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Smartphone app-delivered Acceptance and Commitment Therapy (ACT) for post-traumatic stress disorder and gambling harm in veterans: A pilot feasibility study

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ABSTRACT

Gambling harm and post-traumatic stress disorder (PTSD) tend to be prevalent among veterans. Globally, help-seeking rates for gambling are low, and veterans may experience obstacles in accessing mental health support due to stigma. Digital health interventions may increase treatment uptake and improve outcomes for veterans. Here, we report findings from a pilot feasibility study of a novel smartphone application-based intervention, "ACT Vet", based on Acceptance and Commitment Therapy (ACT) for veterans experiencing PTSD symptoms, gambling harm, or both. A 10-week, within-subjects design was employed with 24 veterans (21 men, 2 women, 1 undisclosed; M_{age} = 45.29 years; SD = 10.70). Outcome measures assessed PTSD symptoms, gambling severity, psychological flexibility, anxiety, alcohol use, suicidality, and loneliness. We also examined participants' quality of life and app usability and acceptability ratings. Findings demonstrated significant reductions in both PTSD and gambling symptoms across the intervention, with a corresponding increase in psychological flexibility. Alcohol use also decreased post-intervention. High usability scores suggest the app was well-received by participants. Overall, the sustained improvements post-intervention indicates the successful deployment of ACT-based methods in an app format. ACT Vet has potential scalability as a first-line digital intervention for PTSD and/or gambling harm.

1. Introduction

Gambling participation rates are increasing globally. Frequent participation in gambling is strongly linked to the experience of harm from gambling (Tran et al., 2024). Gambling harm refers to the adverse effects from gambling on the health and wellbeing of individuals, families, communities, and society (Hautamaki et al., 2025; Hilbrecht et al., 2020; Wardle et al., 2024). Beyond gambling harm, gambling disorder, and problematic gambling represent distinct but overlapping classifications used in clinical and public health frameworks to assess gambling-related risks and consequences (Wardle et al., 2024). Gambling disorder (classified by the DSM-5), is a recognised behavioural addiction characterised by persistent and recurrent problematic gambling leading to significantly impairment or distress, whereas problem or problematic gambling, often assessed using the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001), captures a spectrum of gambling behaviours that may not meet diagnostic criteria but still result in negative consequences.

Armed Forces (i.e., military) veterans appear disproportionately affected by gambling harm (Dighton et al., 2023; Etuk et al., 2020; Jones et al., 2024; Stefanovics et al., 2022). For instance, in a cross-sectional, online survey with n = 1037 UK veterans and n = 1148 age- and gender-matched non-veterans, Dighton et al. (2023) found that veterans were more than 10 times more likely to experience problematic

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gambling than non-veterans. Other evidence suggests that gambling among veterans is associated with increased financial distress, greater reliance on social services, higher contact with the criminal justice system, lost work hours, accumulated debt, and increased benefit claims (Harris et al., 2023). Globally, then, gambling harm among veterans remains a pressing public and mental health issue.

Veterans experiencing gambling harm frequently present with co-occurring mental health challenges, including post-traumatic stress disorder (PTSD), anxiety, substance use disorders, and depression (Etuk et al., 2020; Rhead et al., 2022; Shirk et al., 2022; Stefanovics et al., 2022; Velotti et al., 2021). Combat trauma can further heighten the risk of PTSD, with the hyperarousal and avoidance characteristics of PTSD leading to gambling as an escape from distress (Moore & Grubbs, 2021). Notably, PTSD and gambling harm share a complex bidirectional relationship, where trauma exposure may increase susceptibility to gambling as a maladaptive coping mechanism (Etuk et al., 2020; Grubbs & Chapman, 2019).

Dighton et al. (2023) found that PTSD was a predictor of gambling harm, while Dighton et al. (2025) suggest that chronic hyperarousal, worry, and threat perception drive gambling as a maladaptive escape from distress. Additionally, anxiety seems to mediate the relationship between C-PTSD symptoms and gambling risk severity (Dighton et al., 2025). Although gambling may temporarily alleviate PTSD symptoms, it ultimately reinforces avoidance and exacerbates psychological distress (Neophytou et al., 2023; Subramaniam et al., 2015; Vaughan & Flack, 2022). Given this interplay, understanding and addressing the comorbidity of PTSD and gambling harm in veterans is critical for intervention and treatment.

Globally, help-seeking rates for gambling harm are low, especially in populations like veterans where difficulties in accessing support services may exist (Bijker et al., 2022; Hitch et al., 2023a; Metcalf et al., 2022). Gambling-related stigma reduces treatment-seeking behaviours (Quigley, 2022; Quigley et al., 2020) which may further compound the known difficulties some veterans experience in accessing mental health services (Champion et al., 2022; Randles & Finnegan, 2022; Royal College of Psychiatrists, 2022). Digital health interventions may hold promise in facilitating treatment uptake in veteran populations (Hitch et al., 2023a; Leightley et al., 2022; Reger et al., 2022). Smartphone applications (apps) can provide accessible, self-directed support outside clinical settings through tailored and personalised content and messaging (Williamson et al., 2022). However, at present, no apps exist that directly address the complex interplay of PTSD and gambling harm. Given the potentially high prevalence of PTSD and gambling comorbidity in veterans (Dighton et al., 2023; Shirk et al., 2022), there is a pressing need, therefore, for an empirically validated, veteran-specific digital intervention to treat these comorbid conditions.

Recent guidelines issued by the UK National Institutes for Clinical Excellence (National Institute for Health and Care Excellence, 2023) emphasised the importance of veteran-specific treatment of gambling harm and developing alternative treatment approaches which address the needs of veterans with comorbid conditions (Akbar, Arya, Conroy, Wilcox, & Page, 2023; Armoon et al., 2023; Najavits et al., 2011; Stefanovic et al., 2024). Indeed, treating the harm caused by gambling without addressing the (potential) underlying or co-occurring cause is likely to be counterproductive (Monson et al., 2023; Shirk et al., 2022) and ineffective in the long-term (Pfund et al., 2021). A great deal of evidence-based treatment research therefore needs to be undertaken to better help and support veterans experiencing harm from gambling.

Acceptance and Commitment Therapy (ACT) is a third-wave behavioural therapy primarily aimed at increasing psychological flexibility; the ability to tolerate distress while acting in alignment with personal values (Cherry et al., 2021). Psychological flexibility is the core mechanism through which ACT fosters long-term adaptability and well-being, rather than focusing directly on symptom reduction. ACT is based on six interrelated processes: acceptance of internal experiences, cognitive defusion, present-moment awareness, self-as-context, values clarification, and committed action (Hayes et al., 2006). The acceptability of ACT for military populations is supported by its integration into clinical guidelines, with the United States Department of Veterans Affairs offering a therapy manual for its provision (Settles et al., 2017). ACT is particularly relevant for PTSD, as low psychological flexibility and reliance on avoidance-based coping mechanisms are central to maintaining symptoms (Rowe-Johnson et al., 2024; Thompson et al., 2021). An early case study of a woman with PTSD indicated that twenty-one sessions of therapist-assisted ACT reduced CBT-resistant symptoms (Twohig, 2009). Furthermore, both individual and group ACT sessions show comparable increases in psychological flexibility, which coincides with decreases in PTSD symptoms (Wharton et al., 2019).

