Inclusion of underserved young people in digital public health interventions: Systematic review and equity synthesis of effectiveness, moderation, and implementation evidence

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Scientific Abstract

Background: Young people aged 11-25 worldwide face increased health risks, including substance misuse, mental ill-health, and sexual health concerns, which are often interconnected. These health challenges, such as depression, anxiety, and substance use, can affect decision-making around sexual health and are influenced by factors like peer pressure, stress, and lack of support. In the UK, young people bear a disproportionate burden of STIs, pregnancies, and mental health issues, and relationship violence further compounds these risks. Digital health interventions are seen as a promising solution to address these challenges by improving accessibility, efficiency, and personalisation of care. However, empirical evidence on their effectiveness for underserved populations remains limited. This systematic review aims to examine the evidence on digital public health interventions tailored to young people, particularly those from underserved groups, focusing on mental health, sexual health, and substance use outcomes. Our research questions are,

RQ1 What is the quantity, quality, and strength of evidence for digital public health interventions tailored to underserved groups?

RQ2 How are digital public health interventions tailored to underserved groups?

RQ3 Is there evidence for differential effectiveness of interventions, and differential uptake, acceptability, or accessibility by underserved groups?

Methods

Inclusion criteria

The review will examine public health digital interventions for young people (13–25) in high-income countries, focusing on underserved groups, with any comparator, and outcomes in mental health, sexual health, or substance misuse. We will address RQ1 in two stages, in stage 1 we will identify systematic reviews of trials, and in stage 2, we will identify randomised trials tailored to underserved groups identified within systematic reviews, and randomised trials tailored to underserved groups identified through top-up searches. For RQ2, we will examine randomised trials tailored to underserved groups, drawing from both systematic reviews and top-up searches. RQ3 will be addressed in two stages: in stage 1, we will identify trial-sibling moderation evidence from all relevant trials,

and in stage 2, we will gather trial-sibling implementation evidence related to health inequalities from the same set of trials.

Data sources

We will search systematic reviews published since 2020 in key databases (MEDLINE, Embase, PsycINFO, Web of Science, Scopus) to assess timeliness, quality, and overlap, followed by targeted searches for recent trials in CENTRAL and PsycINFO.

Quality assessment

We will use the AMSTAR-2, the Cochrane risk of Bias tool for trials, and the EPPI-Centre qualitative appraisal tool. We will then use GRADE to assess the certainty of evidence from quantitative evidence, and GRADE-CERQual for assessing the confidence in findings in the qualitative evidence. .Stakeholder consultation, including young people with lived experience and professionals supporting them, will inform the protocol and recommendations.

Syntheses

For RQ1, we will synthesis the evidence identified in the first stage through Overview and mapping of reviews, and we will conduct a narrative synthesis the trials or a metanalysis (where possible) tailored to underserved groups based. For RQ2, we will synthesis the evidence by an intervention components analysis of trials tailored to underserved groups. For RQ3, in stage 1, we will synthesise moderation analyses linked to all relevant trials; in stage 2, we will synthesise health inequalities-based implementation evidence linked to all relevant trials using narrative synthesis for quantitative evidence, and framework synthesis for qualitative evidence.

Dissemination: The review will be an output from the NIHR PHR Reviews Team. It will support the funder in setting research and funding priorities.

Summary

Young people between 11 and 25 face some serious health risks (like using drugs or alcohol), mental health problems, and sexual health issues. These problems are often connected, for example, feeling sad or anxious can lead to using substances, and both can make it harder to make safe choices about sex. Using alcohol or drugs can cause long-term health problems, like heart issues, and can even be life-threatening. These challenges can happen because of things like peer pressure, stress, or not having enough support. Young people also face a higher risk of getting sexually transmitted infections (STIs) or having unplanned pregnancies. In the UK, many young people have these issues. Problems like relationship violence also make mental health and substance misuse worse. To help, we need programs that focus on mental health, substance use, and sexual health. Digital health tools could help improve access to care, but we need to learn more about how well they work. We will review research to understand what has worked for young people and use what we learn to improve future programs. We will use a method called a systematic review, which means that we will draw together previous research on programmes and services. We will look closely at what this research says about how programmes and services were tailored to specific groups of young people. We are doing this work because of what we heard from young people in our previous projects, and we will continue to discuss with these young people and people who support them to understand our findings and to understand how we can make use of the findings to help shape future research and practice.

