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Adolescents accept digital mental health support in schools: A co-design and feasibility study of a school-based app for UK adolescents

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ABSTRACT

Schools in the UK are required to provide frontline mental health promotion and prevention to adolescents, but with few resources. School-hosted mHealth is one option which could meet needs. This study co-designed and feasibility tested a self-help, school hosted, digital intervention for adolescents showing early symptoms of deteriorating mental health. Via extensive co-design, we produced a youth-targeted web-app (MindMate2) and a low-intensity parent component (Partner2U). Feasibility was tested in four UK high schools with n = 31 young people (15-17y). We specified rules for progression to an effectiveness trial, tested candidate primary outcome measures and conducted an exploratory cost-effectiveness analysis. Co-design produced MindMate2U to be a six-week, self-help, smartphone-delivered program targeting risk and protective factors for adolescent mental health. Young people's MindMate2U account was set up by school after which they progressed independently through six topics of their choosing. User ratings (n = 19) and post- intervention interviews (n = 6) showed resource acceptability. We met our recruitment, retention and pre-post measure completion targets and identified the Strengths and Difficulties Questionnaire as the most sensitive outcome measure. This study established the feasibility of a co-designed, mental health app as a low-burden, school-hosted resource for symptomatic young people and opens up new possibilities for the integration of mHealth in schools. Support via schools to parents of symptomatic young people may need to be universal rather than targeted. Following some refinements of MindMate2U, a phase 2 randomised controlled trial is warranted to test its effectiveness.

1. Introduction

In England, 17.4% of 6–16-year-olds and 17.4% of 17-19 -year-olds have a probable mental health disorder (NHS Digital, 2021). Many adolescents experience early debilitating symptoms of deteriorating mental health which can transition to clinical disorder (Kim-Cohen et al., 2003). Early intervention is recommended to reduce this risk (Patton et al., 2016; WHP, 2019) and can be considered both prevention (of disorder) and treatment (of symptoms) (Rapee, 2008). Yet many young people do not seek or find it hard to access support, and innovation to reach young people remains a "fundamental and unmet challenge" in global public mental health (Holmes et al., 2018, p56).

Smartphone applications (apps) represent a platform for delivery of this support (Bergin et al., 2020; Ofcom, 2017; Taylor & Silver, 2018; Van Ameringen et al., 2017). In 2017, there were over 22,000 mental health apps (MH apps), most targeting adult anxiety, stress, panic, depression or well-being (Parker et al., 2018; Torous et al., 2019). MH apps for adolescents are emerging, mostly clinically oriented (Bakker et al., 2016; Bevan-Jones et al., 2018; Price et al., 2014). Young people with mental health difficulties generally find MH apps acceptable (Grist et al., 2018; Kenny et al., 2015) and like the privacy and independence they afford (Abeles et al., 2009; Wilson et al., 2011), although app effectiveness for this age range needs to be improved (Grist et al., 2017).

As part of responsible digital research and innovation, where users

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needs are prioritised (Jirotka et al., 2016), mental health apps for youth need to be co-designed much more extensively with youth and professionals (Bevan Jones et al., 2020; Kennard et al., 2015; Patton et al., 2016; Proudfoot, 2013) and with content targeting prevention (Torous et al., 2019) and experiences that trigger symptoms (e.g. bullying; Holmes et al., 2018). Risk and crisis management should be included along with investigation of optimal implementation, the role of human support and cost-effectiveness (Firth et al., 2017). User adherence to apps is a challenge (Ng et al., 2019) and could be improved by integrating them in settings where young people spend a lot of their time (Murray et al., 2016). Schools can be effective intervention sites but face-to-face mental health programs are resource intensive, difficult to sustain and rarely show effects beyond 12 months (Hugh-Jones et al., 2020; Ssegonja et al., 2019). Schools in the UK have an established human support, risk management and referral structure into which a MH app could be integrated (Edridge et al., 2019; Torous et al., 2019). We are unaware of any such initiative in UK schools to date.