A recent meta-analysis found that in-person and digital ACT interventions are effective for veterans across multiple conditions and may be as effective as CBT (Donahue et al., 2024). Also, ACT may increase social support in veterans with PTSD (Kelly et al., 2022), treat depression in younger and older veterans (Karlin et al., 2013), and reduce symptoms of PTSD and associated alcohol use disorder (AUD) (Meyer et al., 2018). Overall, these studies suggest that ACT is accepted and feasible in producing change in psychological distress in veteran populations, while also targeting addictive behaviours (Hitch et al., 2023b) and may show promise as a transdiagnostic treatment (Dindo et al., 2017). However, little is currently known about digital interventions employing ACT for the treatment of PTSD and comorbid gambling harm among veterans (Hitch et al., 2023b).

To address these gaps, we developed the first smartphone app specifically designed for UK veterans experiencing PTSD with and without experience of gambling harm. The app, ACT Vet, offers a structured, evidence-based intervention aligned with the six core ACT components. A key innovation of ACT Vet is its focus on transdiagnostic symptom management, recognising that PTSD and gambling behaviours are interconnected through avoidance mechanisms (Hitch et al., 2023a, 2025). By improving psychological flexibility, the app aims to reduce PTSD symptoms, and in turn, is expected to decrease gambling symptoms. The aim of the present pilot feasibility study was therefore to evaluate the acceptability, usability and preliminary efficacy of an ACT-based digital intervention - ACT Vet - for UK veterans with symptoms of PTSD, gambling harm, or both. We assessed app acceptability and user engagement using standardised methods. We also expected that following the 10-week intervention, psychological flexibility scores would increase, and PTSD symptoms and gambling symptoms would decrease.

2. Method

2.1. Participants and recruitment

Recruitment occurred between July and October 2024. Participants were invited to take part in a 10-week research program to test a new ACT-based smartphone application for the treatment of gambling and/or PTSD in UK Armed Forces veterans. Participants were recruited from several sources: social media (Twitter/X), targeted advert campaigns on Facebook, Prolific participant panels, in-person veteran community hubs, and word of mouth (Heath et al., 2025; Williamson et al., 2023). Potential participants were provided with a link to the pre-screen eligibility questionnaire. Initially, N = 250 veterans were recruited for pre-screening and confirmed they were over 18, lived in the UK, a former member of the UK Armed Forces (and could provide their service number), used a smartphone (and, if so, what type), and shared their email address. Of these, 114 were excluded for not completing all survey questions and a further 57 respondents provided questionable responses (i.e., spam/bot, contained errors in veterans' service numbers or email addresses, were not based in the UK, or did not meet eligibility for either gambling harm or PTSD symptom severity). An eligible sample of $N = 79$ veterans were sent individual codes to access the ACT Vet app. Of these,

40 accessed or opened the app, while $N = 35$ completed initial baseline measures.

The *PTSD Checklist for DSM-5* (PCL-5; Murphy et al., 2017; Weathers et al., 2013) was administered to assess the severity of PTSD symptoms. The *Problem Gambling Severity Index* (PGSI; Ferris & Wynne, 2001) screened for the severity gambling problems (scores of 1 or above were taken as indicative of some harm from gambling). Participants were eligible if they met the criteria for probable PTSD (PCL-5 $\geq$ 33) and/or gambling harm (PGSI $\geq$1). Although the app was designed to address the co-occurrence of PTSD and gambling harm, this inclusive approach reflected the real-world variability in symptom profiles and allowed exploration of app engagement among veterans. A breakdown of eligibility is included in the Supplementary Materials. Overall, a final $N = 24$ was included in the final analysis; five participants met criteria for self-reported PTSD symptoms only, 10 for gambling harm only, and 9 for both conditions.

All participants provided written informed consent to participate in the study, which was approved by the Swansea University School of Psychology Research Ethics Committee (1-2023-6798-6614).

2.2. Materials and software

Demographics. Following pre-screening, eligible participants completed questions relating to age, gender, relationship status, ethnicity, country of residence, UK native status, level of education, living situation, employment status, and employment. Further questions relating to military characteristics assessed service type, time served, branch of service, highest rank achieved, deployment, and information on medical discharge.

Outcome measures. The outcome measures assessed PTSD symptoms, and gambling symptoms, psychological flexibility, app usability, anxiety, alcohol use, suicidality, social isolation, and quality of life.

PTSD symptom severity was measured using the 20-item PCL-5, on which participants scored how often they had been bothered by problems over a certain period, on a scale of 0 (not at all) to 4 (extremely). A total score is computed by summing all responses. The Cronbach alpha values were 0.96 for Baseline, 0.97 for Week 2, 0.95 for Week 4, and 0.98 for Week 10, indicating very good internal consistency.

The *Gambling Symptom Assessment Scale* (GSAS; Kim et al., 2009) provided 12 different items referring to gambling behaviours (e.g., "How many hours were you preoccupied with your urges to gamble?"). Each item was measured on a 5-point Likert scale, ranging from 0 (no symptoms) to 4 (extreme symptoms), and items were summed to create a total GSAS score from 0 to 48: extreme = 41–48, severe = 31–40, moderate = 21–30, mild = 8–20. The Cronbach alpha values were 0.96 for Baseline, 0.95 for Week 2, 0.94 for Week 4, 0.96 for Week 6, and 0.96 for Week 1, indicating good internal consistency.

The *Psy-Flex* (Gloster et al., 2021) measured psychological flexibility; this includes 6 items regarding psychological experiences rated on a scale of 1 (very seldom) to 5 (very often), such as "I engage thoroughly in things that are important, useful, or meaningful to me". All items were summed to create a total score. The *Psy-Flex* is context-sensitive, asking participants to rate their experiences in the last seven days, making intervention-related changes easy to detect (Gloster et al., 2021) while also capturing the six core components of ACT. The Cronbach alpha values were 0.75 for Baseline, 0.87 for Week 2, 0.86 for Week 4, 0.92 for Week 6, and 0.91 for Week 10, indicating good internal consistency.

For app usability, the 18-item *mHealth App Usability Questionnaire* (MAUQ; Zhou et al., 2019) assessed ACT Vet's ease of use, acceptability, information, and health management on a 7-point scale, ranging from 1 (disagree) to 7 (agree). A mean score was calculated per participant; higher scores correspond to higher usability. Cronbach's alpha was 0.92, indicating very good internal consistency.