1. Background

Epidemiology and inequalities. Young people, defined here as being between the ages of 11-25, worldwide face increased risks in relation to misuse of substances, mental ill health, and poor sexual health.(1) These issues are often interwoven and form a constellation of health and social conditions that co-occur and demonstrate causality. For example, mental health challenges can drive individuals to misuse substances, and both can impact decision-making around sexual health.(2) Young people are at an increased risk for substance misuse, including alcohol, tobacco, and recreational drugs (3) where the risks vary from injuries to cardiovascular toxicity, including risks of sudden death from myocardial ischaemia (4) and infarction. This misuse can stem from a range of factors, such as peer pressure, stress, (5) exposure to substances at an early age (6), and lack of supportive networks. (7) Significant biological, psychological, and social changes occur during the ages of 11-25 (8, 9). These can increase vulnerability to mental health issues, many of which begin before age 24 and may persist into adulthood. (10) This early onset can lead to long-term health burdens, with depression projected to be the leading cause of disability worldwide by 2030. (11)

Social media, academic pressures, family dynamics, and economic uncertainty contribute to high levels of stress and a sense of instability for younger people (12, 13). Without proper mental health support, they often face stigma and lack of access to resources, which can lead to isolation, lower educational outcomes, and increased risk of self-harm or suicidal thoughts. (14, 15) Sexual ill-health includes STI prevention, reproductive cancer screening, and education—essential in mitigating health disparities and improving long-term quality of life.(16, 17) In the UK, young people (15-24) bear a disproportionate burden of STIs, with cases at a 10-year high, and high rates of under-18 pregnancies, over half of which end in termination. (18, 19) Additionally, dating and relationship violence (DRV) is widespread among young people, increasing risks of mental health issues, substance misuse, and even mortality. (20, 21)

Underserved groups amongst young people may experience significant vulnerabilities, for example care-experienced individuals report poorer mental health and wellbeing compared to their non-care-experienced peers, with an increased risk of suicide-related

outcomes.(22) Moreover, poorer mental health and sexual health outcomes are reported in young people from lower-income communities and ethnic minority groups. (23-25)

Comprehensive public health interventions addressing these risks require integrated, individual, or parallel interventions that include, amongst other interventions, accessible mental health care, (26) comprehensive substance misuse education, and open dialogue around sexual health.(27) Digital health interventions are widely regarded as having the potential to improve mental health outcomes, increase accessibility, and address growing service demands through enhanced efficiency, effectiveness, and personalisation. (28) While young people's extensive use of digital technology suggests a ready and early adoption of digital health approaches, this assumption can drive the development of digital public health interventions without sufficient empirical validation of its aetiology. (29-31)

Digital inclusion and the role of digital health interventions. Digital inclusion can help bridge these inequalities by addressing intersecting factors like class, ethnicity, and disability. Unlike the digital divide, which focuses on access to technology, digital inclusion emphasises the necessary support, skills, and resources for effective technology use. (32) Digital inclusion involves access to connectivity, content, and the development of digital skills such as critical thinking, creativity, and the ability to use information and communication technologies effectively. Digital literacies and internet connectivity are key "super social determinants of health," (32) influencing access to essential services like employment and housing. Enhancing digital skills and access potentially offers a cost-effective way to reduce health disparities and improve long-term well-being. (33) 92% of adults in the UK were recent internet users in 2020, up from 91% in 2019. (34) However, many find digital services inadequate, rigid, or not aligned with their preferences (for example, the need for accessibility functions for young people with hearing difficulties or with differing cognitive or language abilities). Common challenges, including device access, costs,(35) and a lack of confidence, were significant barriers to using digital services. Terms like digital inclusion, participation, capability, and literacy all refer to the ability to use digital technologies, especially the internet, to improve lives and overcome challenges.

Digital interventions in public health have contrasting definitions across guidelines and published literature. (36, 37) Digital public health interventions refer to public health interventions provided electronically in a health care system, formally or informally.(38, 39) Figure 1 categorises digital health into four overlapping domains: mHealth (individual-level prevention via mobile tech), eHealth (digital health services for individuals and populations), and Digital Public Health (population-level health promotion and management). Digital Health is the broadest, covering all levels and functions. Each domain varies in scope from individual to population impact across prevention and healthcare management.
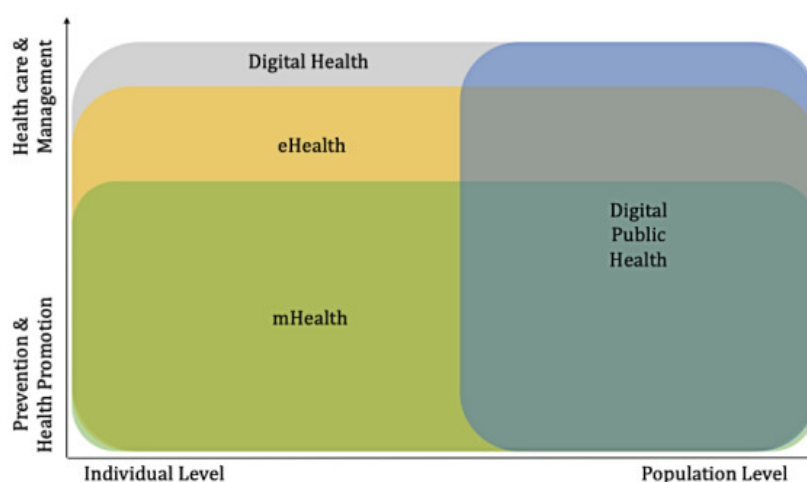
Figure 1. Core field of action and target group level of mHealth, eHealth, digital health, and digital public health (36)

