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Lessons learned from a randomised controlled trial of a digital intervention targeting eating disorder symptoms in cisgender sexual minoritized men

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Abstract

Background: There is an unmet need for evidence-based and accessible interventions designed to treat eating disorders in sexual minoritized men, given their heightened vulnerability to developing disordered eating. Digital interventions are a promising avenue for eating disorder treatment because of their accessibility and flexibility in delivery. Here, we present a randomised controlled trial of *Seed*, a 10-week treatment-focussed digital intervention for eating disorders, among sexual minoritized men.

Methods: Participants ($N = 126$ sexual minoritized men) with a binge-spectrum eating disorder diagnosis (e.g., bulimia nervosa, binge-eating disorder) were randomly allocated to one of three conditions: (1) a waitlist control (2) a personalised intervention, where participants received personalised content recommendations based on their individual symptom profile, or (3) a default intervention, in which participants received no personalised recommendations. Changes from baseline in eating disorder symptoms were evaluated via clinical interview and self-report at 10 week and 6 month follow up.

Results: Relative to the waitlist control and default conditions, participants in the personalised intervention condition reported significantly greater decreases in their global Eating Disorder Examination interview scores at post-intervention/10-week follow up. We did not observe any significant changes in self-reported eating disorder symptoms. Our results are tentative as we were underpowered to detect small-to-medium treatment effects. **Conclusions:** Our study provides preliminary evidence for the efficacy of *Seed* for treating eating disorders in sexual minoritized men, particularly when personalised content recommendations are provided. However, future research must provide greater quality evidence through well-powered, more rigorous clinical trials.

Trial registration: This trial was retrospectively registered on 04/03/2026 (Trial ID: ACTRN12626000271303).

Keywords: Eating disorders treatment, sexual minoritized men, randomised controlled trial, mHealth, digital intervention

Plain English summary

Sexual minoritized (e.g., gay, bisexual) men are more likely to have an eating disorder than heterosexual men. Despite this, no eating disorder treatments have been evaluated specifically among sexual minoritized men. In this study, 126 sexual minoritized men with eating disorders trialled a 10-week eating disorder treatment delivered on a smartphone app called *Seed*. Participants' eating disorder symptoms were measured before and after completing the 10-week treatment both through an interview with a psychologist who recorded their symptoms, and through a questionnaire that participants completed by themselves online. Men who trialled the app reported fewer eating disorder symptoms when their symptoms were assessed through an interview, but not when measured through the questionnaire. Importantly, this study needed a larger number of participants to accurately examine how well the app worked, and whether any improvements in eating disorder symptoms were maintained long term (e.g., 6 and 12 months after finishing the treatment). More research is needed to determine whether the *Seed* app is helpful for treating eating disorders in sexual minoritized men.

Background

Sexual minoritized (i.e., non-heterosexual) men experience higher rates of eating disorders than heterosexual men (Calzo et al., 2017), in part due to minority stressors (e.g., sexual orientation discrimination), alongside intracommunity pressures to have a muscular physique (Bonell et al., 2023). The vulnerability of sexual minoritized men to eating disorders, facilitated by unique risk factors (e.g., minority stress, intracommunity appearance pressures), warrants the development and evaluation of tailored interventions to assist this group. In this paper, we present results and reflections from a randomised controlled trial of *Seed*, a digital intervention for treating eating

disorders, among sexual minoritized men. Notably, our study faced several methodological challenges, including recruitment challenges that led to underpowered analyses. We hope this paper can inform future efforts to develop and evaluate treatment-focussed interventions for sexual minoritized men, an at-risk and underserved population.

Psychological interventions for eating disorders among sexual minoritized men

Few studies have evaluated psychological interventions for eating disorders among men (e.g., Jankowski et al., 2017; Kilpela et al., 2016), and fewer have been conducted with sexual minoritized men. Most studies of psychological interventions for eating disorders are *prevention-focused* and evaluated using non-clinical samples (Linardon et al., 2020), whereas *treatment-focused interventions* typically involve individuals diagnosed with an eating disorder or who exceed clinical thresholds on eating disorder symptom measures.

Hendricks and colleagues (2023) systematically reviewed eight trials of prevention-focussed interventions for eating disorders and body image among men. The authors identified eight interventions, all of which were prevention-focused. Five interventions were dissonance-based, fostering cognitive dissonance between participants' values and behaviours around appearance. The remaining three interventions included two psychoeducational lifestyle modification programs and one media literacy intervention. Across these studies, interventions were predominantly delivered by a mix of clinicians/psychologists, peer-leaders, and members of research team. Evidence for psychoeducation and media literacy interventions was limited; however, the dissonance-based interventions showed promise. The four dissonance-based interventions with moderate quality evidence reported significant improvements in body image concerns at 4-week follow up, including to drive for muscularity (Almeida et al., 2021; Brown et al., 2017; Brown & Keel 2015; Kilpela et al., 2016), and global body dissatisfaction (Brown & Keel, 2015). Some studies observed improvements up to 6 months

follow up, including in muscle dysmorphia symptoms (Almeida et al., 2021) and body fat dissatisfaction (Kilpela et al., 2016). One study found that reductions in body ideal internalisation partially mediated reductions in eating disorder symptoms (Brown & Keel, 2017), suggesting the importance of addressing body ideal internalisation in intervention design and delivery.

Of these dissonance-based interventions, Brown and Keel (2015) is arguably the most relevant to the current study because it is the only intervention, to our knowledge, to have been evaluated with sexual minoritized men specifically. The authors conducted an RCT of a dissonance-based program, The PRIDE Body Project, among 87 young college-aged gay men in the US. The intervention focused on challenging prohibitive appearance ideals among sexual minoritized men across verbal, written, and behavioural activities, and was delivered to participants in groups of four to seven people across two 120-minute sessions by a clinician and a peer leader. Relative to a waitlist control, intervention participants reported moderate-to-large (Cohen's $d = 0.61-1.01$) improvements in dietary restraint, bulimic symptoms, body image dissatisfaction, drive for muscularity, and body-ideal internalisation at 4-week follow-up. This limited evidence suggests that dissonance-based strategies to may be effective in reducing eating disorder symptoms in sexual minoritized men.