1.1. Study aim

Our primary aim was to co-design (Co-D) and feasibility test a MH app for early mental health support for symptomatic 14–18-year-olds when delivered within secondary (high) schools in the UK. We aimed to generate a low-burden, school-based mental health resource for adolescents and their parents/carers (who report feeling unsupported (Armitage et al., 2020). We aimed to determine if feasibility thresholds for the intervention could be met for progression to trial.

Table 1
Co-design for the young person's app and parent component (based on Hagen et al., 2012).

Design stage	Participants	Purpose	Outputs	Web-app development
Identify, Define, Position and Concept	Young people (n = 16,14-19y; 12 female 3 male, 1 transgender) 4 × 3 h workshops MHPs (n = 8; 6 female, 2 male) 1 × 2 h meeting Parents / carers (n = 6; 4 female, 2 male) 1 × 2 h workshop Teachers (n = 5;4 female, 1 male) 1 x half day workshop	Identify problem and its determinants Clarify expected outcomes Understand needs of different groups Determine content and implementation options Consider what has previously worked for utilisation and safety	Emerging structure, content and implementation for both components, and app systems requirements, privacy / security.	Outputs fed into wireframe and user journey specification for MM2U V1 and parent component
Create	MHPs[a] (n = 4; 2 female, 2 male) 1 x half day workshop MHPs (n = 8; 6 female, 2 male) 1 x full day writing workshop Dedicated clinical writers for app[a] (n = 4; 2 male, 2 female) Dedicated clinical writer for parent resource (n = 2 female)	Identification of evidence-based practice Identification of publically-available resources Staging program Writing draft content	V1 content of app and parent component	
Improve	Young people (n = 16,14-19y; 12 female, 3 male, 1 transgender) [a] 3 × 2.5 h workshops	Review and refine V1 content Modification of content, language, concepts Refining implementation	Feedback informed V2 content.	
	Parents / Carers (n = 12; all female) 2 × 1 h focus groups	Review and refine V1 content and implementation	Feedback informed V2 content and implementation.	
	Teachers[a] (n = 4; 3 female, 1 male) Reviews and ratings of version 2 app content	Review and refine V2 content Refine implementation (Appendix A Table 3)	Feedback informed V3 app content. Ratings indicate acceptability and feasibility	
	MHPs[a] (n = 7; 4 female, 3 male) Individual clinical reviews and ratings of V2 app content	Review and refine V2 content Review safety protocols (Appendix A Table 3)	Feedback informed V3 app content. Ratings indicated acceptability and feasibility	
Communication Analysis	Young people (n = 15; 9 female, 6 male) one-to-one interviews	Review V3 content for comprehension and acceptability	Minor amendments informed V4 content.	Approved content built into MM2U V2
	Parents/carers (n = 10) one-to-one interviews	Review V2 parent component for comprehension and acceptability.	Rapid refinements cycled to subsequent interviews. Final version produced.	
User testing and final changes	Young people (n = 10, 9 female, 1 male) 1 × 2 h workshop	Review user interface, on boarding, journey, functionality, security and privacy	Ranking essential and preferred modifications to produce beta version for Test Phase.	Final wireframe + user journey specifications
Final reviews and safety assessment	Teachers from anticipated Test Phase schools[a] (n = 8, 6 female, 2 male) 1 × 2 h workshop	Approve implementation, monitoring and safeguarding plan Determine teacher training needs	Final implementation and training protocols	Beta version of app complete
	Parents (n = 5) remote content reviews	Approve V4 content	Very minor amendments	
	Teachers[a] (n = 5, 4 female, 1 male) remote content reviews	Approve V4 content	Very minor amendments	
	Clinical Safety Assessment (conducted by independent organisation)	Review safety according to the UK's National Health Services principles	Completed case report (Appendix C Figure 1). App safety approved	

[a] Some participants were involved in other Co-D stages.