Defining the scope of public health-relevant digital interventions. A functional **classification of digital interventions** has been proposed by National Institute for Health and Care Excellence which describes the types and levels of evidence needed to show the effectiveness and expected economic impact of digital health interventions.(40) In this classification, Tier A focuses on focuses on health and social care systems without directly affecting individual patient outcomes; Tier B supports health awareness, simple monitoring, and communication between patients, the public, and health professionals; Tier C focuses on strategies that directly impact individual health through behaviour change, self-management, treatment, monitoring, calculations, or diagnostics.(40)

The WHO Classification of Digital Interventions, Services, and Applications in Health (CDISAH) categorises digital health interventions, applications, and services are utilised to address individual and health system needs. Standard 1.0, described as digital health interventions for persons, includes eight categories. These are: targeted communications to persons; untargeted communication to persons; person to person communication; personal health tracking; person-based reporting; on-demand communication with persons; person-centred financial transactions; and person-centred consent management. The key point of difference of WHO classification from the NICE classification is that the WHO classification needs to be used in conjunction with the Health System Challenges (HSC) framework to clarify the use of digital technologies in the needs of a public health system.(41)

Why this review is needed now. The rapid expansion of digital platforms and interventions has transformed the landscape for public health efforts, particularly since COVID-19, which accelerated digital adoption and strengthened resilience within public health systems. Numerous systematic reviews now examine digital interventions for young people, yet it remains challenging to identify effective approaches that address the interconnected issues of sexual ill-health, mental ill-health, and substance misuse, especially for underserved youth populations.(42, 43)

In high-income countries, one contributor to health inequities is the speed at which public health interventions are developed and implemented, often leading to gaps in effectiveness and inclusivity. Evidence from systematic reviews reveal barriers to integrating digital health interventions into routine services, such as technical challenges, limited awareness of data standards, low user engagement,(44) and a lack of economic evaluations and implementation research (45, 46). Although evidence supports the potential of early mental health prevention for young people, current research has limitations with most interventions focusing on secondary school populations, often excluding higher-risk groups such as young people seeking asylum and refugees (47) and young people in unstable care placements (22). Additionally, these interventions primarily target depression and anxiety through Cognitive Behavioural Therapy (CBT), with relatively few aimed at promoting general wellbeing, or aimed at treatment instead of prevention.(48)

This set of linked systematic reviews will examine the effectiveness of public health-relevant digital interventions for priority outcomes (specifically mental health, sexual health and substance use) in young people and the role of these interventions in promoting or preventing digital inclusion, both where these interventions are tailored to underserved groups and where these interventions are designed for general populations of young people.

2. Review Definitions and Aims

We will systematically review evidence on public health-relevant digital interventions for young people in high-income countries, considering both differential impacts and experiences of interventions for underserved groups and interventions tailored to underserved groups, focusing on priority outcome domains of **mental health**, **sexual health,** and **substance use**. We will use the identified evidence to address the following research questions, all with respect to our priority outcome domains:

> RQ1 What is the quantity, quality, and strength of evidence for digital public health interventions tailored to underserved groups?
>
> RQ2 How are digital public health interventions tailored to underserved groups?
>
> RQ3 Is there evidence for differential effectiveness of interventions, and differential uptake, acceptability, or accessibility by underserved groups?

3. Methods

This review will be registered in PROSPERO and reported using PRISMA guidelines. (49) An overall map of the review and its component syntheses is displayed in Table 1.

3.1. Approach to Searching and Data Sources

Given digital health is a fast-moving and well-reviewed field, we will begin by undertaking a search for relevant systematic reviews published since 2020 in MEDLINE, Embase and PsycINFO. Additional targeted searches of Web of Science and Scopus will be added to take advantage of their multi-disciplinary coverage. Based on the number of reviews identified and their overlap, their quality (including the quality of underpinning searches) and their recency (i.e. the absence of multiple, high-quality reviews with searches undertaken in the last 18 months for any outcome domain), we will undertake update

searches for relevant randomised trials of interventions. These searches will take place in CENTRAL and PsycINFO.

