 7*). Nonetheless, many found AoH simple, requiring minimal effort to use (*quote 8*).

Accessibility: AoH was generally considered accessible, convenient, and useful for engaging young people. However, some participants experienced difficulties navigating the controls which may present challenges for some users (including neurodivergent young people; *quote 9*). A desktop-based version of the game may increase accessibility and ease of use and reduce distractions (*note 10*).

3. Characters, stories and content

Appropriateness and relatability: Several participants were able to relate to the characters and stories depicted, with some stories reflecting their own experiences (*quote 12*). The topics presented were ‘*real issues*’ faced by young people and perceived as relevant to ACEs (*note 12*). For others, the content did not fully reflect personal experiences, which was both beneficial and limiting. Contrasting content helpfully allowed emotional distance (*note 13*). Storylines lacking resonance or the ‘wrong message’ were less helpful. Additional mini-games on other topics, such as social media, screen use, school and exam stress, friendships, peer pressure, and family difficulties, were proposed.

Intended for a younger audience: It was widely felt that AoH was suited to a younger audience (e.g., teenagers), owing to the game style, characters, and topics covered (*note 14*). For older groups (particularly over 18 years), the game was viewed as less relevant. More age-appropriate topics (e.g., addiction, substance use), complex characters and storylines were recommended (*note 15*).

Storytelling, metaphors and arts-based methods: Many participants were excited about the topics and found metaphors, storytelling, and creative arts helpful for delivering challenging content (*note 16*). They valued the role of interactive play, to learn about mental health and ACEs.

Participants valued the youth-friendly, non-judgemental approach (*note 17*) and the balance between fun and calming features (e.g., the *cosy den*) and more serious, emotionally heavy elements (*note 18*).

4. Perceived impact

Education, awareness and reflection: AoH raised awareness, helping participants learn about mental health and ACEs (*note 19*). It supported some participants to reflect on their experiences (*note 20*). Many reported a better understanding of others' life experiences, and that AoH might educate people about issues such as gender dysphoria (*note 21*).

Emotional impact and connection: Participants said their experiences were represented and they were seen and understood. They valued validation of different emotions, reassured by others sharing similar experiences (*notes 22-23*). The stories could also evoke emotions such as empathy and sadness, which, fostered a sense of connection with the characters and their narratives (*note 24*). Others reported feeling comforted, hopeful, or happy when positive outcomes occurred for the characters.

Psychological safety: Most participants reported feeling safe while playing the game. However, several noted content which could be challenging and potentially triggering (*note 25*). Participants recommended more trigger warnings (*note 26*), with pause options or return to the *cosy den* option.

Help-seeking: Some said the game could encourage help-seeking (*note 27*) or initiate conversations about mental health (*note 28*). However, many did not seek help themselves, either because they did not need support or had already received it. Participants noted a need for clearer signposting and interactive formats, such as clickable links to external websites or videos to enhance engagement and seeking further support (*note 29*).

Table 3. Themes, subthemes, and illustrative participant quotes or researcher notes

Themes and subthemes	Quote / note No.	Quote or note examples
Key theme 1: Design features, style, and customisability		
Overall design, feel and appearance	1	<i>"This is one of the most unique games I've ever played... There is nothing currently or previously out there that accurately represents young people who have caring responsibilities and so this is a great tool for lots of young people."</i> (P08; researcher note)
	2	<i>"Making it visually nice to play makes people engaged to play from the beginning if people aren't motivated to play. The first and third game, I really like the art style and game design."</i> (P04; researcher note)
	3	<i>"Some of the games just felt a bit simple and slow, I found them too easy or wanted them to go faster as the speed was making me a little bit bored at times... I didn't really like the way the game worked, it felt very repetitive and long, it nearly put me off the game as a whole but I got through it and moved on to more enjoyable mini-games."</i> (P03; quote)
Interactive elements and customisation	4	<i>"Loved the cosy room and the ability to customise this in one's own way and the fact that one could change little things and personalise this was great e.g. the guitar, lots to do in this room and was/is a chill out space after playing the game."</i> (P09; researcher note)

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	5	<i>"...a little journal type area where you could type away and life experience e.g. like the notes app on the phone. And the game could store these... Meditating space where it says 321 breath in and breath out – so a practical place and tips." (P05; quote)</i>
Key theme 2: User experience and accessibility		
User experience, navigation and ease of use	6	<i>"It could be a bit confusing when you were in a room to explore but didn't know where to start and what to do. For people unfamiliar with such game formats, it could be confusing. May be more signposting and direct guidance to play the game. It would also be beneficial for tailoring for people, e.g., neurodiverse users." (P06; researcher note)</i>
	7	<i>"I don't know how it could be more engaging. If you download a game, most of the time they send you notifications or something 'hey you haven't looked at me for two days' or something, if the person who saw the notification had a free moment, it would prompt them to play." (P11; researcher note)</i>
	8	<i>"I liked the simplicity of most of the games as well... It [was] very mostly very low effort, most of the games were very easy and I could easily play them while watching tv or talking to someone." (P03; quote)</i>
Accessibility of the mobile game	9	<i>"Yes I thought it was [accessible] apart from Mina's story because I found the controls didn't work very well with my dyspraxia. Other than that it was fine though because I don't have many other accessibility needs." (P03; quote)</i>