The 7-item *Generalised Anxiety Disorder Questionnaire* (GAD-7; Spitzer et al., 2006) assessed anxiety symptoms at Baseline, Week 6 and Week 10. Participants rated how often they had been impacted by a series of problems, using a scale of 0 (not at all) to 3 (nearly every day). All items were summed to create a total score. The Cronbach alpha values were 0.93 for Baseline, 0.95 for Week 6, and 0.97 for Week 10, indicating good internal consistency.

Alcohol consumption was captured by the *Alcohol Use Disorders Identification Test-Concise* (AUDIT-C; Bush et al., 1998), providing three items that ask about consumption frequency. Scores range from 0 to 12, where the cut-off for low-risk drinking is a score of 3, and severe risk is 8 or above. Cronbach alpha values were 0.75 at Baseline and 0.88 at Week 10.

Suicidality and social isolation, respectively, were assessed with questions derived from the *Adult Psychiatric Morbidity Study* (APMS; NatCen & University of Leicester, 2023). Two questions asked about past-year suicidality, while one question asked about loneliness, with the dichotomous response options of "yes" or "no".

Quality of life was assessed with the *EQ-5D-5L* (EuroQol Research Foundation, 2019). Participants rated their health in terms of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression using a scale ranging from 0 (no problems) to 4 (extreme problems). These items were summed to create a perspective of perceived health (a higher score indicated diminished health) and a separate rating of overall health was provided on a scale of 0–100 (where 0 = "the worst health you can imagine" and 100 = "the best health you can imagine"). Cronbach alpha values were 0.86 at Baseline and 0.91 at Week 10, indicating good internal consistency.

ACT Vet app. The ACT Vet app was developed using IONIC Capacitor framework, with data hosted on Google Cloud infrastructure and developed to a Research Viable Product standard (Leightley, 2024). The ACT Vet app provided ACT through a series of scripts and was manualised, self-directed, and intended to be used without external support. The core components of ACT were delivered through seven modules or steps: 1) Introduction; provides an overview of ACT Vet and ACT as a therapeutic practice; 2) Exploring thoughts around coping (cognitive defusion); 3) Control as the problem (acceptance); 4) Contact with the present (present moment awareness); 5) The self as the observer (self as context); 6) Living by your values (values); 7) Committing to action (committed action). Each step took approximately 15 min to complete and was separated by a period of five days to prevent completion of all intervention steps in one session and to foster opportunities for further self-reflection. The completion of all steps took approximately four weeks and users were instructed to continue to use the app for the remainder of the research program (10 weeks).

2.3. Procedure

On accessing the app for the first time, baseline measures of demographics, PTSD, gambling symptoms, psychological flexibility, anxiety, suicidality, loneliness, alcohol consumption, and quality of life were completed. Following baseline, participants had full access to the app and began to complete the seven steps of ACT content. The app was programmed so that each step opened five days after prior step completion; thus, Step 2 opened on Day 5 of the intervention, Step 3 on Day 10, Step 4 on Day 15, Step 5 on Day 20, and Step 6, and a "Brief" module on Day 25. All steps begin with a 3-min breathing exercise to encourage individuals to enter a mindful state prior to completing the steps. Push notifications alerted users to a newly opened step, as well as any outstanding questionnaires.

Intervention content. For a summary of the modules, content, and days of the intervention, see Fig. 1 and for examples of the app visuals, see Fig. 2. The Introduction module provided the authors' overview of ACT as an experiential therapy, including the aims of the intervention and the therapy process. As a result, there are likely to be alternative interpretations and representations of some of the psychological flexibility constructs to those adopted here.

Fig. 1. The intervention content. The theme of each module/step is provided, as well as the day of the intervention that the step became available to participants.

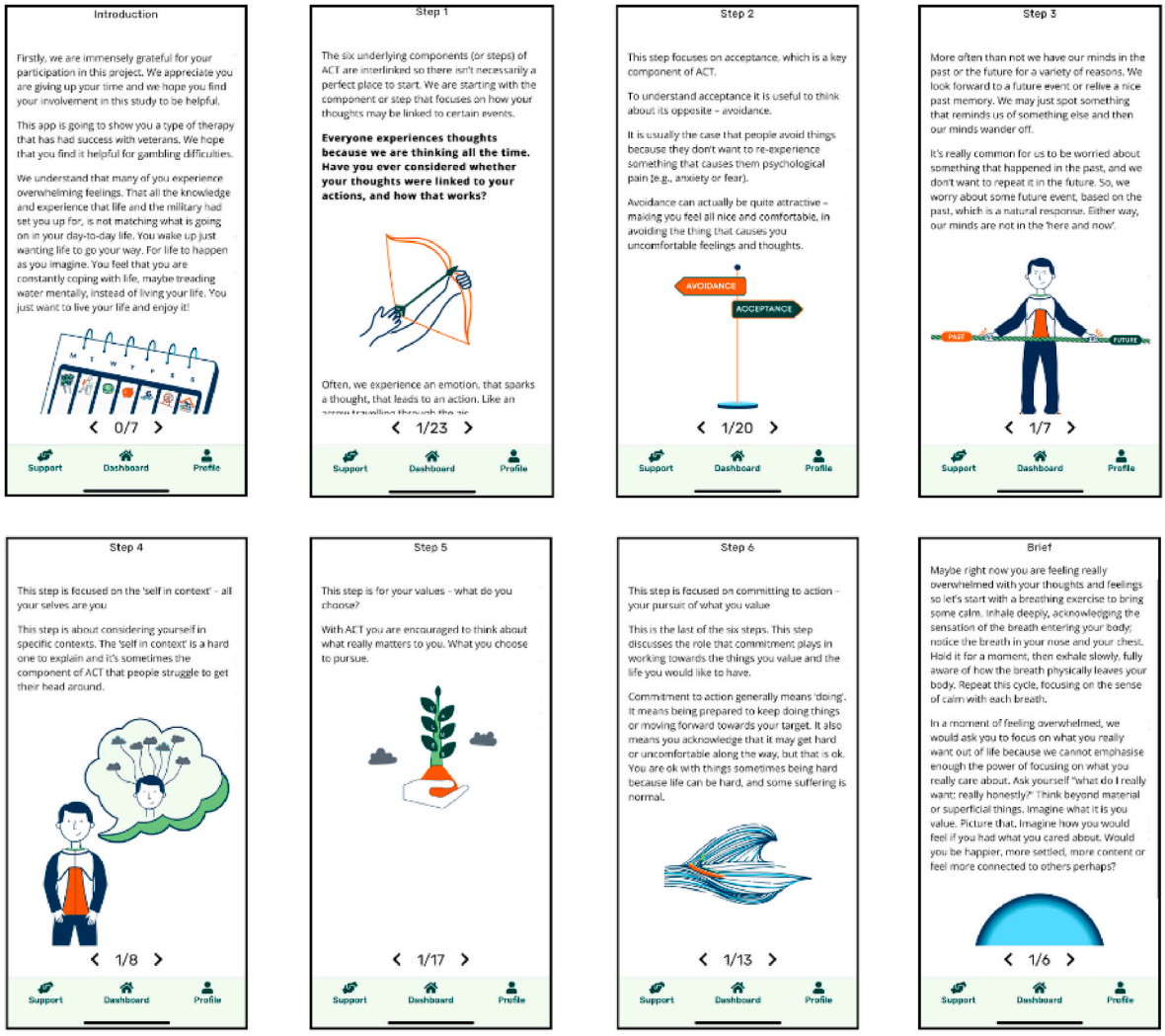

Fig. 2. Examples of the visual in-app screens presented to participants. A screenshot is taken from each Step of the app, from Step 1 to the Brief module.