In sum, existing interventions for eating disorders among men are prevention-focussed and employ dissonance-based approaches. Treatment-focussed interventions, evaluated among clinical samples, are required to support to those whose eating disorder symptoms exceed clinical thresholds. To date, there are no treatment-focussed interventions designed specifically for sexual minoritized men.

Digital interventions for eating disorders

Unlike the in-person intervention described above, digital interventions for eating disorders are psychological interventions delivered via the Internet, smartphones, or other technological means and may be particularly useful when trying to reach under-served minority groups, including sexual minority

men. One meta-analysis identified eight RCTs of treatment-focused digital interventions for eating disorders (Linardon et al., 2020), which primarily implemented cognitive-behavioural therapy (CBT) and dissonance-based strategies. Intervention participants reported moderate-to-large improvements to eating disorder symptoms (e.g., binge episodes, global eating disorder symptoms) relative to a control condition, with follow-up periods ranging from eight to 24 weeks across studies. No digital interventions have been evaluated in sexual minoritized men, despite this being a high-risk group.

Digital mental health interventions can be personalised, tailoring content to users' specific needs through feedback or recommendations; doing so may improve participant engagement and enhance treatment outcomes (Bakker et al., 2016). A recent review highlighted that few studies have examined the impact of personalisation of digital mental health interventions on treatment efficacy, relative to a non-personalised version of the same intervention (Matthews & Rhodes-Maquire, 2024). The authors highlight users should be able to complete intervention content *autonomously* (i.e., in an order of their choosing), providing users a sense of agency.

Several studies have explored the feasibility of personalisation in eating disorder treatment (e.g., Levinson et al., 2023; Levinson et al., 2026). In this body of work, individual symptom profiles are developed through network analysis of ecological momentary assessment data. These symptom profiles are then used to provide individualized treatment plans, delivered by a clinician. While these personalised treatments have been shown to be effective at reducing eating disorder symptoms, RCTS are required to determine whether they are *more* effective than existing gold standard treatments (e.g., CBT).

We are unaware of any existing research implementing personalization to *digital* eating disorder interventions. However, Jarman and colleagues (2022) qualitatively explored the preferences of potential end-users of the digital intervention trialled in the current study, finding that participants would

prefer smartphone treatment apps that are personalised and can be completed flexibly (e.g., in a time or order of their choosing). Overall, personalisation and flexibility in digital interventions might enhance participants' engagement and improve treatment outcomes; however, evidence is limited.

The current study

We are unaware of any published randomised control trials evaluating treatment-focused interventions for eating disorders among sexual minority men despite the vulnerability and unmet treatment need of this population. This study evaluates *Seed*, a digital treatment-focused intervention, among sexual minoritized men with binge-spectrum eating disorders (e.g., binge-eating disorder, bulimia nervosa). *Seed* is a self-guided app (i.e., with no clinician involvement) that implements CBT and dissonance-based approaches to treat eating disorder symptoms. This combined approach was based on evidence indicating that CBT and dissonance-based therapy are effective in the treatment and prevention of eating disorders (e.g., Grilo et al., 2024; Hendricks et al., 2023; Stice et al. 2019).

We had three conditions: a waitlist control, a *personalised* intervention (where participants receive tailored recommendations for app content based on their eating disorder symptom profile), and a *default*, non-personalised intervention. We hypothesised that intervention participants would report improved outcomes relative to a waitlist control at post-intervention: (i) greater reduction in disordered eating, and (ii) greater improvement in quality of life, depressive symptoms, body image flexibility, and body image internalisation. We also hypothesised that (iii) personalised intervention participants would report greater improvements in outcomes than default intervention participants.¹

Method

¹ Note: Our Supplementary Materials reports outcomes up to 6-month follow-up. Our main text reports our pre- to post-intervention outcomes only, as our 6-month follow-up analyses were substantially underpowered.

Participants

We recruited 132 sexual minoritized men living in Australia. Eligible participants: were cis-gender sexual minoritized men; ≥ 18 years old; not receiving treatment for eating or body image concerns; not at risk of suicide; and met criteria for an eating disorder diagnosis other than Atypical Anorexia Nervosa (AAN), Anorexia Nervosa (AN) and Avoidant Restrictive Food Intake Disorder (ARFID). These diagnoses were excluded either on ethical grounds due to medical risk (AN, AAN) or because the app did not incorporate evidence-based treatments for the specific diagnosis (ARFID). We excluded data for six participants who were provided a different version of the intervention than they were allocated to, resulting in a final sample of 126 participants (Table 1).

