

A Scoping Review of Self-Guided Smartphone Applications for Mental Health and Wellbeing for Middle-Aged Adults from Racial and Ethnic Minority Groups Worldwide

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Lay Summary

Introduction: People from ethnic minority groups around the world often experience higher rates of mental health issues. This is due to factors like discrimination, economic challenges, and historical trauma. For middle-aged individuals, these mental health challenges can be even more significant due to family responsibilities, job-related stress, and ageing.

Unfortunately, traditional mental health services often do not adequately meet the needs of ethnic minorities, leaving many without the help they need. Digital mental health tools, like smartphone apps, could help close this gap by providing flexible and accessible support to a broader audience.

A review of existing literature was carried out to answer the key question: What does the current research say about self-guided smartphone apps for mental health and wellbeing for people aged 40-65 from racial and ethnic minority groups around the world**?**

Several secondary questions were also explored to get a more comprehensive picture on:

- **Participant Generational Status:** Do studies report whether participants are from first, second, or later-generation ethnic minority groups?
- **Purpose**: How are self-guided mental health apps being used for this age group and demographic?
- **Design and Features**: What designs and features do these apps have?
- **Stakeholders**: Who are the important people and groups involved in creating these apps?
- **Considerations**: How do these apps address issues of accessibility, acceptability, cultural relevance, and usage?
- **Barriers and Facilitators**: What makes it easy or difficult for people to use these apps?

- **Outcomes**: What results do these apps achieve?
- **Gaps**: What important areas have not been covered by the existing research?

Methods: A comprehensive review of relevant research on four electronic databases was undertaken to understand what is known about self-guided smartphone applications for mental health and wellbeing that support middle-aged adults (aged 40-65) from racial and ethnic minority groups worldwide. The databases included in the search were Medline, Embase, PsycINFO, Science Citation Index & Social Science Citation Index. Rayyan software was used to support the process of screening references.

Results: Out of 998 studies initially considered, the full text of 114 were reviewed, and ultimately 16 studies were included in the analysis. These studies indicate that content specially designed to respect and reflect the traditions, values, and needs of different cultures is crucial for making mental health apps feel relevant and engaging to users. When apps use familiar language, symbols, and cultural references, they are easier for users to navigate and use regularly. Barriers to using these apps include concerns about cost, privacy, and confidentiality. Additionally, technical issues and a lack of digital skills can prevent people from using these apps effectively.

Conclusions: The review found a paucity of published research on this important topic worldwide. To fully realise the benefits of digital mental health tools, future research needs to focus on different aspects such as long-term studies, involving users in the design process, and effectively integrating these tools into existing health systems. Addressing these areas can lead to more effective, culturally sensitive, and sustainable digital mental health solutions for racial and ethnic minority groups around the world.

Abstract

Introduction: Ethnic minority groups worldwide are often disproportionately affected by mental health issues due to factors such as systemic discrimination, socioeconomic disparities, and historical trauma. Middle-aged individuals may face compounded stressors related to family responsibilities, employment challenges, and ageing. Traditional mental health services frequently fail to adequately serve ethnic minority populations, resulting in unmet mental health needs. Digital interventions have the potential to help reduce this gap by offering scalable and adaptable support that can reach a broader audience.

Methods: A scoping review was conducted to identify the existing literature about self-guided smartphone applications for mental health and wellbeing (SAMHW) targeting middle-aged adults aged 40-65 from Racial and Ethnic Minority Groups (REMG) worldwide. Four databases were systematically searched: Medline, Embase, PsycINFO, Science Citation Index & Social Science Citation Index. Rayyan software was used to record screening decisions.

Results: Screening of 998 studies and a full-text review of 114 studies resulted in 16 studies for inclusion. Studies suggest culturally tailored content is more likely to resonate with users, making the app feel relevant to their daily lives and personal experiences. This increases engagement and the likelihood of sustained use.