Step 1 provided information on cognitive defusion or how we might come to see thoughts as possessing literal meaning by increasing awareness of the process of thinking itself (Assaz et al., 2023; Blackledge, 2015). This step emphasised how to notice the often-unhelpful connections between thoughts and behaviours such as gambling in response to psychological distress.

Step 2 focused on acceptance. In it, reasons for avoidance were considered, as well as how to accept that life has unexpected and unpleasant experiences that need their own space. Avoidance as an ineffective long-term strategy was noted.

Step 3 considered being present and in contact with the moment. The emphasis was on focusing on the moment and being mindful, but

also to notice thoughts and feelings which may evoke problematic gambling.

Step 4 focused on the self-in-context. This step explored the "immutable I" (Dymond & Barnes, 1997) which emphasised that the individual has existed throughout time; "*the you that is now and the you that you will become*". The purpose was to encourage the individual to notice that "all your selves are you" and to think of their selves in different contexts in the past, present, and future where gambling may or may not have been involved.

Step 5 focused on the power and changeability of values and the difference between values and goals. Choosing to work towards values, rather than maladaptive behaviours (e.g., gambling), was encouraged as it facilitates increased psychological flexibility.

Step 6 was the final (main) step, which concerned committing to action. Individuals were encouraged to keep moving forward towards their valued goals, while acknowledging the difficulties and discomfort that can be faced. Positive responses to distress were highlighted that promoted moving towards goals, such as going for a walk instead of gambling, as well as acceptance of what is outside of one's control (e.g., urges to gamble).

A "Brief" module opened at the same time as Step 6 which provided an overview of the six modules and was intended to be used as a rapid-support tool or a reminder of the ACT skills learned to date.

The intervention was approximately four weeks in duration. Participants were instructed to continue to use the app as and when required for the remainder of the 10-week research programme and that they could use the "Brief" module or revisit previous steps. Outcome measures were administered at five different time points: Baseline, Week 2, Week 4, Week 6, and Week 10 (follow-up) (see Table 1), with the first four obtained in-app and the final week (Week 10) via Qualtrics. For a visualisation of the study flow, see Fig. 3.

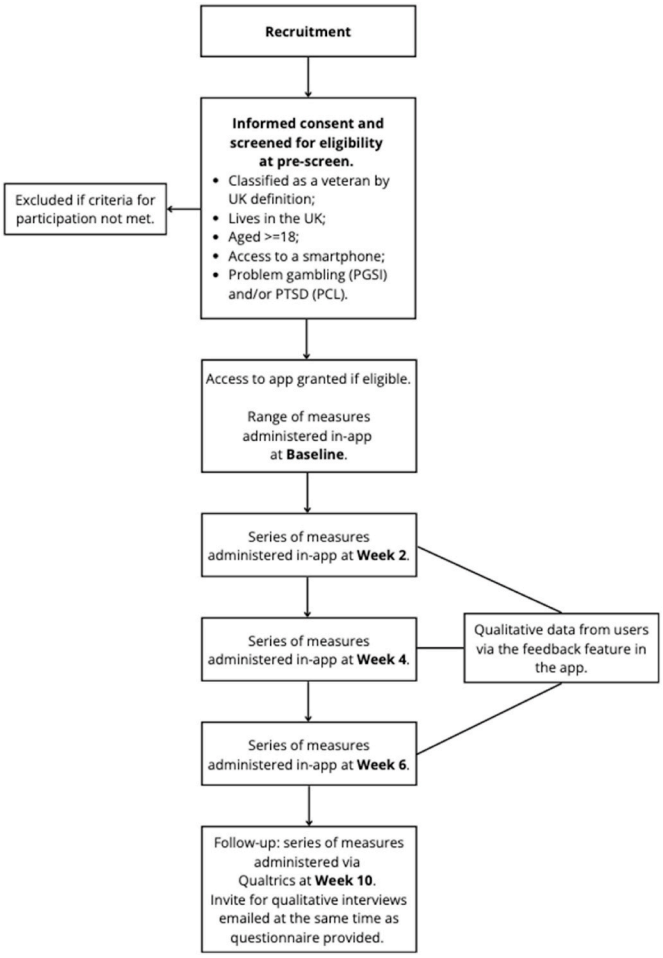

Fig. 3. An overview of the study procedure.

2.4. Statistical analysis

Analyses were conducted using SPSS (version 29.0.2.0) and R (version 3.6.3). A within-subjects design with repeated measures was calculated to evaluate changes in psychological flexibility (PsyFlex), PTSD symptoms (PCL), and gambling symptoms (GSAS) across five time points (Baseline, Weeks 2, 4, 6, and 10). Descriptive statistics (means, SDs) were reported for all outcomes. Multilevel models were estimated using the lmer function (lme4 package) to assess changes over time. A total of 24 participants were included in the analysis, contributing 107 observations across the five timepoints (Baseline, Weeks 2, 4, 6, and 10). Random intercepts were included for participants. Data were compared between participants who completed all timepoints and those with missing data at any interim point. No significant differences were found for PTSD symptoms, gambling symptoms, psychological flexibility, and age ($p > .05$), supporting the assumption that the data were Missing at Random (MAR). Full Information Maximum Likelihood (FIML) was used to account for missing data in longitudinal models (Dong & Peng, 2013). Pairwise comparisons were conducted using the *emmeans* package with corrections for multiple comparisons. Intraclass Coefficients (ICCs) and residual variances were conducted for each model (assumptions were tested and met). Scores on the AUDIT-C, EQ 5D, GAD-7, PGSI-SF were analysed using Wilcoxon signed-rank tests or Friedman's ANOVA, depending on the number of time points, and given the non-normal distribution of these data. Suicidality and loneliness measures were summarised using descriptive statistics. As this was a feasibility investigation, no a priori power analysis was conducted. Finally, app-engagement metrics were assessed and summary statistics

Table 1
Outcome measures collected across the ACT Vet study.