Finally, we will need to identify trial-sibling process and implementation evaluations and effect modification evidence for research question 3. We will do this using forward and backward citation searching for relevant trials identified within systematic reviews and any additional trials, including as informed by guidance from the Cochrane Handbook on searching for sibling studies (targeted searches for project names, related article searches, and contacting authors). We will also explore other citation searching methods following recommendations from the TARCiS statement(50).

3.2.   Search Strategy

The search strategy for systematic reviews will have two conceptual facets. The first will cover digital interventions, including associated platforms, devices, and software as well as individual interventions. Terms for this have been derived from existing strategies from relevant systematic reviews and further refined via iterative explorative searching.

The second will capture the three outcome areas. Early scoping searches revealed some search strings warranted greater precision, for example, general terms for smoking. In these instances, search terms have been qualified by additional "prevention" terms. A systematic review filter[1] that will work across MEDLINE and PsycINFO will be applied to these searches. Any additional searches will be developed responsively in accordance with the needs of the review.

The MEDLINE search strategy is presented in Supplement A. We will summarise search results using a search summary table(51).

3.3.   Inclusion Criteria

This review's eligibility criteria unfold in two stages, focusing first on eligibility criteria for reviews included in the first stage search before focusing on evidence from primary studies. We will be guided by the following definitions:

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[1] The CADTH 2021 search filter works for MEDLINE, Embase and PsycINFO: https://searchfilters.cda-amc.ca/link/33

- This review will focus on **digital interventions**. These interventions are interventions that solely or primarily use digital technologies for the delivery of intervention content. Interventions using digital technologies solely for measurement or assessment (e.g. wearables, pedometers) without any linked digital delivery of content will be excluded, as will digital interventions consisting solely of one-time passive delivery of information (e.g. a single video or static webpage). Included interventions might include mobile apps; social media-based interventions; or other text message-based interventions.

- We will also focus on **public health-relevant interventions** by including interventions for universal, selective, and indicated prevention. With respect to the NICE taxonomy, this relates to interventions in Tier B and Tier C; drawing on WHO CDISAH, relevant interventions would belong to categories 1 to 6 of Standard 1.0 (i.e. excluding person-centred financial transactions and person-centred consent management). We will also exclude interventions that are designed as telehealth/telemedicine, i.e. for online provision of clinical services, or for individual management of health services, and interventions intended for delivery to pre-existing groups (e.g. to entire classes in schools), but will reconsider this based on identified evidence.

- We will define **young people** as people aged 13-25, to include adolescence and early adulthood. We will also define **underserved groups** using the PROGRESS-Plus heuristic(52), described in Table 2. We have chosen a lower age range of 13 to capture when young people are likely to begin engaging with digital interventions.

We will also focus on three public health-relevant outcome domains defined as:

1. **Mental health,** including symptomatology of depression or anxiety, internalising and externalising problems, and mental well-being;

2. **Sexual health,** including sexually transmitted infections, sexual risk behaviours, uptake of contraception or protective technologies (barrier methods, pre-exposure prophylaxis); or

3. **Substance use,** including use of alcohol, tobacco, or other drugs.

We will include **reviews** meeting the following criteria:

- **Types of studies:** systematic reviews meeting the DARE criteria,(53) where systematic reviews focus specifically on randomised controlled trials. Scoping reviews not focused on evaluations of relevant interventions, or focusing on digital health more generally, will be excluded.

- **Types of populations:** young people, either as the sole focus of the review or where evidence pertaining to young people is synthesised separately as a main focus of the review.

- **Types of interventions:** public health-relevant digital interventions, as defined above. Reviews focusing on digital interventions generally will be included if public health-relevant interventions are synthesised separately as a main focus of the review.

- **Types of outcomes:** outcomes relating to mental health, sexual health, or substance use, as described above.

- **Types of publications:** published in full text since 2020. Conference abstracts will be excluded.

We will include **primary studies** meeting the following criteria.

- **Types of studies:** randomised trials; linked evidence to randomised trials relating to moderation of intervention effects by equity-relevant characteristics; linked evidence to randomised trials relating to the implementation and experience of interventions.

- **Types of populations:** young people in high-income countries as the focus of evaluated interventions. This includes groups of young people that are underserved. Trials where young people may be a substantial proportion of the study population, but are not the focus, will be excluded.

- **Types of interventions:** public health-relevant digital interventions, as defined above.

- **Types of comparators:** any comparator, including waitlist, no-treatment control, another digital intervention, or a face-to-face intervention.

- **Types of outcomes:** outcomes relating to mental health, sexual health, or substance use, as described above, or evidence linked to randomised trials evaluating these outcomes.