Using culturally familiar language, symbols, and references can make the apps more intuitive and easier to navigate for users from diverse backgrounds. Barriers to app use include concerns around cost, privacy, and confidentiality. Technical problems and a lack of digital literacy are additional barriers.

Conclusions: This review revealed a paucity of published research on this topic worldwide. Studies were absent in most countries, with 12 publications from the USA and 4 from Australia. Studies showed that multidimensional approaches, including longitudinal studies, iterative co-design processes, and robust healthcare integration strategies, will be essential in realising the full potential of SAMHW for REMG.

Future research should prioritise these areas to develop more effective, culturally sensitive, and sustainable mobile health solutions.

Key words: Middle-Aged People, Racial and Ethnic Minority Groups, Mental Health and Wellbeing, Smartphone Applications, Mobile Health Interventions.

Background

Mental Health Inequalities

Globally, about one in eight people live with a mental disorder, equating to nearly a billion people, most of whom remain untreated (1). Mental health operates on a complex, fluid continuum, encompassing a spectrum of experiences from optimal well-being to severe distress and emotional suffering (1).

Studies worldwide have consistently shown that mental disorders are more common among people from racial and ethnic minority groups (REMG) than the majority population (2-4). Stark mental health inequalities include differences in mental disorder prevalence rates, clinical diagnoses, access to mental health services, and types of care received (3).

Definition of REMG

REMG are defined as people of "ethnic origins different from most of the population. They are people of first, second, or later generations who can be distinguished from the majority of people living in a specific country or region, through their skin colour, family names, specific habits or behaviour, and who can be identified as a minority in regard to most inhabitants of a specific country" (5). REMG differ in each country.

Mental Health In Middle-Age

Middle-age is a pivotal life-course stage that bridges early adulthood and older adulthood (6). This period is typically defined as occurring between the ages of 40 and 65 (7). Middle-age is characterised by distinct role constellations and experiences, as outlined in Appendix 1 (6). It is marked by significant physical, psychological, and social developments that influence an individuals' overall life trajectory (8).

Complex life course processes can contribute to worse mental health and wellbeing in middle-age, such as physical signs of ageing (9), juggling multiple responsibilities (9), health concerns, family problems, divorce (9), work-related and financial vulnerabilities, deaths, and unfulfilled goal attainment (10). A reduction in wellbeing is likely due to a unique combination or accumulation of these factors (9). Much remains unknown about middle-age, as most studies examining the links between these events and later mental health or wellbeing incorporate all ages and treat age as a confounding factor, or limit the scope to a narrow age range (9).

People in middle-age are commonly referred to as the "sandwich generation" (11), with responsibilities for work, raising children or grandchildren, and caregiving for ageing parents or in-laws (12). This scenario can be associated with depressive symptoms, adverse mental health, and poorer wellbeing, particularly for women who often have more carer responsibilities (13). This has broader societal and public health implications, particularly for younger and older people who may largely depend on middle-aged adults for their own wellbeing (14).

Untreated mental health issues in middle-aged adults have associations with poor health outcomes, including functional disabilities (12), cognitive impairments, and reduced quality of life (12). Middle-aged men are at the greatest risk of dying from suicide, and they do not respond to psychotherapy as well as other age groups (9).

Middle-aged adults can be highly interested in personal development programmes to enhance their spiritual, emotional, and mental wellbeing (15). While these adults may not have grown up with mobile apps, they can still adapt to and benefit from these digital tools for mental health support (16). Establishing healthy habits, prevention, and addressing any mental health issues in middle-age can significantly impact the quality of a persons life in later years (17).

Mental Health In REMG

For some REMG, stressors may be greatly exacerbated (18-20). Contributing factors encompass variations in family structure, cultural norms, responsibilities, and living arrangements, such as the prevalence of multigenerational households in certain REMG (18). Additionally, more precarious economic and social conditions, often stemming from weakened social networks, language barriers, and limited financial resources, play a role (18). The adherence to traditional gender roles within families also disproportionately places caregiving responsibilities on women rather than men (18).