	Week number									
	Baseline	1	2	3	4	5	6	7	8	9	10
Demographics	X										
Psychological Flexibility (PsyFlex)	X		X		X		X				X
PTSD (PCL-5)	X		X		X		X				X
Anxiety (GAD-7)	X						X				X
Alcohol Intake (AUDIT-C)	X										X
Suicide/Loneliness (APMS)	X		X		X		X				X
Gambling (PGSI)[a]											
Gambling (SF-PGSI)			X		X		X				X
Gambling (GSAS)	X		X		X		X				X
Quality of Life (EQ5D)	X										X
Usability (MAUQ)											X

[a] Full PGSI administered at pre-screen only.

calculated. Revisits to completed steps were calculated for the different phases of the study (intervention – Weeks 0–4; post-intervention – Weeks 5–10; after Week 10). App activity was also collated by sessions of continuous engagement; a new session was defined when at least 15 min occurred between consecutive events for a user. For each session, the duration was calculated as the difference between the first and last event time. Duration within a given phase was summed, mean duration was calculated per session, and maximum session duration within each phase determined in minutes. Engaged weeks were defined as having three or more interactions within a given week; the total number of engaged weeks were calculated overall and per phase. Passive or system events, such as notification processing, were excluded from calculations.

3. Results

3.1. Recruitment

A range of recruitment methods were employed with mixed success (Heath et al., 2025). In recruitment campaign lasting 27 days, targeted study adverts on Facebook accounted for 21 eligible veterans (seven unpaid, 14 via paid-for advertising). Calls for participants submitted to Prolific, an online recruitment panel for a range of scientific studies, accounted for 50 veterans. Additional recruitment strategies such as in-person meetings with veterans' services charities recruited eight eligible veterans. In total, 79 eligible veterans were recruited and received activation codes for ACT Vet, with 25 completing the full programme; of these n = 79, 31 were men, 3 were women, and one participant did not respond. The mean age was 44.77 years (SD = 10.89), all were of White British ethnicity, 48.57 % met criteria for self-reported PTSD symptoms using the PCL, and none had a formal diagnosis of gambling disorder. Following commencement of data collection, one participant formally withdrew and a further 7 veterans either completed only baseline measures or none and were thus excluded from analysis. Rates of attrition varied across the multi-week intervention. A total of 25 veterans completed Week 2 measures, 21 completed Week 4 measures, 16 completed Week 6 measures, and 24 completed Week 10 measures. Two participants missed Week 2 and Week 6 measures, and three participants missed Week 4 and Week 6 measures. A total of n = 13 completed all questionnaires. Those who completed baseline and Week 10 measures were included in the final analysis (n = 24).

The final sample size consisted of 24 veterans, mean age 45.29 years (SD = 10.70), of which there were 21 men and 2 women (one participant did not respond). Nine (37.5 %) had a PTSD diagnosis and none had a formal diagnosis of gambling disorder. More than 37 % were receiving treatment for a mental health condition, and 8.3 % for gambling-harm related problems.

3.2. Demographic characteristics

Table 2 displays the demographics and characteristics of military experience of the participants, as well as the mean PCL and PGSI scores at pre-screening (see also Supplementary Materials). At pre-screen, the mean PCL score was 40.92 (20.12) and the mean PGSI score was 5.47 (3.59) indicating moderate risk of problem gambling.

Descriptive statistics are provided in Table 3. At Baseline, the mean PsyFlex score was 20.13 (SD = 4.09), mean PCL score was 39.71 (SD = 18.44), which was higher than the cut-off score of 33 for probable PTSD (Weathers et al., 2013), and the mean GSAS score was 18.88 (SD = 11.40), which indicated a mild level of gambling symptomatology. The MAUQ revealed high perceptions of usability (M = 6.09; SD = 0.76; range 4.18–7.00) indicating that ACT Vet was well-received and deemed highly usable by veterans.

Table 2
Summary statistics (frequency, N and percentage, %) of education levels, employment, employment types, military branch, and medical discharge status. Means (SD), minimums, and maximums are provided for number of deployments, length of service, and participants' PCL and PGSI scores at pre-screen.

	N	%
Education Level		
No Qualifications	0	0.0 %
Functional Skills	1	4.2 %
GCSE or Equivalent (D-G)	1	4.2 %
GCSE or Equivalent (A*-C)	3	12.5 %
AS/A Levels	3	12.5 %
Certificate of Higher Education	4	16.7 %
Diploma of Higher Education (Bachelors)	12	50.0 %
Employment		
Employed	18	75.0 %
Unemployed	5	20.8 %
Retired	0	0.0 %
Other	1	4.3 %
Employment - Type		
Clerical Worker	1	4.2 %
Armed Forces	0	0.0 %
Services/Sales	1	4.2 %
Professional	3	12.5 %
Skilled Labourer	6	25.0 %
Manager	6	25.0 %
Other	7	29.2 %
Military Branch		
Army	14	58.3 %
Navy	4	16.7 %
Royal Air Force	6	25.0 %
Royal Marines	0	0.0 %
Medical Discharge		
Yes	2	8.3 %
No	22	91.7 %
Number of Deployments		
Mean (SD)	3.58 (3.24)	
Min	0	
Max	12	
Length of Service		
Mean (SD)	10.00 (6.26)	
Min	3	
Max	27	
Pre-screen PCL Score		
Mean (SD)	40.92 (20.12)	
Min	9	
Max	80	
Pre-screen PGSI Score		
Mean (SD)	5.47 (3.59)	
Min	0	
Max	11	

3.3. Multilevel modelling

Three separate multilevel models were conducted to determine the effect of time on PsyFlex (ICC = 0.590, σ^2 = 13.48), PCL (ICC = 0.889, σ^2 = 351.65), and GSAS scores (ICC = 0.680, σ^2 = 66.39). The estimated mean PsyFlex score at Baseline was 20.13 (SE = 0.98, $p < .001$, 95 % CI [18.16, 22.09], mean PCL was 39.71 (SE = 4.06, $p < .001$, 95 % CI [31.38, 48.03]), and mean GSAS score was 18.88 (SE = 2.02, $p < .001$, 95 % CI [14.80, 22.95]). The fixed effects and pairwise comparisons for each model are displayed in Table 4, and the estimated mean scores across the weekly timepoints are displayed in Fig. 4. For PsyFlex scores, only Week 10 significantly differed from Baseline ($p < .001$); psychological flexibility increased from Baseline to Week 10.

Pairwise comparisons revealed a significant increase from Week 2 and Week 10 ($p = .01$), and Week 6 and Week 10 ($p = .007$). Considering PCL scores, all time points were significantly different from Baseline ($p < .001$), suggesting PTSD symptoms significantly decreased across the intervention. Pairwise comparisons found significant differences between Week 2 and Week 4 ($p = .01$), and Week 2 and Week 10 ($p = .002$). PCL scores showed significant decreases between these time

Table 3
Means, standard deviations (SD), proportion endorsement, and N for all variables across the intervention.