- **Types of publications:** completed and reported trials, either in full text or in conference abstract form.

3.4. Study Screening Methods

In the review search, titles and abstracts will be screened in duplicate and independently, as will be full texts. The same will apply for the follow-on search of randomised trials, and for results of forwards and backwards citation searching.

Conflicts in assessments will be resolved through discussion and recourse to a third member of the review team.

3.5. Software

Retrieved study reports from the data sources will be exported to Endnote 20, where they will be combined and de-duplicated. They will then be uploaded to EPPI Reviewer 6(54) for screening and extraction of characteristics. Data extraction and appraisal will be conducted using Covidence. Intervention components analysis will be undertaken using Microsoft Excel.

3.6. Quality Appraisal

Appraisals will use AMSTAR-2 for systematic reviews(55) and the original Cochrane Risk of Bias Tool 1 (56) for newly identified randomised trials. Implementation evidence will be assessed using the EPPI-Centre qualitative appraisal tool(57) because of its dual focus on relevance and trustworthiness. Appraisal will be conducted independently by two reviewers.

3.7. Data Extraction and Coding

All extraction will be undertaken by one reviewer and checked by a second.

Extraction for reviews. We will extract data items for reviews for: review questions, structured as population/intervention/comparator/outcome where appropriate; types of

evidence synthesised; number of relevant studies identified; currency of the search; and relevant summary findings from reviews.

Extraction for trials. We will prioritise full data extraction for trials of interventions tailored to underserved groups. We will extract data items for trials for: basic study details (first author, year; study location, timing and duration; participant characteristics); study design and methods (design, sampling and sample size, inclusion/exclusion criteria, allocation, blinding, accounting for data clustering, data collection, attrition, analysis, standard of care in control arm); and outcome measures (timing, reliability of measures, intra-class correlation coefficients, effect sizes). For moderation evidence, we will additionally extract: how subgroups were defined; which outcomes were tested; and how moderation was tested. For implementation evidence, we will extract: how and from whom data were collected, how data were analysed, and key qualitative findings relevant to underserved groups.

Where relevant, we will label the focal equity characteristics to which interventions have been tailored, structuring our description using PROGRESS-Plus(52). Because inequities do not occur 'one at a time,' we will also label trials with respect to equity characteristics of interest present in over half of the trial population. For example, if a trial is described as testing an intervention tailored to minoritised young people but more than half of the trial population is described as living in poverty, we will label the trial as 'focally' about minoritised young people but 'of interest' for poverty as well.

Finally, we will extract intervention descriptions both in summary and as free text across all included trials.

3.8. Synthesis

To address **research question 1**, we will produce a map using EPPI Reviewer 6 of the identified systematic review-level evidence **across all populations**, applying descriptors by outcome focus (mental health, sexual health, substance use), population focus (general population, underserved groups), age focus (adolescents only vs young adults), and any emergent categories relating to public health-relevant digital interventions. Where multiple similar reviews exist in any one cell, we will calculate the corrected covered area to describe overlap.

We will also label individual trials identified both in existing reviews and in any follow-on searches using similar descriptors, focusing specifically on **trials tailored to underserved groups**. We will use a narrative synthesis and weight-of-evidence approach with GRADE to assess how strong the evidence for effectiveness is per outcome domain and per population group. If possible or necessary, we will register a protocol addendum to describe methods for meta-analysing trial results.

To address **research question 2**, we will use intervention components analysis(58) using reports of intervention descriptions in **trials tailored to underserved groups** to identify how digital interventions are tailored to these groups, and compare these components both across outcome domains and across groups. At least two reviewers will use open coding to generate a comprehensive list of possible intervention descriptors from five different intervention descriptions relating to a range of underserved groups, focusing on aspects of interventions described by trialists as developed to meet the specific needs of underserved groups. The two lists will be compared and combined. Using principles of axial coding, the two reviewers will proceed through the remaining intervention descriptions, collapsing codes and adding new ones as required and meeting periodically to compare codes, determine if new axial codes are required and organise axial codes into categories. The final result is a comprehensive list of descriptors to characterise the equity-relevant components of included interventions. We will relate components to intervention effectiveness using narrative synthesis.

To address **research question 3**, we will draw on moderation and implementation evidence from **all relevant trials**. Drawing on moderation evidence, we will use harvest plots organised by outcome domain to capture evidence of within-trial effect modification over underserved groups. We will also use narrative synthesis with quantitative implementation evidence to capture evidence of differential uptake/availability, accessibility, or acceptability by underserved groups. We will use framework synthesis to (59) analyse qualitative implementation evidence relevant to experiences of young people from underserved groups, using the availability, accessibility, acceptability framework.(60) Framework synthesis will be undertaken by two reviewers working in tandem.