2. Methods

2.1. Co-design of the app and parent component

This phase received ethical approval from the Faculty of Medicine and Health Research Ethics Committee of the University of Leeds (7/4/18; PSC-362). The end-product for this feasibility stage was a web app, although it looked and functioned like a native app. The Co-D phase sought to generate an evidence-informed resource via consensus seeking with key informants (Hartson & Pyla, 2018). Co-D spanned resource content, user journey, study recruitment and protocols for risk management, implementation and evaluation. It was pre-defined that the app would be a school hosted, evidence-based self-help tool for symptomatic young people (Gellatly et al., 2007; Lavis & Hewson, 2011) and that the parent component should target parent mental health literacy and confidence in supporting their young person.

2.2. Participants

Table 1 details participants and processes in Co-D. All adolescent participants had experienced mental health difficulties and all parents / carers had a young person with lived experience. Adolescent participants were given £20 as recommended by local consultation (Common Room, 2021). Following recommendations (Baumel et al., 2017; Marshall et al., 2020), our mental health professional's (MHP) group included representation from educational psychology, clinical psychology, psychotherapy, counselling, children's services and social work. Most young people and adult participants were White British. However, the adolescent group included one person of each of the following nationalities or ethnicity: British Afghan, Pakistani, Russian, Spanish, Indian and Black African. One young person described themselves as transgender.

2.3. Procedure

We based our Co-D approach on the Young and Well Cooperative Research Centre's framework (Hagen et al., 2012). Co-D processes involved personas, scenarios and user stories (Kankainen et al., 2012), identification and discussion of *Matters of Concern* (Poderi et al., 2018) including consideration of evidence, guidelines and resources (Supplementary Materials A Tables 1-2), artefacts (e.g., visual maps), functionality, user journeys and user testing (see Appendix B for multiple examples).

3. The app: MindMate2U

3.1. Content

Key app content is reported in Appendix C, including decisions made during Co-D, the intervention logic model and a map of the intervention against the TIDieR checklist (Hoffman et al., 2014). The needs of adolescents were privacy, choice, credible and relevant content, a friendly tone, and gamification. The end product, MindMate2U (MM2U), was designed by stakeholders to be a 6-week program for 14–18-year-olds who are feeling that "life has become more difficult, or are more worried, stressed or anxious than usual and / or are finding it difficult to cope".

Users begin by selecting six topics from a choice of ten. Five topics focused on overcoming specific mental health difficulties and five focused on building protective factors (see Fig. 1 menu of topics). Users had to choose at least one difficulty to overcome and to then work through one topic per week (see Fig. 1 for example app screenshots). Chosen topics were released weekly and comprised 10 units, each taking 3-10 min to read. Content drew upon evidence-based psychoeducation, cognitive-behaviour therapy (James et al., 2020), acceptance and commitment therapy (Halliburton & Cooper, 2015), mindfulness (Kallapiran et al., 2015), and solution-focused approaches (Wheeler, 2001), and included activities (e.g., mood and thought monitoring, action planning), links to videos and suggestions for things to try (e.g., golden hour pre-bedtime), informed by behaviour change techniques (Kok et al., 2016).

Multiple design principles were implemented including simple and friendly, positive language (Michie et al., 2017) and use of icons (Crane et al., 2017). Help-seeking was encouraged and signposting included