	Baseline	Week 2	Week 4	Week 6	Week 10
PsyFlex	20.13 (4.09)	19.70 (5.00)	21.05 (4.30)	19.88 (6.37)	23.29 (4.44)
PCL	39.71 (18.44)	32.00 (20.72)	25.70 (16.23)	31.06 (22.66)	24.38 (20.76)
GSAS	18.88 (11.40)	15.52 (10.73)	10.55 (8.55)	12.81 (10.44)	8.54 (8.34)
MAUQ					6.09 (0.76)
AUDIT-C	4.92 (2.57)	–	–	–	2.75 (2.71)
GAD-7	10.63 (6.04)	–	–	8.40 (7.17)	6.79 (6.59)
PGSI-SF	–	1.65 (2.08)	1.40 (1.67)	1.69 (2.12)	1.13 (1.80)
Suicide					
Thoughts					
Yes	45.8 %	39.1 %	55.0 %	43.8 %	20.8 %
No	54.2 %	60.9 %	45.0 %	56.3 %	79.2 %
N	24	23	20	16	24
Attempts					
Yes	16.7 %	8.7 %	5.0 %	12.5 %	4.2 %
No	83.3 %	91.3 %	95.0 %	87.5 %	95.8 %
N	24	23	20	16	24
Loneliness					
Not at all	4.2 %	8.7 %	5.0 %	6.3 %	12.5 %
Not usually	45.8 %	56.5 %	65.0 %	56.3 %	62.5 %
Much of the time	29.2 %	8.7 %	20.0 %	12.5 %	8.3 %
Almost all of the time	20.8 %	26.1 %	10.0 %	25.0 %	16.7 %
N	24	23	20	16	24
EQ5D	8.83 (4.01)	–	–	–	8.13 (4.82)
EQ5D (Overall Health)	68.75 (20.24)	–	–	–	74.50 (22.02)

points. The remaining comparisons were non-significant ($p > .05$). Finally, for GSAS scores, all time points except Week 2 ($p > .05$) differed from Baseline ($p < .001$), indicating a general decrease in gambling symptoms. Pairwise comparisons revealed a significant decrease between Week 2 and Week 10 ($p = .01$). The remaining comparisons were non-significant ($p > .05$).

Also, AUDIT-C scores significantly decreased over the 10- week intervention ($Z = -4.05$, $p < .001$). GAD-7 scores did not significantly differ between Baseline, Week 6, and Week 10 ($X^2(2) = 1.82$, $p = .404$). Also, PGSI-SF scores did not differ between Weeks 2, 4, 6 and 10 ($X^2(3) = 0.76$, $p = .859$). Both thoughts of suicide and attempts decreased across the intervention, while self-reported loneliness and social isolation showed similar reductions. Finally, overall health scores significantly increased ($Z = -2.11$, $p = .035$) between Baseline and Week 10. Regarding quality of life, total EQ5D scores did not show a significant change ($Z = -1.27$, $p = .204$).

3.4. App engagement

The mean number of weeks where participants engaged with ACT Vet was 14.92. (SD = 4.29) To explore use of the app during and following the 4-week intervention, the mean number of engaged weeks, total minutes spent on the app, as well as the number of revisits were calculated per phase (Table 5). The intervention period (Weeks 0–4) showed the highest level of revisits (875; 63.09 %), and as expected, revisits of the app content decreased post-intervention (388; 27.97 %), and after Week 10 (124; 8.94 %). The breathing exercises (227, 65, and 10 revisits per phase, respectively) and Support tab (101, 59, 30 revisits per phase, respectively) were the most revisited content. Overall time spent on the app was highest during the intervention phase (a total of 2491.55 min). This decreased to 714.31 min in Weeks 5–10, and 283.00

Table 4
Fixed effects and pairwise comparisons for the model testing the differences between each time point on PsyFlex scores, PCL scores, and GSAS scores. The fixed effect statistics show how each Week (2, 4, 6, 10) differs from Baseline. b = standardised estimate, SE = standard error, df = degrees of freedom, 95 % CI = confidence intervals, t = t-statistics, p = p-value. Significance is highlighted in bold. Number of observations = 107.

	b	SE	df	95 % CI	t	p
PsyFlex - Fixed Effects						
Week 2	−0.474	0.895	79.331	[-2.255, 1.306]	−0.530	0.597
Week 4	1.282	0.935	79.733	[-0.579, 3.143]	1.371	0.174
Week 6	−0.338	1.009	80.386	[-2.345, 1.669]	−0.335	0.738
Week 10	3.167	0.882	79.135	[1.411, 4.923]	3.589	**< .001**
Pairwise Comparisons						
Week 2 - Week 4	−1.756	0.948	79.873	[-4.403, 0.890]	−1.853	0.351
Week 2 - Week 6	−0.136	1.015	80.099	[-2.970, 2.698]	−0.134	0.999
Week 2 - Week 10	−3.641	0.895	79.210	[-6.138, −1.144]	−4.070	**.001**
Week 4 - Week 6	1.620	1.059	80.765	[-1.334, 4.574]	1.531	0.546
Week 4 - Week 10	−1.885	0.935	79.613	[-4.495, 0.726]	−2.015	0.268
Week 6 - Week 10	−3.505	1.009	80.269	[-6.322, −0.688]	−3.472	**.007**
PCL - Fixed Effects						
Week 2	−7.864	1.941	79.045	[-11.727, −4.001]	−4.052	**.001**
Week 4	−14.609	2.031	79.129	[-18.651, −10.567]	−7.193	**< .001**
Week 6	−10.987	2.195	79.266	[-15.355, −6.620]	−5.007	**< .001**
Week 10	−15.333	1.914	79.001	[-19.142, −11.525]	−8.013	**< .001**
Pairwise Comparisons						
Week 2 - Week 4	6.745	2.060	79.187	[0.994, 12.496]	3.274	**.013**
Week 2 - Week 6	3.124	2.207	79.228	[-3.037, 9.285]	1.415	0.620
Week 2 - Week 10	7.469	1.941	79.045	[2.051, 12.888]	3.848	**.002**
Week 4 - Week 6	−3.622	2.304	79.371	[-10.054, 2.81]	−1.572	0.520
Week 4 - Week 10	0.724	2.031	79.129	[-4.946, 6.394]	0.357	0.996
Week 6 - Week 10	4.346	2.195	79.266	[-1.781, 10.473]	1.980	0.285
Fixed Effects - GSAS						
Week 2	−3.150	1.637	79.295	[-6.408, 0.108]	−1.924	0.058
Week 4	−7.515	1.712	79.583	[-10.922, −4.108]	−4.389	**< .001**
Week 6	−6.381	1.849	80.052	[-10.058, −2.704]	−3.452	**.008**
Week 10	−10.333	1.614	79.150	[-13.547, −7.120]	−6.401	**< .001**
Pairwise Comparisons						
Week 2 - Week 4	4.365	1.736	79.633	[-0.480, 9.211]	2.514	0.098
Week 2 - Week 6	3.231	1.859	79.788	[-1.959, 8.421]	1.738	0.417
Week 2 - Week 10	7.183	1.637	79.152	[2.613, 11.753]	4.388	**< .001**
Week 4 - Week 6	−1.134	1.940	80.270	[-6.547, 4.279]	−0.585	0.977
Week 4 - Week 10	2.818	1.712	79.441	[-1.961, 7.598]	1.646	0.473
Week 6 - Week 10	3.952	1.849	79.912	[-1.207, 9.112]	2.138	0.215