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	10	<i>"Maybe, it might be better if it was a desk top game. That's a space I dedicated to play the game. It's quite easy for me to pick up the phone but also easy to distract by other thing using my phone"</i> (P12; researcher note)
Key theme 3: Characters, stories and content		
Appropriateness and relatability	11	<i>"I liked that multiple of the characters represented experiences I've been through and I saw myself in them, I've never had that with a game before, although I don't play video games very often."</i> (P03; quote)
	12	<i>"In the Horse and Foal game the anxious aspect [referring to the anxiety bar] resonated with my experience and reminded me it's only temporary and doesn't last forever."</i> (P02; researcher note)
	13	<i>"Some of it was relatable but not a lot of it which is good thing because if it was all relatable that would be a bummer. When I reflect on it I'm not going to complain about not being able to relate to negative life experiences."</i> (P07; researcher note)
Intended for a younger audience	14	<i>"... but maybe I was a bit too old for them. I know I was at the upper end of the target demographic so I noticed it was targeted to people younger than me in the way it was portrayed. The first story was horse-riding and there was a metaphor for being a horse and that feels a bit childish.. I think it depends on the target audience. I'm 25 now so at that age of the end group it would make sense to have more complex characters."</i> (P11; researcher note)

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	15	<i>"Loads of outcomes for people in the ACEs categories (smoking, alcoholism, earlier death), they are real dangerous risks, kids who have been abused, self-harming activities (smoking, drinking, drugs), that the game doesn't explore which makes sense not including as not wanting to talk about them with younger kids... If targeted at older audience, those kinds of things definitely need to brought up." (P04; researcher note)</i>
Storytelling, metaphors and arts-based methods	16	<i>"I loved, the gender dysphoria, it might have been my favourite of the bunch. I loved the egg analogy; you hear about that all the time in the trans community. It's really cool that the term was incorporated into the game, in a youth friendly way. Can definitely see it being easy to understand for teenagers/pre-teens." (P04; researcher note)</i>
	17	<i>"Caring for parent(s) as a young age can bring shame and this was portrayed well in the game and was not super super judgemental." (P08; researcher note)</i>
	18	<i>"I really like the setting and customisation, e.g., painting, guitar. Take away the heaviness of the game, and be able to interact with the game and make fun" (P12; researcher note)</i>
Key theme 4: Perceived impact		
Education, awareness and reflection	19	<i>"I would say a bit of yes, especially in raising awareness. For someone who hasn't thought about these issues before, it could be quite eye-opening and change their mindset." (P06; researcher note)</i>

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	20	<i>"Thoughtful. It made me think more about it, the situation. Even if you haven't experienced those it makes you think about your own experiences even if it's not the same but similar."</i> (P11; researcher note)	Deleted: non-binary, 18-24 years;
	21	<i>"...a lot of the experiences weren't my experiences but they were interesting and it can be interesting to know about the experiences about other people, I know the game was to help heal people from these experiences but it was cool to learn about others experiences."</i> (P07; researcher note)	Deleted: non-binary, 18-24 years;
Emotional impact and connection	22	<i>"I think it reassured me that these experiences are shared by a lot of people as well as fictional characters and it did help me reflect a bit."</i> (P03; quote)	Deleted: man/boy, 16-17 years;
	23	<i>"It [the game] has helped in their journey and the shame that they experienced in their own journey in life"</i> (P08; researcher note)	Deleted: woman/girl, 18-24 years;
	24	<i>"They covered really dark topics and part of you feels sad when you read it, empathy for the characters, but you also feel seen and not normalises your experience but gives it a shape, a name."</i> (P04; researcher note)	Deleted: woman/girl, 18-24 years;
Psychological safety	25	<i>"Sometimes, it makes you feel emotional and stressful. When the darkness chases and approaches [horse and foal mini-game], it could be a bit stressful. For people with severe mental health challenges, that could be triggering ... Personally, I was okay. It's more about raising awareness and for advocating for these kinds of ACEs."</i> (P06; researcher note)	Deleted: man/boy, 16-17 years;
	26	<i>"...everyone is different so if someone is really currently traumatised this game could be triggering but then trigger warnings could be used perhaps."</i> (P08; researcher note)	Deleted: woman/girl, 18-24 years;

Help-seeking	27	<i>"Yes, it encouraged me to consider seeking help. It gave me the mindset that maybe I do need to take action, and made me feel that talking to a counsellor is a good decision."</i> (P06; researcher note)
	28	<i>"Good to start a conversation, maybe with teens who might not be willing to open up and talk about it or early 20s when you've matured more, when it would be easier to talk to someone about it, without having to go to someone about it."</i> (P11; researcher note)
	29	<i>"It could do a better job of connecting people to outside sites (Samaritans, suicide hotline ect) people you can talk to if you need to talk to...Especially if you come out of one of the minigames, and you're feeling down you can click one of the icons and see if you can talk to someone there."</i> (P10; researcher note)

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4. Harms / Adverse Events

There were no adverse events associated with this study.

No serious adverse events or other adverse events were reported by participants or identified by the study team during the three-month intervention period or at any assessment point. No harms or unintended effects were identified in the quantitative outcome data or in the process evaluation interviews.