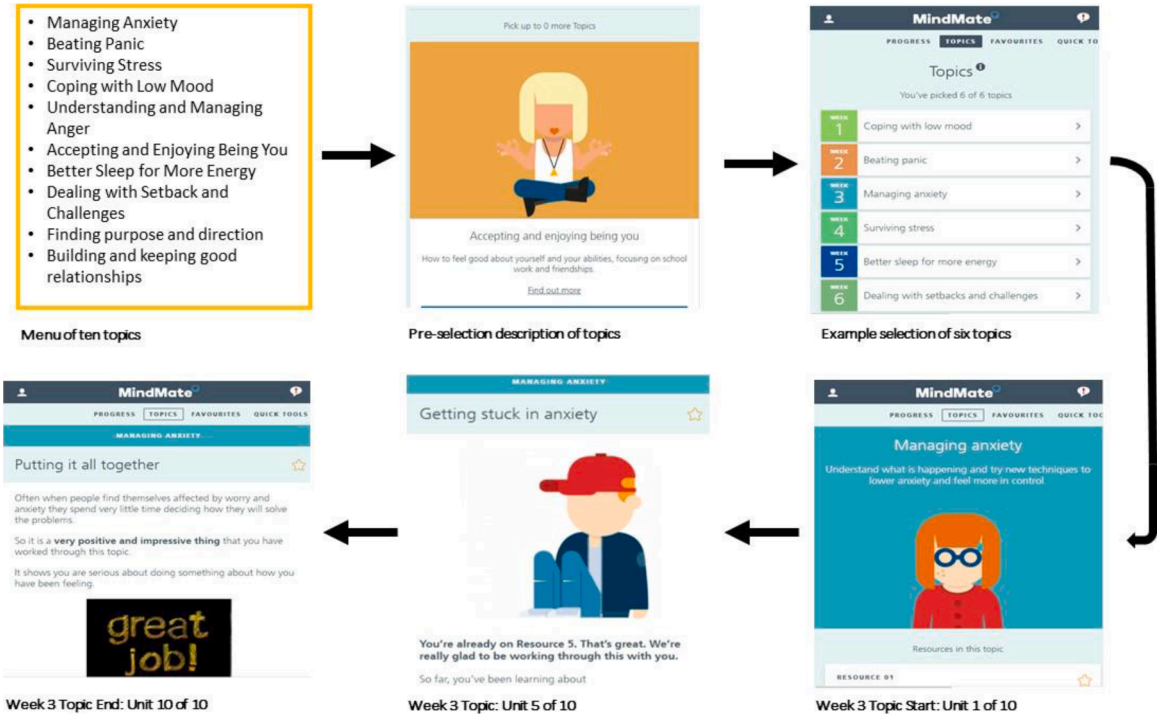

Fig. 1. MM2U screen shots showing the topic list and example topics, choices and units.

in-school support (with a direct link in the app to the school facilitator) as well as local and national / online organisations. Other features are shown in Appendix C Figure 3. The final beta version satisfied an independent safety review according to the UK's National Health Services (2018) (NIS Digital, 2018) principles defined in the DCB 0129 standard, which included satisfying General Data Protection Regulations (ICO, 2018).

3.2. Implementation

Young people designed MM2U to be launched via a login provided by a teacher (facilitator), and to limit school knowledge of MM2U use to that facilitator who was a form of 'support on standby'. Users were invited to navigate the six-week program in their own (non-school) time. Facilitators were asked to invite users to an exit meeting to assess needs at program end.

4. Parent component

4.1. Content and implementation

Co-D processes developed the parent component (called Partner2U) as six weekly emails explaining MM2U and providing psychoeducation and support to parents (Appendix C Table 3). No information about the young person's engagement with MM2U was shared. In Co-D, young people decided that only the adolescent could tell parents if they were using MM2U and invite them to the parent component.

5. Test phase: feasibility study

5.1. Study design

This test phase was approved by the Faculty of Medicine and Health Research Ethics Committee of the University of Leeds (12/6/18; PSC-517). We conducted a feasibility study of MM2U and the parent component utilising a randomised, pre-post intervention design with waitlist. We collected data on feasibility thresholds to inform progression to, and design of, a future effectiveness trial. We assessed acceptability of assignment to waitlist, candidate primary and secondary outcome measures and the responsiveness of health economics measures.