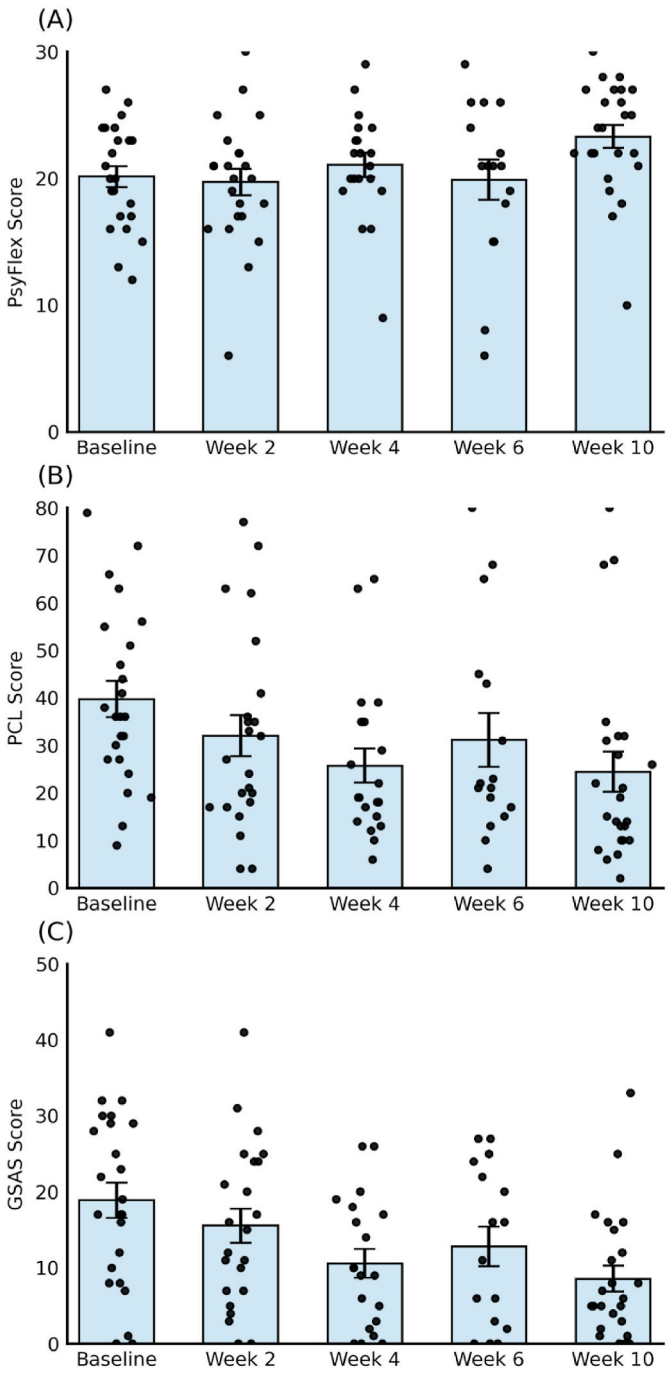

Fig. 4. The change in predicted PsyFlex (A), PCL (B), and GSAS (C) (estimated means) from Baseline (intercept) to Week 10. Black dots represent the participants' raw scores. Error bars represent 95 % Confidence Intervals. The self-directed intervention lasted to Week 4, with participants instructed to continue using the app as and when needed from Week 4 to Week 10.

min after Week 10.

4. Discussion

The aim of the present study was to pilot the preliminary efficacy of ACT Vet, a smartphone-based ACT intervention for veterans experiencing PTSD symptoms and/or gambling harm. We expected to see improved symptomology post-intervention, with changes in psychological flexibility, PTSD symptoms, and gambling symptoms. Our findings supported these predictions and highlight the central role of psychological flexibility in addressing comorbid PTSD and gambling harm. Significant increases in PsyFlex scores occurred from Baseline to Week 10, as well as from Weeks 2 and 6 to Week 10. The gradual rather than immediate improvement suggests that psychological flexibility develops incrementally through ongoing engagement with ACT principles (Hayes et al., 2006). In addition, significant reductions in PTSD symptoms (Donahue et al., 2024; Kelly et al., 2022) and gambling symptoms (Meyer et al., 2018) further support the effectiveness of the intervention. Also, although app engagement decreased after Week 4, the stability of symptoms between Weeks 4 and 10 suggest that short-term interventions can produce lasting benefits (Dindo et al., 2017; Østergaard et al., 2020).

Observed reductions in negative symptoms may be explained by how ACT targets shared underlying processes across both conditions. Psychological flexibility supports veterans in reducing avoidance-based coping, a transdiagnostic feature central to both PTSD and gambling (Thompson et al., 2021; Twohig et al., 2021). For example, acceptance skills enable individuals to open up to distressing trauma-related thoughts and emotions, rather than suppressing or escaping through gambling. Cognitive defusion may help veterans to defuse from unhelpful trauma-linked beliefs, weakening their behavioural impact (Assaz et al., 2023). Moreover, values clarification and committed action encourage re-engagement with personally meaningful goals, which may be particularly important for veterans adjusting to civilian life and rebuilding identity post-service.

These processes are theoretically coherent with symptom changes observed in this study and highlight ACT's relevance for complex comorbid presentations (Hitch et al., 2023b). Our results align with ACT's theoretical framework, emphasising the transdiagnostic status of psychological flexibility and the central role played by avoidance in maladaptive behaviour (Hayes et al., 2006). Furthermore, the role of psychological flexibility in shaping individuals' responses to internal distress may explain differences in gambling motivation among veterans. Research suggests that gambling to escape or avoid negative emotions is strongly associated with "problem gambling", particularly in those experiencing PTSD (Dighton et al., 2023). In contrast, gambling for social or recreational reasons tends to be less harmful. Within the current sample, reductions in gambling symptoms coincided with decreases in PTSD severity and increases in psychological flexibility, suggesting that as veterans developed greater capacity to stay present with difficult internal experiences, they become less reliant on gambling as an avoidant coping strategy.

Although ACT has been applied to the treatment of PTSD and addictive behaviours, this study is the first to examine its effects via a self-directed digital intervention tailored for veterans experiencing both PTSD symptoms and gambling harm. With high prevalence of these co-occurring conditions and the unique challenges faced by veterans (Dighton et al., 2023), these findings contribute novel insights into how psychological flexibility can be harnessed to reduce the reliance on maladaptive coping mechanisms. Beyond the veteran population, ACT Vet may also have relevance for addressing gambling harm in the general population. As highlighted by McCurdy et al. (2023), the quality and theoretical grounding of publicly available gambling apps remain limited, with few addressing comorbid mental health conditions.