Table 1

Participant characteristics at baseline ($N = 126$)

Variable	Category	Condition		
		Waitlist Control ($N = 44$)	Default ($N = 39$)	Personalised ($N = 43$)
		<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Sexual identity	Gay	39 (88.64)	37 (94.87)	32 (74.42)
	Bisexual	2 (4.55)	2 (5.13)	9 (20.93)
	Pansexual	2 (4.55)	0 (0.00)	0 (0.00)
	Questioning	0 (0.00)	0 (0.00)	1 (2.33)
	Prefer not to say	1 (2.27)	0 (0.00)	1 (2.33)
Eating disorder diagnosis	BED	12 (27.27)	11 (28.21)	13 (30.23)
	BN	8 (18.18)	4 (10.26)	6 (13.95)
	OSFED ^a	22 (50.00)	19 (48.72)	21 (48.83)
	Sub-threshold BED	7 (15.91)	7 (17.95)	7 (16.28)
	Sub-threshold BN	8 (18.18)	10 (25.64)	11 (25.58)
	No specifier provided	7 (15.91)	2 (5.13)	3 (6.98)
	Unspecified Feeding or Eating Disorder	1 (2.27)	5 (12.82)	3 (6.98)
Race	Missing *	1 (2.27)	0 (0.00)	0 (0.00)
	White	31 (70.45)	29 (74.36)	21 (48.84)
	Asian	2 (4.55)	2 (5.13)	6 (13.95)
	South Asian	0 (0.00)	1 (2.56)	2 (4.65)

	Middle Eastern or North African	0 (0.00)	1 (2.56)	2 (4.65)
	Aboriginal or Torres Strait Islander	2 (4.55)	0 (0.00)	0 (0.00)
	Hispanic, Latino, or Spanish	3 (6.82)	0 (0.00)	3 (6.98)
	Pacific Islander	0 (0.00)	0 (0.00)	1 (2.33)
	Multiple racial identities	2 (4.55)	0 (0.00)	3 (6.98)
	Prefer not to say	0 (0.00)	1 (2.56)	1 (2.33)
	Missing	4 (9.09)	5 (12.82)	4 (9.30)
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	
Age		41.02 (11.61)	38.90 (11.80)	38.87 (12.58)
SES		6.10 (1.53)	6.85 (1.46)	5.82 (1.71)
BMI		31.26 (6.56)	30.66 (5.27)	31.77 (8.99)
EDE Global		3.06 (0.89)	2.84 (0.98)	3.12 (0.80)
EPSI Body dissatisfaction		18.89 (4.06)	18.62 (4.71)	17.84 (5.19)
EPSI Binge		20.32 (5.43)	20.44 (5.99)	21.70 (5.69)
EPSI Cognitive Restraint		6.50 (2.77)	6.15 (2.75)	6.53 (2.50)
EPSI Purging		5.27 (5.01)	2.82 (4.36)	4.74 (4.35)
EPSI Restricting		6.70 (5.35)	5.46 (4.63)	5.42 (4.20)
EPSI Excessive Exercise		7.75 (4.73)	6.74 (4.82)	9.12 (5.01)
EPSI Obesity		10.66 (3.97)	10.18 (4.67)	11.12 (4.31)
EPSI Muscle build		7.59 (5.23)	6.54 (5.16)	8.26 (5.16)

Notes: EDE = Eating Disorder Examination, BN = Bulimia nervosa, BED = Binge eating disorder, OSFED = Other Specified Feeding or Eating Disorder, BMI = Body Mass Index (kg/m²), SES = socioeconomic status (a score of 1 indicates the lowest subjective SES, and 10 the highest possible subjective SES). * Uncategorised diagnosis due to server-side error in data collection. ^a Other OSFED specifiers were either not observed in our sample (e.g., Purging Disorder), or not assessed due to the EDE protocol not generating sufficient information to reach a diagnosis (e.g., Night Eating Syndrome).

Materials

Demographics

Participants self-reported their age, gender identity, sex at birth, race/ethnicity, height and weight. We measured subjective socioeconomic

status with the MacArthur Scale of Subjective Social Status (Adler et al., 2000), where scores range from 1 (lowest) to 10 (highest).

Primary outcomes

Eating Disorder Examination. The Eating Disorder Examination (EDE; Fairburn et al., 2014) is a clinician-led interview that examines the frequency of disordered eating over the previous 28 days. The EDE can be used to derive DSM-5 eating disorder diagnoses, and a global eating disorder symptom score is calculated by averaging scores across four subscales. Scores range from 0 to 7, with higher scores reflecting greater symptom frequency/severity. The global score demonstrated excellent reliability (McDonald's omega [w]s: 0.87–91).

Eating Pathology Symptoms Inventory. The Eating and Pathology Symptoms Inventory (EPSI; Forbush et al., 2013) captures self-reported eating disorder symptoms across eight domains: body dissatisfaction; binge eating; excessive exercise; cognitive restraint; purging; negative attitudes towards obesity; restricting; and muscle building. The EPSI subscales demonstrated good reliability (w s: 0.70–0.89).

Secondary outcomes

Our secondary outcomes were: body image internalization (Sociocultural Attitudes Towards Appearance Questionnaire; Schaefer et al., 2017); (2) body image flexibility (Body Image Acceptance and Action Questionnaire-5; Basarkod et al., 2018); quality of life (Assessment of Quality of Life – 4 Dimension [AQoL-4D]; Hawthorne et al., 1999); and depressive symptoms (Patient Health Questionnaire-2; Kroenke et al., 2003). All scales demonstrated acceptable reliability (w s > 0.70), except for the AQoL-4D, which we excluded from our reporting.

Our intervention: Seed

Seed is a smartphone app-based intervention with eight modules that provide psychoeducation and guided exercises addressing key components of eating disorder pathology and maintaining factors (Table 2). The modules are intended to be completed at a rate of approximately one per week. *Seed*

primarily uses CBT approaches, with some elements adapted from dissonance-based therapy. For example, the “Regulated Eating” and “Mood Management” modules reflect a CBT approach and incorporate cognitive restructuring and behavioural experiments to challenge unhelpful thoughts and behaviours related to food and eating, appearance ideals, and their overvaluation. The “Overvaluation” module uses a dissonance-based approach, encouraging users to critically evaluate and reject sociocultural appearance ideals.

Table 2.

Overview of *Seed*'s content modules, therapeutic approaches employed, and recommended order of completion for personalised intervention participants.