People from REMG are less likely to access mental health support or do not seek support at all; the majority of mental health disorders in this population remain undiagnosed (21) or untreated (16), even in high-income countries (22).

Middle-Aged People From REMG

The number of middle-aged individuals from REMG globally is unknown, as ethnic groups vary across countries (23). The complexity of measuring ethnicity is influenced by a myriad of factors, including definitional variability (24), data collection challenges (24), political and social sensitivities, migration patterns (23), ethnic mixing, cultural and linguistic barriers, technological and resource constraints, and historical contexts (24).

The age range that constitutes middle-age can also vary (9). While it is commonly defined as 40-65 years (9), some sources may use different age ranges ± 10 years (12). This lack of standardisation makes compiling consistent data across different global regions and countries difficult.

Global Mental Health Challenges

Mental health systems worldwide are marked by major gaps and imbalances in resources, services, information, funding, and research (1). The World Health Organisation has reported that on average, countries allocate less than 2% of their healthcare budgets to mental health services (1). In middle-income countries, over 70% of mental health funding is still directed towards psychiatric hospitals and treatment rather than self-directed interventions and preventative measures (1). Furthermore, approximately 50% of the global population resides in areas where there is only one psychiatrist per 200,000 people, and access to affordable essential psychotropic medications is particularly scarce in low-income countries (1).

In every country, the quality of mental health care is inconsistent, further exacerbating service coverage gaps (1). Barriers include poor quality of services, low levels of mental health literacy, stigma, and discrimination (1). Formal mental health services do not often exist, and when available, they are often inaccessible or unaffordable (1).

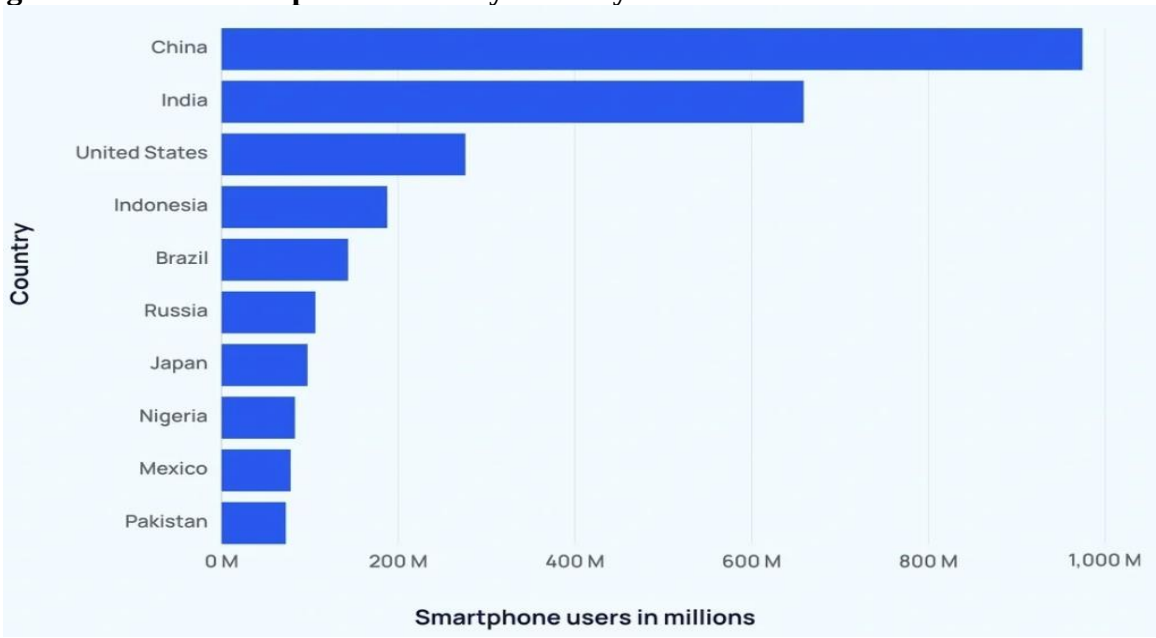
Self-Guided Smartphone Applications For Mental Health And Wellbeing (SAMHW)

SAMHW offer individuals a potentially convenient, accessible, and confidential source of support for managing their mental health and wellbeing on their own terms and an opportunity to bridge existing mental health support access gaps. Applications may not necessarily substitute professional mental health care, but they can complement traditional therapy and provide valuable self-care and symptom management resources (22).