3.9. Synthesis Output

For **research question 1**, we will produce matrices of evidence, at both review level and trial level, to guide decisions on future commissioning of digital public health interventions for underserved groups. This includes areas of high certainty of evidence and areas of low certainty, where more research is required.

For **research question 2**, we will present a summary table of equity-relevant components alongside a) estimates of their frequency both overall and by different equity characteristics, b) exemplar descriptions, and c) conclusions relating to the impact of components on effectiveness where possible. This will shape forward development of tailored interventions.

For **research question 3**, we will present an analysis of 'risk areas' where commissioners and developers will need to consider inequity-generating impacts of digital interventions, as well as where in the implementation pathway these inequities might be generated.

Throughout the review, we will consult with interested parties to understand the best and most useful way to disseminate review findings beyond academic publications. This may include infographics, webinars, or other practice-facing tools.

3.10. Patient and Public Involvement (PPI)

Stakeholder consultation will occur at three key stages of the review: (a) the refinement of the initial findings, (b) the development and confirmation of recommendations, and (c) the dissemination strategy (see Table 3). At least three groups will be involved across the review: young individuals with lived experience of mental ill-health, poor sexual health, or substance misuse, a specialist young people's involvement group, and policy and practice networks including the NIHR Incubator for AI and Digital Healthcare and Organisation for the Review of Care and Health Apps (ORCHA). The final round of stakeholder groups near the end of the review will focus on the development and confirmation of recommendations and the dissemination strategy. All stakeholders from the first stage will be re-engaged, alongside a feedback session with professionals who support young people, as well as commissioners and policymakers.

4. Ethics

Ethical approval for the review will not be required. PPI consultation with stakeholder groups will be conducted in accordance with any ethical requirements stipulated by the organisations and research studies that recruit participating members.

5. Discussion

Digital public health interventions refer to public health interventions provided electronically in a health care system, formally or informally. Digital public health interventions, delivered electronically within healthcare systems, (39) address a range of interconnected issues, including substance misuse, mental health challenges, and poor sexual health, particularly among young people. These issues often exacerbate each other, influenced by factors such as peer pressure, social media, academic stress, and a lack of support networks, leading to long-term health consequences. This review will use the WHO digital health framework to explore the quantity, quality, and strength of evidence for digital public health interventions tailored to underserved groups, and the effectiveness of general interventions across underserved groups.

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Table 1. Synthesis Questions and Evidence Sources

Review question	Evidence source	Synthesis description
1. What is the quantity, quality, and strength of evidence for digital public health interventions tailored to underserved groups?	Systematic reviews of randomised trials	Overview and mapping of reviews
	Randomised trials tailored to underserved groups identified within systematic reviews Randomised trials tailored to underserved groups identified in top-up searches	Synthesis of trials tailored to underserved groups
2. How are digital public health interventions tailored to underserved groups?	Randomised trials tailored to underserved groups identified within systematic reviews Randomised trials tailored to underserved groups identified in top-up searches	Intervention components analysis of trials tailored to underserved groups
3. Is there evidence for differential effectiveness of interventions, and differential uptake, acceptability, or accessibility by underserved groups?	Trial-sibling moderation evidence identified from all relevant trials	Synthesis of moderation analyses linked to all relevant trials
	Trial-sibling implementation evidence relevant to health inequalities identified from all relevant trials	Synthesis of health inequalities-based implementation evidence linked to all relevant trials: • narrative synthesis for quantitative evidence • framework synthesis for qualitative evidence

Table 2. PROGRESS-Plus Characteristics that Stratify Health Opportunities and Outcomes

PROGRESS-Plus Stratifying Characteristics	
P	Place of residence
R	Race/ethnicity/culture/language
O	Occupation
G	Gender/sex
R	Religion
E	Education
S	Socioeconomic status
S	Social capital
Plus	1. Personal characteristics associated with discrimination (e.g. age, disability)
	2. Features of relationships (e.g. smoking parents, excluded from school)
	3. Time-dependent relationships (e.g. leaving the hospital, respite care, other instances where a person may be temporarily at a disadvantage)

Table 3. Stakeholder Engagement in Review Process

Review Stage	Stakeholder Groups	Identification of Stakeholders	Aims of Engagement
Early-stage engagement relating to the protocol	Two stakeholder groups: • One with young people with lived experience of mental ill-health, sexual ill-health, or substance misuse • Specialist young people's involvement group	Young people Charities Other non-NHS settings	Provide feedback on protocol. Develop sensitising concepts to inform forward analysis.
Refinement and confirmation of preliminary and final findings	Three stakeholder groups: • One with young people with lived experience of mental ill-health, sexual ill-health, or substance misuse • Specialist young people's involvement group • Broader policy networks (e.g. ORCHA, NIHR Incubator for AI and Digital Healthcare) and including commissioners and policymakers	Young people Charities Other non-NHS settings	Provide feedback on preliminary findings. Refine and confirm final findings.
Development and confirmation of recommendations and dissemination strategy	Three stakeholder groups: • One with young people with lived experience of mental ill-health, sexual ill-health, or substance misuse. • One with professionals providing support to young people. • Broader policy networks (e.g. ORCHA) and including commissioners and policymakers	Policy networks specific to the review	Refine and confirm dissemination strategy. Ensuring findings are accessible to intended audience. Develop recommendations for commissioners and funders.