App Module	Description of Content	Therapeutic Approach	Personalised condition: Recommended module for high EPSI subscale score¹
1. Values and Motivations	Introduction to values, identifying values, and building motivation to change in accordance with values	CBT; Dissonance-based activities	NA – first module completed by all participants
2. Regulated Eating	Psychoeducation on regular eating, compensatory behaviours, strategies to help with regular eating	CBT	Restriction ² ; Purging ³ ; Binge eating ⁴
3. Mood Management	Identifying, challenging, and balancing negative thoughts	CBT	Binge eating ⁴
4. Diet Rules and Exercise	Identifying beliefs about dieting, challenging unhelpful beliefs, and generating positive attitudes about exercise	CBT; Dissonance-based	Excessive Exercise ⁵ ; Muscularity Concerns ⁶ ; Cognitive Control ⁷
5. Overvaluation	Psychoeducation on overvaluation of appearance, societal influences on appearance values, and challenging	CBT; Dissonance-based	Body dissatisfaction ⁸

these societal messages about appearance and diet

6. Body Checking & Appearance Comparisons	Body checking, appearance comparisons, the role of social media in facilitating body checking & appearance comparisons	CBT; Dissonance-based	Body dissatisfaction ⁸
7. Emotion Regulation	Linking emotions to eating and appearance, learning emotion regulation techniques, distress tolerance	CBT	Binge eating ⁴
8. Maintaining Progress	Identifying and managing relapses, generating a relapse plan	CBT	NA

Notes: ¹ Participants in our personalised condition were provided module recommendations based on their level of specific eating disorder symptoms (as measured by the EPSI). EPSI 'high' scores for each subscale (Forbush et al., 2013); ² Restriction scores >15; ³ Purging scores > 9; ⁴ Binge Eating scores > 24; ⁵ Excessive Exercise scores > 18; ⁶ Muscle Building scores > 12; ⁷ Cognitive Restraint scores > 11; ⁸ Body Dissatisfaction scores > 25.

We evaluated *default* and *personalised* versions of Seed. Participants in the personalised condition were recommended to first complete modules whose content addressed the symptoms for which they had 'high' EPSI subscales scores (Table 2) but could follow any order of their choosing. For example, participants with high Binge Eating subscale scores (>24; Forbush et al., 2013) were recommended to first complete the Regulated Eating, Mood Management, and Emotion Regulation modules. Participants assigned to our default format were not provided personalised recommendations and had to complete the content modules in sequential order. All participants completed Module 1 (Values and Motivations) before moving to the next modules. This module was designed to help users clarify their personal values, explore their motivations for change, and begin to build commitment to the therapeutic process, thereby enhancing engagement and treatment adherence.

Tailoring *Seed* for sexual minoritized men. The current study trials a version of *Seed* app tailored specifically to sexual minoritized men. Changes to the app included changes in language referring to dieting, exercise, and

body ideals; for example, instead of referring exclusively to dieting and exercise in pursuit of thinness, this version of the app also referenced behaviours engaged in pursuit of muscularity (e.g., example, muscle building, bulking, and shredding). App content discussing dieting was edited to make more frequent references to protein intake and specific supplements more often taken by men (e.g., testosterone boosters). App content discussing appearance ideals was adjusted to refer to physiques idealized more (on average) by queer men; that is, physiques that are both lean and muscular.

Following initial development of this version of *Seed*, sexual minoritized men with a history of eating disorders trialled the app. Participants discussed their experience with *Seed* and provided feedback via interview; their dislikes and preferences were compiled and informed subsequent revisions to the app.

Procedure

This study (trial registration: ACTRN12626000271303) is related to another RCT evaluating *Seed* among men and women (trial registration: ACTRN12621001244897). Unlike the larger RCT, this study examines the efficacy of a version of *Seed* tailored specifically for sexual minoritized men. We retrospectively registered the trial reported in this paper for clarity, both because of the changes to the app, along with the separate population from which we sampled from. Our Open Science Framework page contains our preregistration, data, code, and example intervention content. We received ethics approval from the University of Melbourne (IDs: 30177, 13046).

Figure 1 presents our CONSORT diagram. We recruited participants via dating apps (e.g., Grindr), social media, and eating disorder organisations. Interested participants completed a screening survey, and eligible participants were contacted to book an EDE interview. Provisionally or generally registered psychologists with ≥ 6 months' clinical experience administered the EDE – these interviewers were trained by a clinical psychologist with expertise in the EDE.

Eligible participants were randomised to an intervention condition using Qualtrics' randomisation function. Participants who were randomised to the