5.2. Eligibility criteria

Eligibility criteria were established during Co-D. Young people could participate if they self-defined as feeling more stressed, worried, nervous, unhappy, upset or negative about themselves than usual, and / or if they were finding it harder than usual to manage or cope. They were ineligible if they were: receiving mental health support from school or a professional; on medication for mental health; self-defined as in crisis (in which case support was offered); and / or had a diagnosed mental health condition. Parents could participate if they could receive and understand email in English.

5.3. Recruitment and consent

Guidance for designing feasibility studies (Sim & Lewis, 2012; Tennant et al., 2007) suggests sample sizes between 12 and 25 for each condition, and 30 participants overall. We aimed to recruit a minimum of 32 participants via 4 secondary schools with 2 facilitators per school (i.e., one primary and one back up). Schools decided to which year group, spanning 14–18-year-olds, they would like to advertise the study and nominated two facilitators for a half day training. Young people consented into the study via a study website. Schools and young people preferred parent / carer opt out consent for this study. Signed parental consent (online) was required for under 16 study participants. Once consenting was complete, the young person indicated if they wanted to release the parent component by providing a parent email address; if so, parents were emailed information and consent forms for their component.

5.4. Procedure

Young people completed baseline measures before random assignment to intervention group (IG; immediate start) or waitlist group (WL; start in six weeks). Following account set up by the facilitator, young people received a text messaged secure link to create their login and launched MM2U by selecting their six topics. Topic one was made available immediately and subsequent topics were released weekly. Parents who were given access to the parent component were emailed a resource once per week for six weeks.

5.5. Intervention usage data

We created a system to track usage, and with consent, collected data on: topic choice and frequency of topic changes, time to complete each topic, resource ratings, resources added to favourites, accessing 'Support', 'Quick tools' and facilitator email link, and frequency of password change. We did not capture any personal identifiable information.

5.6. Pre-post intervention measures

IG and WL participants completed seven measures pre-and post-intervention. Our two candidate primary outcome measures for a future trial were the Strengths and Difficulties Questionnaire (SDQ) (Goodman (2001) and the Warwick and Edinburgh Mental Well-being Scale (WEMWBS) (Tennant et al., 2007). Candidate secondary measures are reported in Appendix D Table 1. As behavioural intention to use a technology precedes its use and is affected by performance expectancy (Venkatesh et al., 2003), participants rated their motivation to use MM2U and their optimism that it would be useful. Facilitators were asked to keep a log of technical difficulties and / or requests by young people for support. As only one young person gave their parent access to the parent component, the data is not reported here. Young people and facilitators were invited to a post-intervention interview.

5.7. Feasibility thresholds

Our feasibility thresholds were: meeting recruitment and retention targets (n = 4 secondary schools; n = 2 facilitators per school; n = 32 adolescent participants); no refusal to be assigned to waitlist; and 21 out of 32 participants (65%) post-intervention measure completion rate. Acceptability thresholds were: 24 out of 32 (75%) of users completing the MM2U six-week program; 75% of MM2U content rated a minimum of 3 stars (out of 5); no unresolvable technical issues; and no major adverse events or reports in post-intervention interviews (see Appendix D Table 2 for interview questions).

5.8. Data analysis

Analysis involved cross tabulating IG and WL groups against participant characteristics at baseline and post-intervention with absolute numbers and percentages. Analysis of the two candidate primary outcome measures (SDQ and WEMWBS) required adjusting for baseline values so an ANalysis of COVAriance was conducted and we examined the role of motivation and optimism. We generated a more powerful analysis with a multilevel model with measurements clustered within participants. This had a random intercept term for participant as well as an overall fixed intercept. The most sensitive measure would demonstrate larger pre-post standardised effect size. For the economics evaluation, we costed resource units based on national sources (Personal Social Services Research Unit, 2021). The algorithm to calculate the

utility score for ReQoL-10 was obtained from the developers (Keetharuth et al., 2018). Interview data was content analysed.