Table 4. Timeline for Delivery of Digital Inclusion Reviews

	2024			2025											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Protocol															
Protocol development	■	■	■												
Submission to NIHR			■												
Patient and public involvement															
Phase 1: Protocol				■											
Phase 2: Synthesis										■					
Phase 3: Dissemination														■	
Searches and Screening															
Database searches				■	■										
Supplementary searches				■	■	■									
Screening				■	■	■									
Extraction and Appraisal															
Data extraction							■	■	■						
Quality appraisal							■	■	■						
Synthesis of Findings															
Synthesis of findings										■	■	■			
Publication and Reporting															
Draft of publication													■	■	■
Submission to NIHR													■	■	■

Supplement A: Example Search Strategy (MEDLINE)

Ovid MEDLINE(R) ALL <1946 to November 05, 2024>

#	Query	Results from 7 Nov 2024
1	exp Mental Disorders/pc [Prevention & Control]	56,903
2	Mental Health/	69,892
3	Mindfulness/	7,401
4	Stress, Psychological/	138,541
5	Depression/	163,314
6	Anxiety/	116,591
7	Resilience, Psychological/	10,383
8	(mental* or psych* or ?mood*).ti.	574,545
9	(mental* adj3 health*).ab,kf.	249,070
10	(depress* or anxious* or anxiet* or emotion* or mood or resilience or self-efficacy or self-esteem or mindful* or cope or coping or cognitive* or lifeskills or "life skills" or stress* or psychosocial or "psychological* distress*").ti,kf.	1,085,079
11	(well-being or well being or wellbeing).ti,ab,kf.	168,401
12	((social or emotional) adj1 (skills or support or network*)).ti,ab,kf.	101,690
13	((depress* or anxiet*) adj5 (symptom* or prevent*)).ab.	144,922
14	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13	1,956,587
15	exp Substance-Related Disorders/pc [Prevention & Control]	26,106
16	(cannabis or marijuana or "substance use").ti.	39,371
17	"legal high*".tw.	445
18	exp "Marijuana Use"/	7,452
19	Cannabis/	15,318
20	"Tobacco Use Disorder"/pc [Prevention & Control]	1,953
21	"Tobacco Use Cessation"/	1,541

22	Smoking Reduction/	121
23	Smoking Cessation/	33,936
24	exp Alcohol Drinking/pc [Prevention & Control]	5,448
25	binge drinking/ or alcohol drinking in college/ or underage drinking/	4,760
26	(alcohol* or beer* or wine* or liqo?r* or spirits or alcopop*).ti.	185,226
27	15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26	283,615
28	exp Substance-Related Disorders/ or Illicit Drugs/	328,014
29	exp *Alcoholic Beverages/	17,829
30	exp *Smoking/	83,819
31	(Drug* or substance* or polysubstance or polydrug or "poly-drug" or "legal high*" or cannabis or weed or marijuana or skunk or cocaine or stimulant* or ketamine or pingers or MDMA or Molly or ecstasy or hotboxing or "hot boxing" or hallucinogen* or inhalant* or psychoactive* or "psycho active*").ti,ab,kf.	2,567,824
32	(smoking or smoker* or tobacco* or nicotine or cigar? or cigs or cigarette* or cigarilloi* or "hand roll*" or handroll* or rollies or "roll up*" or "roll-up*" or rollup* or vape or vaping or ecig* or e-cig* or "e cig*").ti,ab,kf.	431,800
33	(drink* or alcohol* or beer* or wine* or liqo?r* or spirits or alcopop*).ti,ab,kf.	575,022
34	28 or 29 or 30 or 31 or 32 or 33	3,446,814
35	*Health Promotion/	54,072
36	Psychosocial Intervention/	1,303
37	exp Preventive Health Services/	706,920
38	Primary Prevention/	20,347
39	exp Public Health/	9,714,609
40	("public health" or "health promotion" or prevent* or avoid* or reduc* or protect* or abstain* or abstinence or refus* or stop* or delay or influenc* or reduc* or abstain* or abstinence or temperance or refus*	11,614,607