Evidence shows that REMG experience greater barriers to accessing mental health care due to stigma, systemic racism (25), historical trauma (26), discrimination, and a preference for self-reliance (27). SAMHW can circumvent some of these barriers by enabling people to access support in their own time, when needed, and in the privacy of their homes. This flexibility may be especially beneficial for middle-aged adults with busy schedules balancing work, family, and other responsibilities (28). However, many existing SAMHW may not address the specific cultural beliefs, values, and norms of REMG (27).

In 2024, the number of global smartphone users will reach 7.1 billion, which is more than 86% of the worlds population, and this number is growing (29). Figure 1 shows the top 10 countries for smartphone users and highlights that 55% of smartphone users come from Asia (29). In the USA, almost 19 in 20 people own a mobile (29); mobile ownership in this country is similar across ethnic groups: Black population (98%), White population (94%), Hispanic population (97%) (29). The Millennial generation (aged 28-43) has the highest proportion of smartphone users (94.40%). This is followed by Gen X (aged 44-59 years) at 88.80% (29).

Figure 1: Active Smartphone Users By Country



Source: How Many People Own Smartphones? (2024-2029) (whatsthebigdata.com)

There are over 10,000 mental health mobile applications available on the market (30). This number is growing, and selecting appropriate apps for users is increasingly challenging (30). For most SAMHW, the utility, efficacy, and effectiveness are unknown, and some may be damaging (30). There is a lack of adequate regulation and accountability for potential harm to users (30).

Imperative For This Research

Digital mental health interventions, including SAMHW, have been chiefly designed as a one-size-fits-all (31). Assessments of these interventions have overrepresented white, particularly female participants, and REMG are not routinely considered or involved during intervention development and evaluation (32). Therefore, queries about their viability among REMG exist (33). If REMG are not engaged during the development and evaluation of digital interventions for mental health, these technologies might further entrench, rather than overcome existing disparities (32, 34).

A scoping review published in 2023 examined 15 studies that described self-guided SAMHW targeting 14-36 year olds from REMG (1). However, there is no synthesis of the worldwide evidence relating to self-guided SAMHW targeting adults aged 40-65 from REMG. In April 2024, a preliminary search of JBI Evidence Synthesis, Open Science Framework, FIGSHARE, PROSPERO, and the Cochrane Database of Systematic Reviews was undertaken, which identified no systematic or scoping reviews on this topic were currently available or underway. Hence, a scoping review was conducted on this topic.

The findings of this review could be a first step towards producing novel solutions and informing the improved development, implementation, and sustainment of user-friendly, inclusive, culturally sensitive, and effective SAMHW in the future.

Review Questions

The primary research question was: What does the existing literature say about self-guided smartphone applications for mental health and wellbeing (SAMHW) that target people aged 40-65 from Racial and Ethnic Minority Groups (REMG) in any country?

The secondary research questions were:

- Do existing studies report whether participants are from first, second, or later-generation REMG?
- What are the purposes of using self-guided SAMHW for this population?
- What designs and features of self-guided SAMHW are reported in the literature?
- Who are the key stakeholder groups involved in informing app development?
- How are accessibility, acceptability, cultural tailoring and sensitivity, and uptake of interventions considered in these self-guided apps?
- What are the barriers and facilitators of using these self-guided apps?
- What intervention outcomes are reported?
- What are the gaps in the literature?

Methods

This review was conducted following the Joanna Briggs Institute (JBI) methodology for scoping reviews as outlined by Peters et al (35).