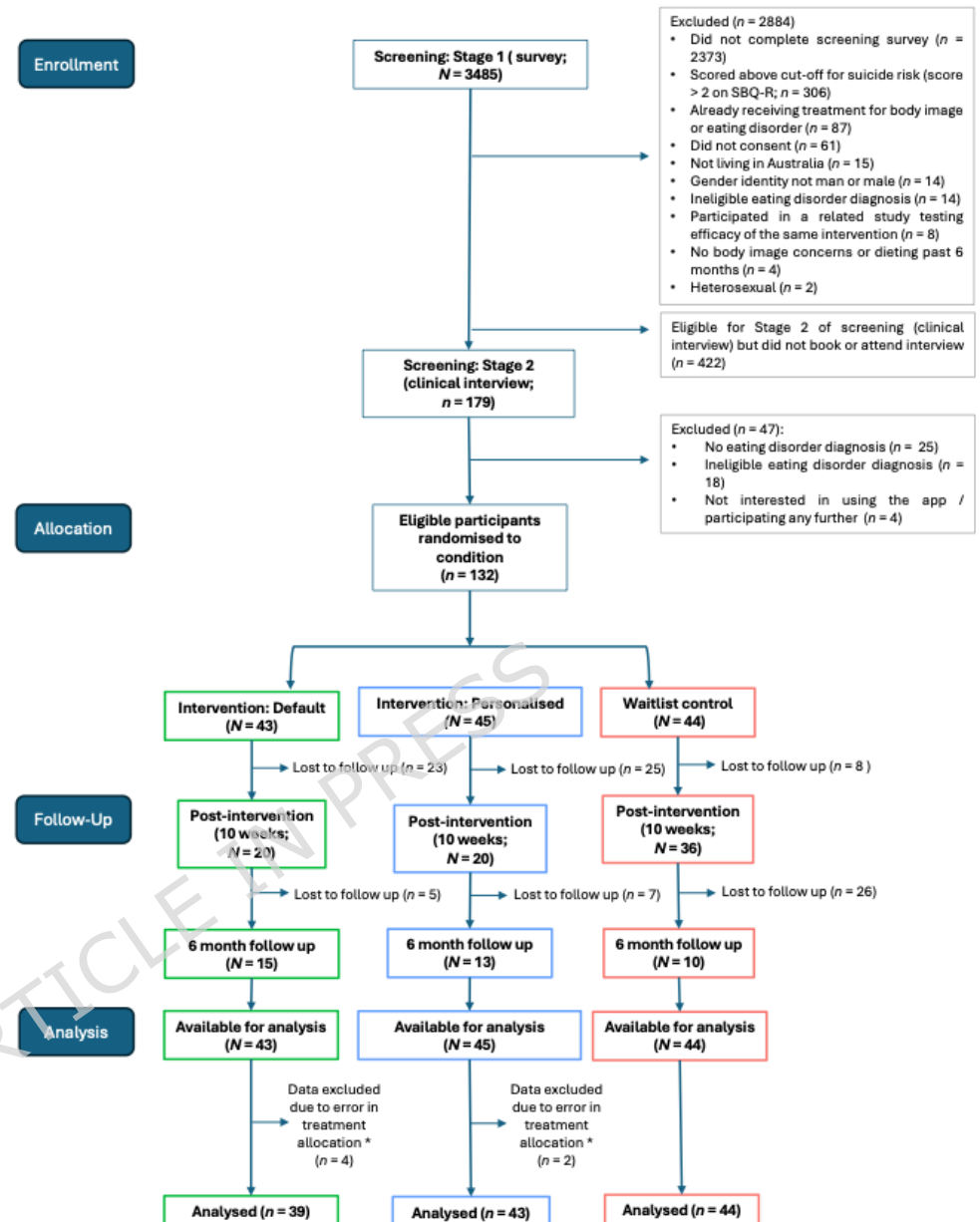
personalised or default conditions were then emailed app download instructions by the psychologist who administered their EDE interview. This study was conducted single-blind: participants were not told what condition they were allocated to.

Participants re-completed the baseline measures and EDE at 10-weeks post-intervention, and baseline measures at 6-months. Participants were remunerated at follow-ups. Data collection periods were: recruitment (February–October 2024), post-intervention (April–December 2025), and 6-month follow up (August 2024–April 2025).

We discovered an error in treatment allocation while cross-checking our randomisation record against app access instructions distributed to participants. Some participants randomised to our default ($n = 4$) and personalised ($n = 2$) conditions were provided access to the alternate version of the app (e.g., default participants given access to personalised format, and vice-versa). This was an administrative error, whereby a staff member on the project erroneously provided participants with instructions to download the opposite version of the app to which they were randomised. We excluded data for these participants prior to analysis.

Figure 1

CONSORT Diagram visualising the flow of our participant numbers from enrolment through to analysis.



Notes: * Some participants in the default and personalised intervention conditions were erroneously provided the other version of the intervention (i.e., default participants provided personalised version, and vice-versa). We excluded data for these participants prior to analysis.

Data Analysis

Statistical Power

Our pre-registered power analysis (Supplementary Figure 1) assumed 80% power, a standardised mean difference of 0.3 between intervention groups, $\alpha = .05$, and 50% attrition, generating a recruitment target of 300

participants. This calculation did not account for the multilevel structure of our analyses and likely underestimated the required sample size. Compounding this, our recruitment period was limited due to funding constraints, and we did not meet our recruitment target. Given our achieved sample size and attrition, our analyses are underpowered: readers should prioritise the 95% confidence intervals around observed effects to interpret the range of plausible effect sizes.

Missing data

A Little's Test provided no evidence against the assumption that our data were missing completely at random, $\chi^2(375) = 358.10$, $p = .726$. We handled missing data with multiple imputation via chained equations ($N = 60$ imputations; van Buuren & Groothuis-Oudshoorn, 2011).

Intervention efficacy

We deviated from our pre-registered analysis plan due to power constraints. Instead of modelling all timepoints together, we simplified our analyses into two stages: (i) intervention efficacy (Times 1 and 2; reported in our main text), and (ii) symptom maintenance (Times 2 and 3; Supplementary Table A).

We used mixed effects regressions to examine changes in outcomes from Time 1 to Time 2. We regressed each outcome on time (Time 1, Time 2), condition (waitlist control, personalised, default), and their interaction. We included a random intercept for participant, and fixed effects for condition and timepoint. Our models assumed an unstructured covariance structure. The focal effects were the time x condition interactions: a significant negative interaction indicates that, relative to the waitlist control, intervention participants reported significantly greater reductions in outcomes from Time 1 to 2, suggesting that changes in outcomes were attributable to the intervention.