	or prevent* or stop* or delay* or binge* or excessive* or underage* or under-age* or "under age*" or high-risk or "high risk" or behavio?r* or teen* or youth* or adolescen* or juvenile* or youngster* or highschool* or college* or universit* or school* or education).ti,ab,kf.	
41	35 or 36 or 37 or 38 or 39 or 40	17,447,742
42	34 and 41	2,050,628
43	27 or 42	2,143,353
44	exp Sexual Behavior/	130,050
45	Unsafe Sex/	5,284
46	exp Sexually Transmitted Diseases/pc [Prevention & Control]	76,696
47	(sexually transmitted disease* or std* or STI*).ti.	428,496
48	(sex* adj2 (health* or safe* or unsafe or protect* or risk or risky or high-risk or unprotected or abstinence or behavio?r* or activit*)).ti,ab,kf.	96,500
49	((STI or STIs or STD or STDs or sexually transmitted disease* or sexually transmitted infection* or Chlamydia or gonorrhoea or syphilis) and (prevent* or control* or risk* or reduc*)).ti,kf.	8,458
50	(contraception or contraceptive* or condom* or "HPV vaccine" or "human papillomavirus" or "pre-exposure prophylaxis").ti,ab,kf.	154,967
51	Safe Sex/	3,618
52	Pregnancy in Adolescence/pc [Prevention & Control]	1,582
53	Sexual Health/	3,060
54	(sexual adj3 (health* or behavio?r*)).ti,ab,kf.	58,071
55	Contraception/	22,848
56	Condoms/	11,323
57	*Reproductive Health Services/	2,024
58	44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57	785,860
59	14 or 43 or 58	4,546,477

60	Digital Technology/	1,186
61	Mobile Applications/	13,599
62	Wearable Electronic Devices/	10,008
63	exp Cell Phone/	24,661
64	Videoconferencing/	2,484
65	gamification/	139
66	(digital* or online* or internet* or web* or email or mobile or app or apps or browser or virtual).ti.	247,210
67	((Digital* or online or web* or internet or virtual* or email*) adj2 (technolog* or intervention* or deliver* or based or support*)).ab,kw.	98,447
68	(smartphone* or (smart adj phone*)).tw.	28,714
69	(mobile adj (device* or health or phone*)).tw.	24,525
70	text messag*.tw.	7,018
71	(e-health or ehealth or m-health or mhealth).tw.	14,800
72	(SMS or MMS).tw.	14,977
73	wearable*.tw.	31,563
74	(facebook or twitter or snapchat or facetime or Tiktok or youtube or whatsapp or Instagram or reddit or blog or blogs or blogging or webinar* or podcast*).tw.	26,219
75	(social adj (media or network*)).tw.	59,119
76	(smart adj (device* or tech*)).tw.	2,183
77	(electronic adj2 device*).tw.	17,964
78	((mobile or online or tablet or computer or phone) adj2 (app or apps)).ab.	7,187
79	(Zoom or skype or "video conferenc*").tw.	6,743
80	virtual reality/	7,260
81	(virtual adj2 (realit* or world* or environment*)).tw.	24,586
82	3d vision.tw.	343

83	Gamification.tw.	1,529
84	60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83	487,353
85	59 and 84	115,200
86	(systematic review or meta-analysis).pt.	367,446
87	meta-analysis/ or systematic review/ or systematic reviews as topic/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or network meta-analysis/	410,310
88	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kf.	388,262
89	((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))).ti,ab,kf.	18,510
90	((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)).ti,ab,kf.	44,445
91	(data synthes* or data extraction* or data abstraction*).ti,ab,kf.	47,999
92	(handsearch* or hand search*).ti,ab,kf.	11,814
93	(mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kf.	39,860
94	(met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*).ti,ab,kf.	13,555
95	(meta regression* or metaregression*).ti,ab,kf.	17,384
96	(meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw.	547,646
97	(medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw.	403,827
98	(cochrane or (health adj2 technology assessment) or evidence report).jw.	22,166

99	(comparative adj3 (efficacy or effectiveness)).ti,ab,kf.	19,932
100	(outcomes research or relative effectiveness).ti,ab,kf.	12,042
101	((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab,kf.	4,813
102	(multi* adj3 treatment adj3 comparison*).ti,ab,kf.	322
103	(mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab,kf.	183
104	umbrella review*.ti,ab,kf.	2,339
105	(multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	15
106	(multiparamet* adj2 evidence adj2 synthesis).ti,ab,kf.	19
107	(multi-paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	13
108	86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107	792,132
109	85 and 108	7,346
110	limit 109 to yr="2020 -Current"	4,766