6. Results

6.1. Participants

Four large (n~2000), urban secondary schools were recruited, each nominating two teachers as facilitators. Across the four schools, 32 adolescents consented to take part and parental consent for under 16s (n = 5) was given. The ratio of females to males was 4:2. None had participated in the Co-D phase. One participant withdrew before completing baseline measures stating they no longer felt the need for the intervention. Baseline measures were completed by 31 participants and post-intervention measures were completed by 21 participants (18 IG, 3 WL) (68% retention). The characteristics of participating adolescents are presented in Appendix E Table E1. There were no significant baseline group differences in age, gender, school motivation or optimism. Most cited reasons for taking part in the intervention were to cope with stress and anxiety (Appendix E Table 2). At baseline, most participants reported they were 'very' or 'quite' motivated to complete the intervention (n = 29, 94%) and were 'very' or 'quite' optimistic that it would be helpful to them (n = 21, 68%).

6.2. Intervention usage

Logins and topic choices were completed by 29 of the baseline 31 participants. One participant lost before login had technical difficulties linked to multiple accounts created by their school. Reasons are unknown for the loss of the other participant. Topic selections across 29 participants were Managing Stress (n = 27), Coping with Low Mood (n = 27), Better Sleep (n = 22), Anxiety (n = 20), Accepting and Enjoying Being Me (n = 18), Dealing with Challenges and Setbacks (n = 15), Panic (n = 15), Finding Purpose and Direction (n = 14), Relationships (n = 11) and Anger (n = 5). Other tracking data proved problematic, complicated by participants moving back and forth between completed and current topics, which was not anticipated. Ratings of topics were available from 19 participants and spanned 74 units (each topic had 10 units, but many users did not rate the introduction or summary units). Each topic was rated by at least three users. The mean submitted rating was 4.12 out of 5. Data on time to complete each topic was only available for 12 participants as not all participants marked a topic as complete; of these, 9 completed each topic within 10 days. Twenty-four participants added a unit to their 'Favourites', 19 utilised Quick Tools, 18 accessed the Further Support page, 26 changed passwords (although it is unclear if this was at the point of account creation) and none accessed the Facilitator link. Only one of the 31 baseline participants nominated a parent to receive the parent component.

6.3. Analysis of standardised measures

The seven measures were well completed. Pre-intervention, most participants scored high or very high in mental health symptomatology (see Appendix E Tables 3 - 4). We examined sensitivity in the SDQ and WEBWMS to detect pre-post change. Reductions in SDQ scores indicate improved mental health. Based on those completing both pre-post measures, in the IG, the mean change in SDQ scores was -2.17, close to one SD (2.81, n = 18) but scores increased in the WL group (0.67, SD = 0.58, n = 3). The change in WEBMWS scores was positive by 7.06 (SD = 11.37, n = 18) in the IG and 3.67 in the WL group (3.67, SD = 5.03, n = 3). Differences between IG and WL in these measures were not statistically significant (unsurprising as the feasibility study was not powered to detect such an effect). An ANCOVA examining the role of baseline SDQ scores in change scores (Appendix E Table 5) showed that MM2U was associated with a reduction in SDQ scores of 2.12. The measure appears useful as baseline SDQ had a significant influence on post-intervention SDQ scores (<0.001).

Adding 'optimism' ratings that the intervention would be helpful improved the regression model markedly (Appendix E Table 6). MM2U was associated with a reduction in mean SDQ scores by 2.65. Being 'quite' or 'very' optimistic that the intervention would help was associated with an additional 3.2 points on the post SDQ score, which was highly significant. We did not explore the role of motivation as almost all participants reported being motivated. An ANCOVA (Appendix E Table 7) shows that baseline WEBMWS did not influence change scores. MM2U was associated with an increase in WEMWBS scores by 3.242 units. The associated t value was 0.480, less than the absolute value of that in the SDQ regression. This suggests that SDQ is more sensitive to the intervention that WEMWBS.