To compare intervention groups, we computed mean differences in outcomes within each condition from Time 1 to 2, adjusting our p -values for the false discovery rate (Verhoeven et al., 2005). We then computed the

	EDE			EPsi		
Regression parameters	Global Score	Muscle Building	Purging	Binge Eating	Body Dissatisfaction	Restrained eating
Intercept	0.16 [-0.11, 0.43]	0.16 [-0.13, 0.45]	0.32 [0.03, 0.61]	0.18 [0.11, 0.47]	0.29 [0.01, 0.58]	0.29 [0.01, 0.58]
Time 2^a	-0.19 [-0.56, 0.18]	-0.36 [-0.69, 0.03]	-0.30 [-0.48, -0.12]	-0.48 [-0.83, -0.13]	-0.41 [-0.76, -0.06]	-0.29 [-0.58, 0.00]
Default^b	-0.21 [-0.62, 0.20]	-0.20 [-0.63, 0.23]	-0.54 [-0.95, -0.13]	0.02 [-0.39, 0.43]	-0.05 [-0.46, 0.36]	-0.29 [-0.68, 0.11]
Personalised^b	0.05 [-0.36, 0.46]	0.13 [-0.28, 0.54]	-0.12 [-0.53, 0.29]	0.20 [-0.21, 0.61]	-0.19 [-0.60, 0.22]	-0.29 [-0.68, 0.11]
Time 2 × Default	0.07 [-0.66, 0.80]	0.01 [-0.52, 0.54]	0.11 [-0.16, 0.38]	-0.22 [-0.83, 0.39]	-0.46 [-1.09, 0.17]	-0.29 [-0.88, 0.29]
Time 2 × Personalised	-0.83 [-1.46, -0.20]	0.14 [-0.39, 0.67]	0.10 [-0.19, 0.39]	-0.34 [-0.91, 0.23]	-0.01 [-0.62, 0.60]	0.14 [-0.33, 0.61]
Standardised mean difference (<i>d</i>)						

Waitlist T1 - T2	0.19 [-0.18, 0.57]	0.36 [0.02, 0.70]	0.30 [0.11, 0.48]	0.49 [0.14, 0.84]	0.41 [0.04, 0.77]	0.2 [-0.0, 0.6]
Default T1 - T2	0.12 [-0.52, 0.75]	0.36 [-0.08, 0.80]	0.19 [-0.03, 0.40]	0.71 [0.19, 1.23]	0.88 [0.34, 1.40]	0.5 [0.11, 1.0]
Personalised T1 - T2	1.02 [0.50, 1.54]	0.22 [-0.20, 0.64]	0.19 [-0.05, 0.44]	0.83 [0.36, 1.29]	0.42 [-0.06, 0.90]	0.1 [-0.3, 0.5]
Δd Personalised - Default	0.90 [0.14, 1.66]	-0.14 [-0.73, 0.45]	-0.01 [-0.30, 0.32]	0.12 [-0.55, 0.79]	-0.45 [-1.14, 0.24]	-0.4 [-1.0, 0.3]

Notes: Estimates are pooled across 60 imputed datasets. *Ns* at T1/T2: Waitlist = 44/36; Default = 43/20; Personalised = 45/20. Regression estimates are formatted as β [95% CI], mean differences as Cohen's d (i.e., standardised mean difference) [95% CI], and the difference in mean difference values for personalised and default conditions as Δ [95% CI]. **Bold** = significant ($p < .05$). The p values for our mean difference values are adjusted for the false-discovery rate (Verhoeven et al., 2005). ^a reference group = Time 1, ^b reference group = Waitlist Control. EDE = Eating Disorders Examination, EPSI = Eating Pathology Symptoms Inventory, NATO = Negative Attitudes Towards Obesity.

Discussion

We evaluated *Seed*, a treatment-focussed digital intervention, among sexual minoritized men with binge-spectrum eating disorders. We hypothesised that, relative to a waitlist control, intervention participants would report significantly greater improvements in eating disorder symptoms and secondary outcomes. We expected participants in our personalised intervention would report greater symptom improvement than default intervention participants. As expected, participants in the personalised condition reported greater improvements in their clinician-evaluated symptoms than the default intervention and waitlist control; however, no significant changes in self-reported eating disorder symptoms or secondary outcomes were observed. Several methodological limitations impact the strength of evidence provided by this study, as discussed below.

Evidence suggests users may prefer digital eating disorder interventions that are personalised and can be completed flexibly because they might be more engaging (Jarman et al., 2022). Supporting this, participants assigned to our personalised app, which offered tailored content recommendations and flexible completion, reported greater improvements to their clinician-

evaluated symptoms than those assigned to the default, non-personalised app. Critically, *Seed* was not set up to record engagement data (e.g., time spent on app, amount of content completed; Liu et al., 2026); therefore, we could not evaluate whether heightened engagement accounted for greater improvements in the personalised condition. However, we observed a large attrition rate in our intervention groups (>50% for intervention versus 19% for waitlist), which is considered a close proxy for engagement (Liu et al., 2026); here, the large attrition rate in our intervention groups may reflect that these participants were not engaged with the app and therefore not motivated to complete the follow-up assessments. Supporting this, a meta-analysis of RCTs of digital eating disorders interventions highlighted attrition is 44% higher for interventions delivered via smartphone app than those delivered on a computer or website. The authors contend that smartphones tend to be used in a less structured and more momentary manner than computers, “inadvertently reduc[ing] users’ ... investment in the intervention and commitment to completing trial assessments” (p. 8).

We note we observed significant treatment effects when measured via the EDE, but not the EPSI. The lack of treatment effects on self-reported eating disorder symptoms may result from differences in clinician-led and self-report measurement: clinician-led assessments may be more accurate than self-reports for symptoms whose identification benefits from clinical expertise (e.g., distinguishing objective from subjective binge episodes; Fairburn & Beglin, 1994). Compounding this, the null effects observed across a range of outcomes may be due to low statistical power, resulting from our small sample and substantial attrition. Lower rates of recognition and treatment-seeking among men with eating disorders (Griffiths et al., 2015), combined with our short recruitment period (nine months) may explain our small sample size.