Most existing apps focus on CBT-based strategies and behavioural tracking, potentially overlooking transdiagnostic factors such as experiential avoidance that underpin gambling and mental health difficulties. ACT-based approaches are increasingly recognised for their effectiveness in targeting shared mechanisms (Dindo et al., 2017), and thus, by increasing psychological flexibility, ACT Vet offers a model that could be adapted for broader use in non-veteran populations affected by gambling harm and poor mental health. Importantly, the digital format of ACT Vet aligns with growing evidence that scalable, self-guided interventions are acceptable and effective (Torous et al., 2021), especially for veterans (Leightley et al., 2022; Possemato et al., 2017).

A notable impact of the intervention was the decrease in self-

Table 5
App engagement information, split by phase. The total number and percentage per phase of step/activity revisits are presented, as well as the total amount of time (minutes) spent on the app during each phase (usage). The mean length of a session, as well as the maximum length of a session, is presented.

	Intervention (Weeks 0–4)		Post-Intervention (Weeks 5–10)		After Week 10	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Total Revisits	875	63.09 %	388	27.97 %	124	8.94 %
Introduction	73	67.59 %	50	25.00 %	13	7.41 %
Step 1 – Defusion	73	60.83 %	30	25.00 %	17	14.17 %
Step 2 – Acceptance	80	68.38 %	28	23.93 %	9	7.69 %
Step 3 – Present contact	76	65.52 %	31	26.72 %	9	7.76 %
Step 4 – Self-in-context	80	67.23 %	32	26.89 %	7	5.88 %
Step 5 – Values	75	66.37 %	26	23.01 %	12	10.62 %
Step 6 – Commit to action	43	47.78 %	38	42.22 %	9	10.00 %
BRIEF	46	42.20 %	50	45.87 %	13	11.93 %
Breathing Exercise	227	75.17 %	65	21.52 %	10	3.31 %
Support Tab	101	53.16 %	59	31.05 %	30	15.79 %
Mean Engaged Weeks (SD)	4.17 (0.96)		5.67 (1.52)		5.81 (3.30)	
Total Usage Minutes	2491.55		714.31		283.00	
Mean Session Minutes (SD)	4.37 (6.82)		1.48 (3.32)		1.80 (5.25)	
Maximum Session Minutes	49.76		48.33		51.09	

reported alcohol use by Week 10 (Meyer et al., 2018). Risky drinking is considered a typical escape/avoidance behaviour associated with PTSD in veteran populations (Livingston et al., 2022), and thus ACT Vet may have a broader impact on individuals' coping strategies. This reduction in alcohol consumption suggests that psychological flexibility may have shifted individuals away from avoidance-based coping strategies, leading to healthier behavioural patterns. Additionally, improvements in PTSD symptoms and gambling symptoms may have indirectly influenced drinking behaviours. Veterans who gamble often engage in social drinking within gambling environments (Pennay et al., 2020), and this finding aligns with research suggesting that changes in one maladaptive behaviour can impact other related behaviours when underlying psychological mechanisms are addressed (Swerdlow et al., 2020).

We expected positive user experiences and high usability scores and, indeed, the app achieved high MAUQ ratings, surpassing those of previous digital interventions for addictive disorders in veterans (Leightley et al., 2022). This indicates the app was user friendly, well-received, and understandable. According to the UK Medical Research Council (MRC) framework for the development of complex interventions (Skivington et al., 2021), the next steps in research evaluation of the smartphone app should involve optimisation, further feasibility testing, and full-scale evaluation. Refinements could focus on enhancing engagement (e.g., interactive features) and addressing barriers to sustained use (e.g., personalisation, increased content). A randomised controlled trial (RCT) design could be used to assess efficacy with longer-term follow-ups. Ultimately, implementation research should explore scalability within NHS and veteran support services, ensuring ACT Vet's real-world impact.

4.1. Limitations

The small sample of mainly male veterans, derived from an opportunistic sample, restricts generalisability. Attrition was a notable limitation, and while multilevel modelling accounted for missing data, the sample may not have been representative of the larger veteran population. In total, 79 eligible veterans were recruited, with 25 completing the full study, many of whom were treatment-seeking and familiar with smartphone. The maintenance of symptom improvement is unclear, as extended follow-ups were not conducted beyond Week 10 due to time constraints. Thus, any causal inferences about the impact of the app must remain preliminary. Not all participants met criteria for both self-reported PTSD symptoms and gambling harm. This heterogeneity in comorbid profiles makes it difficult to determine whether effects differ for individuals with one vs. both conditions, and thus, future studies would benefit from stratified analyses or eligibility criteria that reflect more homogeneous clinical profiles. Although Psy-Flex is a practical, easy-to-use scale (Cunha et al., 2024; Gloster et al., 2021), it is a relatively new measure of psychological flexibility and may not fully capture all facets like other more holistic measures such as the Acceptance and Action Questionnaire-II (Bond et al., 2011) or the Comprehensive Assessment of Commitment Therapy Processes (Francis et al., 2016). Finally, the intervention content may benefit from further refinement such as whether a condensed app format, optional pathways, or additional interactive elements could improve both adherence and outcomes.

5. Conclusion

ACT Vet shows promise as a digital, smartphone-based intervention for alleviating symptoms of PTSD and gambling harm in veterans. The app increased psychological flexibility and reduced both self-reported PTSD symptoms and indicators of gambling harm, showing the potential of digital ACT as a transdiagnostic intervention to address co-occurring mental health symptoms among veterans. Symptom improvement was maintained post-intervention. High usability scores and sustained engagement suggests that ACT Vet may be a viable option for veterans who face barriers to traditional treatment. The findings of this pilot study suggest that ACT Vet has potential as a scalable, flexible, evidence-based digital intervention. Future work should build on these findings through larger-scale trials, including RCTs, to establish long-term efficacy and implementation potential within clinical settings.

CRediT authorship contribution statement

Jess M. Williams: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Conor Heath:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Daniel Leightley:** Writing – review & editing, Software, Resources, Methodology, Investigation, Funding acquisition, Conceptualization. **Dominic Murphy:** Writing – review & editing, Software, Resources, Investigation, Funding acquisition, Conceptualization. **Simon Dymond:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Pre-registration

The research team had originally planned to submit a separate protocol paper, detailing the trial and analysis plans. Due to time and funding constraints, we opted to run the pilot without pre-registration.

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Conflicts of interest

JMW, CH, DM, and SD have no disclosures. DL is a reservist in the UK Armed Forces. This work has been undertaken as part of his civilian employment.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcbs.2025.100956.

Data availability

Study data available here: https://osf.io/34h9f/?view_only=397942de1bea437fa73e8366177f727f.

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