6.4. Economic evaluation

Pre-post completion rates of Resource Use and ReQoL were acceptable. The Resource Use questionnaire showed 53 instances of healthcare service use for the 31 participants at baseline and 36 instances post-intervention for 21 participants. Clinical psychologist and school/other counsellors were the most frequently accessed services. Pre-post average change in costs was -£14.12 ($P = 0.27$). As cost data distribution was skewed, we used a Generalised Linear Model with Gamma family and log link examining the impact of the intervention on the change of expected cost (Appendix E Table 8). Although there was a minor increase in expected log cost post-intervention (£0.49p), this was not statistically significant. However, WL was associated with a significant increase in the expected log cost by £3.12 (a relative change of £22.64 ($P = .001$). The change in average ReQol-10 utility score was positive by 0.046 ($P = .25$). OLS regression to examine the role of the intervention on the change of expected utility showed that the minor increase in utility post-intervention was not statistically significant (Appendix E Table 9).

6.5. Qualitative data analysis

Six adolescent participants (14-16yr, 5 females, 1 male from three study schools) and one facilitator were interviewed. During Co-D, young people indicated post-intervention interviews could be difficult to recruit to as young people feel self-conscious. Our options for a telephone, on-line or in-school interview appeared largely unacceptable. The interview data we did secure (Appendix E Table 10) indicated MM2U feasibility and acceptability.

7. Discussion

Our primary aim was to develop and feasibility test a self-help, school-based, digital mental health resource for adolescents and their parents/carers. To inform a future effectiveness trial, we also aimed to identify a sensitive primary outcome measure, completion rates of candidate secondary outcome measures and to complete an exploratory health economics assessment.

7.1. Co-design outcomes: what did young people and stakeholders want in a school-hosted MH app?

Co-D identified different priorities for young people (privacy, autonomy), teachers (low-burden, safety nets, technical ease), parents (safety and shared information about their child's engagement with the app) and MHPs (limitations of digital vs. face-to-face help). Although the support of another person can improve mHealth outcomes (Baumeister et al., 2014), young people designed parental involvement in MM2U to be within their control. They explained that their need for privacy (commonly reported, e.g. Wilson et al., 2011) was driven by a need for autonomy, to not worry parents or to avoid difficult conversations. Ensuring psychological safety when using MH apps is critical (Firth

et al., 2017). Young people only accepted implementation of MM2U with two teachers' (facilitators') knowledge, showing youth preference for minimal teacher support when using a school-hosted app.

Young people designed MM2U content to be both risk reducing and resilience building. Being able to choose multiple risk topics is important given co-morbidities, and the benefit of targeting common elements of mental health (Aitken et al., 2020). Building protective factors aligns with a public health approach (Campion et al., 2012). Young people's preference for a six-week program is an important insight to acceptable dosage. MM2U content met many of Bakker et al. (2016) recommendations for MH apps.

7.2. Feasibility and acceptability of MM2U

Our feasibility thresholds were met. The acceptability of MM2U to young people, parents and schools is an important finding, opening up routes for early intervention via apps in schools without overburdening teachers.

Academic stress is a major contributor to adolescent mental health difficulties so it is not surprising that our schools chose (after consultation with their leadership teams) to offer MindMate2U to year groups 11-13 (broadly 15-18y), which are the UK school years when academic pressure and exam stress are high. School choices here suggests that they see academic stress management as a priority target for adolescent mental health and / or as a suitable for app delivery, and perhaps also that they consider a MH app suitable for older rather than younger year groups. Our study schools were particularly motivated to deliver more support for adolescent well-being in schools and were involved in Co-D and therefore knew the app. Including our Co-D schools in the feasibility stage was an important return-on-investment for the schools. Upscaling school recruitment for a larger trial may require work to build a new school's trust in the app. However, once that is achieved, it is likely that similar implementation feasibility thresholds could be met by new schools, given its' standards of clinical safety, the low burden on school resources and that no parent / guardian objected to its availability in the study schools. It is likely that schools with an established structure of tiered support for mental health will be able to incorporate the app more easily that schools without this, as follow-up support may be needed for some users.