Future directions: lessons learned from our study

We recommend several avenues through which future research can provide stronger evidence for the efficacy of *Seed* among sexual minoritized men. First, our recruitment period was limited due to funding constraints, and

we recruited primarily from online dating apps such as Grindr and Scruff. Future studies might accrue larger samples at enrolment with a longer recruitment period and more diversified recruitment strategy.

Second, future studies can incorporate strategies demonstrated to improve engagement and participant retention – for example, through delivering *Seed* via a web- or computer-based format, and increasing human contact throughout the intervention (e.g., regular therapeutic support). Relatedly, any future trials must record participants' level of engagement with *Seed*, for example, through recording the number of modules completed, number of program logins or views, and/or the number of days that participants actively use the program (Liu et al., 2026). Future trials may also gather qualitative feedback from participants to supplement engagement data; for example, by providing insight into the specific barriers to their engagement with the app, and/or the elements of the app they found the most engaging.

Third, we may have prevented or reduced the number of participants provided the incorrect version of the app through more frequent cross-checking of our randomisation record against the instructions provided to participants. We recommend that future studies evaluating *Seed*, or indeed any other intervention, engage in regular administrative cross-checking to reduce the incidence of similar errors.

Fourth, we did not examine inter-rater reliability for the EDE; inter-rater variation may have reduced the precision of EDE model estimates (Hoyt, 2018). Future research should account for inter-rater variation to generate more precise estimates. Lastly, the generalizability of our findings is limited, as our sample predominantly identified as gay, White, with average age of 38 to 41 years. Future research can evaluate the efficacy of *Seed* in more diverse populations (e.g., across intersections of age, sexual identity, and ethnicity), for whom the risk factors for, and presentation of, eating disorders vary (Burke et al., 2020).

Conclusions

In conclusion, while our study provides preliminary evidence of the efficacy of *Seed* among sexual minoritized men, well-powered and more methodologically rigorous RCTs are required to reliably evaluate *Seed's* efficacy.

References

- Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology, 19*(6), 586-592. <https://doi.org/10.1037/0278-6133.19.6.586>
- Almeida, M., Brown, T. A., Campos, P. F., Amaral, A. C. S., & de Carvalho, P. H. B. (2021). Dissonance-based eating disorder prevention delivered in-person after an online training: A randomized controlled trial for Brazilian men with body dissatisfaction. *International Journal of Eating Disorders, 54*(3), 293-304. <https://doi.org/10.1002/eat.23423>
- Bakker, D., Kazantzis, N., Rickwood, D., & Rickard, N. (2016). Mental health smartphone apps: review and evidence-based recommendations for future developments. *JMIR Mental Health, 3*(1), e7.
- Basarkod, G., Sahdra, B., & Ciarrochi, J. (2018). Body Image-Acceptance and Action Questionnaire-5: An Abbreviation Using Genetic Algorithms. *Behavior Therapy, 49*(3), 388-402. <https://doi.org/10.1016/j.beth.2017.09.006>
- Bonell, S., Wilson, M. J., Griffiths, S., Rice, S. M., & Seidler, Z. E. (2023). Why do queer men experience negative body image? A narrative review and testable stigma model. *Body Image, 45*, 94-104. <https://doi.org/10.1016/j.bodyim.2023.02.005>
- Brown, T. A., Forney, K. J., Pinner, D., & Keel, P. K. (2017). A randomized controlled trial of The Body Project: More Than Muscles for men with body dissatisfaction. *International Journal of Eating Disorders, 50*(8), 873-883. <https://doi.org/10.1002/eat.22724>

- Brown, T. A., & Keel, P. K. (2015). A randomized controlled trial of a peer co-led dissonance-based eating disorder prevention program for gay men. *Behaviour Research and Therapy*, 74, 1-10. <https://doi.org/10.1016/j.brat.2015.08.008>
- Burke, N. L., Schaefer, L. M., Hazzard, V. M., & Rodgers, R. F. (2020). Where identities converge: The importance of intersectionality in eating disorders research. *International Journal of Eating Disorders*, 53(10), 1605-1609. <https://doi.org/10.1002/eat.23371>
- Calzo, J. P., Blashill, A. J., Brown, T. A., & Argenal, R. L. (2017). Eating Disorders and Disordered Weight and Shape Control Behaviors in Sexual Minority Populations. *Current Psychiatry Reports*, 19(8), 49. <https://doi.org/10.1007/s11920-017-0801-y>
- Fairburn, C. G., & Beglin, S. J. (1994). Assessment of eating disorders: Interview or self-report questionnaire? *International Journal of Eating Disorders*, 16(4), 363-370. [https://doi.org/10.1002/1098-108X\(199412\)16:4<363::AID-EAT2260160405>3.0.CO;2-#](https://doi.org/10.1002/1098-108X(199412)16:4<363::AID-EAT2260160405>3.0.CO;2-#)
- Fairburn, C. G., Cooper, Z., & O'Connor, M. (2014). Eating Disorder Examination (17.0D). In C. G. Fairburn (Ed.), *Cognitive Behavior Therapy and Eating Disorders* (pp. 265-308). Guildford Press.
- Forbush, K. T., Wildes, J. E., Pollack, L. O., Dunbar, D., Luo, J., Patterson, K., Petrucci, L., Pollpeter, M., Miller, H., Stone, A., Bright, A., & Watson, D. (2013). Development and validation of the Eating Pathology Symptoms Inventory (EPSI). *Psychological Assessment*, 25(3), 859-878. <https://doi.org/10.1037/a0032639>
- Griffiths, S., Mond, J. M., Li, Z., Gunatilake, S., Murray, S. B., Sheffield, J., & Touyz, S. (2015). Self-stigma of seeking treatment and being male predict an increased likelihood of having an undiagnosed eating disorder. *International Journal of Eating Disorders*, 48(6), 775-778. <https://doi.org/10.1002/eat.22413>
- Hawthorne, G., Richardson, J., & Osborne, R. (1999). The Assessment of Quality of Life (AQoL) instrument: A psychometric measure of Health-