That we met our thresholds for young people recruitment, and that the sample scored high on mental health symptomatology indicated that MM2U attracted the intended demographic. Acceptability thresholds were also met in terms of user completion rates and app content quality ratings. Although the latter was only available for 19 participants, our clinical safety review, user testing workshops, and post-intervention interviews were additional sources of positive reviews. Our findings are consistent with other studies that adolescents find psychoeducation-based self-help MH apps acceptable (Bevan-Jones et al., 2018, 2020). No user approached a school facilitator for support, and the parent component did not appear acceptable to young people as only one participant opted to release it. Although an overview of the parent component was available, young people may have needed more detail to be confident that parental involvement would not be over-intrusive. School-based mental health support for parents may be most acceptable to young people when delivered universally, rather than contingent upon a young person's help-seeking. The SDQ was a more sensitive measure than WEMWBS and will be our primary outcome measure in an effectiveness trial. Optimism will be used to stratify randomisation. The economic analysis suggests that MM2U has the potential to reduce cost and improve the quality of life of participants.

7.3. Evaluation and next steps

Strengths of this study included responding to call for extensive Co-D processes and adherence to standards for app development and feasibility studies (Bennion et al., 2019; Craig et al., 2008). Outcomes will inform the development and effectiveness testing of MM2U and will address the following:

(1) The research team was involved in both Co-D and app evaluation. Future work will use blind and independent evaluators.
(2) Our study recruited more females than males, although this is common in these types of studies (e.g. Thapar et al., 2012). We will aim to recruit more adolescent males. Gamification may make MM2U intrinsically more engaging for both males and females.
(3) It has been argued that benefits from self-help apps are limited to populations with mild symptomology and that the clinical application of apps may be limited (Wand, Varma & Prosperi, 2008). However, many of our participants' baseline scores were in the clinical range (i.e., their frequency and intensity of symptoms was indicative of a mental health disorder), suggesting even those with high symptomology found a self-help app attractive. A definitive trial will add to knowledge of the clinical impact of MH apps even when delivered in a non-clinical setting. Our future study will also track the dominant MH need for each participant to learn more about which mental health needs can be best supported via an app and which protective factors can be bolstered.
(4) Whilst MM2U content was grounded in everyday examples of young people's lives, we need to do more to help users apply general MM2U learning to specific everyday difficulties. This is a recurring recommendation for MH Apps although it remains unclear what effective engagement with an MH app means in practice (Bergin et al., 2020), e.g., brief use at critical times vs. program completion (Michie et al., 2017).
(5) We secured few feedback interviews. The likelihood of this was flagged during Co-D. We need to shift process evaluations to within the app.
(6) Participants non-release of MM2U's component for parents means challenges of how to support parents when their young person is using a school-based MH app remain. Disaggregation of components seems the best option to meet youth's primary need for privacy and autonomy.

8. Conclusion

This study contributes to our understanding of MH apps in public health approaches and what young people, schools, clinicians and parents want from such a resource. This study established the app's feasibility as a low-burden, school-hosted mental health resource. MM2U meets many recommendations for adolescent mental health support that is accessible, flexible, private and tailored (Patton et al., 2016). There is scope to consider how MM2U could operate within schools as an adjunct to school counselling. Opt-in, targeted mental health support available via an app in schools as a public health and early intervention resource has promise. A subsequent phase 2 randomized controlled trial is warranted to demonstrate the effectiveness of MM2U in reducing the clinical risk of symptomatic young people.

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Declaration of Competing Interest

There are no conflicts of interest to report.

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Supplementary materials

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