- Related Quality of Life. *Quality of Life Research*, 8(3), 209–224.
<https://doi.org/10.1023/A:1008815005736>
- Hendricks, E., Jenkinson, E., Falconer, L., & Griffiths, C. (2023). How effective are psychosocial interventions at improving body image and reducing disordered eating in adult men? A systematic review. *Body Image*, 47, 101612. <https://doi.org/10.1016/j.bodyim.2023.08.004>
- Hoyt, W. T. (2018). Interrater Reliability and Agreement. In L. M. Stapleton & R. O. Mueller (Eds.), *The Reviewer's Guide to Quantitative Methods in the Social Sciences* (2nd ed.). Routledge.
<https://doi.org/10.4324/9781315755649>
- Jankowski, G. S., Diedrichs, P. C., Atkinson, M. J., Fawcner, H., Gough, B., & Halliwell, E. (2017). A pilot controlled trial of a cognitive dissonance-based body dissatisfaction intervention with young British men. *Body Image*, 23, 93–102. <https://doi.org/10.1016/j.bodyim.2017.08.006>
- Kilpela, L. S., Blomquist, K., Verzijl, C., Wilfred, S., Beyl, R., & Becker, C. B. (2016). The body project 4 all: A pilot randomized controlled trial of a mixed-gender dissonance-based body image program. *International Journal of Eating Disorders*, 49(6), 591–602.
<https://doi.org/10.1002/eat.22562>
- Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2003). The Patient Health Questionnaire-2: Validity of a Two-Item Depression Screener. *Medical Care*, 41(11), 1284.
<https://doi.org/10.1097/01.MLR.0000093487.78664.3C>
- Levinson, C. A., Williams, B. M., Christian, C., Hunt, R. A., Keshishian, A. C., Brosof, L. C., Vanzhula, I. A., Davis, G. G., Brown, M. L., Bridges-Curry, Z., Sandoval-Araujo, L. E., & Ralph-Nearman, C. (2023). Personalizing eating disorder treatment using idiographic models: An open series trial. *Journal of Consulting and Clinical Psychology*, 91(1), 14–28.
<https://doi.org/10.1037/ccp0000785>
- Levinson, C. A., Slipetz, L., Henry, T., Crumby, E., & Pennesi, J. L. (2026). What Makes Personalized Treatment Work? Mechanisms of Change in

- Personalized Treatment for Eating Disorders: A Proof-of-Concept Study. *Behavior Therapy*, 57(1), 50–62. <https://doi.org/10.1016/j.beth.2025.04.003>
- Linardon, J., Shatte, A., Messer, M., Firth, J., & Fuller-Tyszkiewicz, M. (2020). E-mental health interventions for the treatment and prevention of eating disorders: An updated systematic review and meta-analysis. *Journal of Consulting and Clinical Psychology*, 88(11), 994–1007. <https://doi.org/10.1037/ccp0000575>
- Liu, C., Anderson, C., Messer, M., McClure, Z., & Linardon, J. (2026). Patterns of Uptake, Engagement, and Attrition in Randomized Controlled Trials of Digital Interventions for Eating Disorders: A Systematic Review and Meta-Analysis. *International Journal of Eating Disorders*. <https://doi.org/10.1002/eat.70046>
- Schaefer, L. M., Harriger, J. A., Heinberg, L. J., Soderberg, T., & Kevin Thompson, J. (2017). Development and validation of the sociocultural attitudes towards appearance questionnaire-4-revised (SATAQ-4R). *International Journal of Eating Disorders*, 50(2), 104–117. <https://doi.org/10.1002/eat.22590>
- van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, 45, 1–67. <https://doi.org/10.18637/jss.v045.i03>

Declarations

Ethics approval and consent to participate

This study received ethics approval from the University of Melbourne (IDs: 30177, 13046).

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are openly available on the Open Science Framework at <https://osf.io/hzyqv/>.

Competing interests

Not applicable.

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Authors' contributions

Emma Austen: Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Visualization, Project administration; **Matthew Fuller-Tyszkiewicz:** Conceptualization, Methodology, Software, Resources, Writing – Reviewing & Editing, Supervision, Project administration, Funding acquisition; **Siân A. McLean:** Conceptualization, Methodology, Resources, Writing – Review & Editing, Funding acquisition; **Beth O’Gorman:** Conceptualization; Methodology; Writing – Review & Editing, Supervision; **Katie Bishop:** Methodology, Software, Writing – Review & Editing; **Hannah K. Jarman:** Conceptualization, Writing – Review & Editing; **Susan J. Paxton:** Conceptualization, Methodology, Writing – Review & Editing, Funding acquisition; **Rachel F. Rodgers:** Conceptualization, Methodology, Writing – Review & Editing, Funding acquisition; **An Dang:** Methodology, Investigation, Resources, Writing – Review & Editing; **Emily A. Harris:** Methodology, Writing – Review & Editing, Project administration; **Felicity Angelopoulos:** Software, Writing – Review & Editing; **Wesley Grey:** Software, Writing – Review & Editing; **Suku Sukunesan:** Conceptualization, Software, Funding acquisition; **Alexandra Parker:** Conceptualization, Methodology, Funding acquisition; **Adrian Shatte:** Conceptualization, Software, Methodology, Funding acquisition; **Long Khanh-Dao Le:** Conceptualization, Writing – Review & Editing; **Scott Griffiths:** Conceptualization, Methodology, Formal analysis, Resources, Writing – Review & Editing, Supervision, Funding acquisition.

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