Protocol Development

A scoping review protocol was developed and published on Figshare on the 10th May 2024. The protocol is available from: https://figshare.com/articles/online_resource/_b_SelfGuided_Smartphone_Applications_for_Mental_Health_and_Wellbeing_Targeting_MiddleAged_Adults_from_Racial_and_Ethnic_Minority_Groups_Worldwide_A_Scoping_Review_Protocol_b_/25795375/1

Search Strategy

An initial limited search of PubMed, Google, and Google Scholar was undertaken to identify articles on the topic in April 2024. The text words contained in the titles and abstracts of relevant articles, the index terms used to describe the articles, and consultation with other stakeholders or subject matter experts and an information specialist were used to develop a complete search strategy in May 2024. Scoping reviews and systematic reviews were also searched for relevant search terms used in previous studies.

On 20th May 2024, following expert advice from an experienced information specialist to ensure the implementation of comprehensive and precise search strategies, four databases were systematically searched: Medline, Embase, PsycINFO, Science Citation Index & Social Science Citation Index. These were selected because they cover a wide breadth of social sciences, medical, nursing, and psychological literature.

A focus on published research only was undertaken because this was feasible within the time available to complete the dissertation. In addition, published research generally undergoes peer review, which can act as a filter to exclude studies with methodological flaws or unsubstantiated claims, ensuring a certain level of quality and validity. Research in databases is easily accessible to other researchers, facilitating reproducibility and verification of results which can enhance the reviews' credibility.

The comprehensive search framework used a wide range of keywords and free text items to increase the sensitivity and inclusiveness of the searches. The search strategy, including all identified keywords and index terms, was adapted for each included database. The reference lists of all included sources of evidence were screened for additional relevant studies. The specific search strategies and terms used are detailed in Appendices 2-5.

Types Of Sources

This review considered any sources which met the inclusion criteria, such as experimental and quasi-experimental designs, randomised and non-randomised control trials, interrupted time series studies, and before and after studies. It also considered analytical observational studies such as prospective and retrospective cohort studies, analytical cross-sectional, and case-control studies.

Descriptive observational study designs were considered for inclusion, including case series, case reports, and descriptive cross-sectional studies. Qualitative study designs such as grounded theory, ethnography, phenomenology, action research, qualitative description, and mixed methods studies were also considered.

Inclusion Criteria

Studies were included if they fulfilled the following criteria:

1. More than 50% of the study participants came from a REMG background.
2. The study participants average age was between 40-65 years.
3. The study focused on apps developed to support mental health issues, designed to help individuals manage their mental health and wellbeing independently, without the direct involvement of a mental health or healthcare professional.
4. The study was published in English.
5. There were no geographical or time limits on published studies.
6. Any study design was considered, e.g., qualitative, quantitative, and mixed-methods research, protocols, and reports of completed studies.

Relevant exclusions included apps that were not self-guided and apps that were not related to mental health, wellbeing, or self-care. Studies were excluded if they were used only for adherence to medication or other lifestyle changes such as diet and exercise, or if they evaluated apps solely as adjuncts to face-to-face therapy. Any published study protocols, dissertations, and conference abstracts identified in the searched databases that did not fully meet the inclusion criteria were excluded.

Evidence Selection Process

All identified citations from the search were collated and uploaded into EndNote version 21.2 (36), and duplicates were removed. Two researchers independently screened all titles/abstracts and full texts. Screening decisions were recorded on Rayyan, an online tool to manage and record decision-making in a systematic review (37).

Any disagreements between the author and second reviewer at each stage of the selection process were resolved through discussion. This robust process was used to minimise personal biases and increase validity and reliability. When information was lacking in a paper to decide whether to include it (e.g., about the age of participants), the publications authors were contacted for further details.

Data Extraction

A customised data extraction tool was developed by the author and then used to extract data from the information sources. The extraction tool, which was modified but informed by the JBI scoping review guidance (35), is included in Appendix 6. Data from the included papers was extracted into an Excel file by the author and cross checked by the second reviewer.

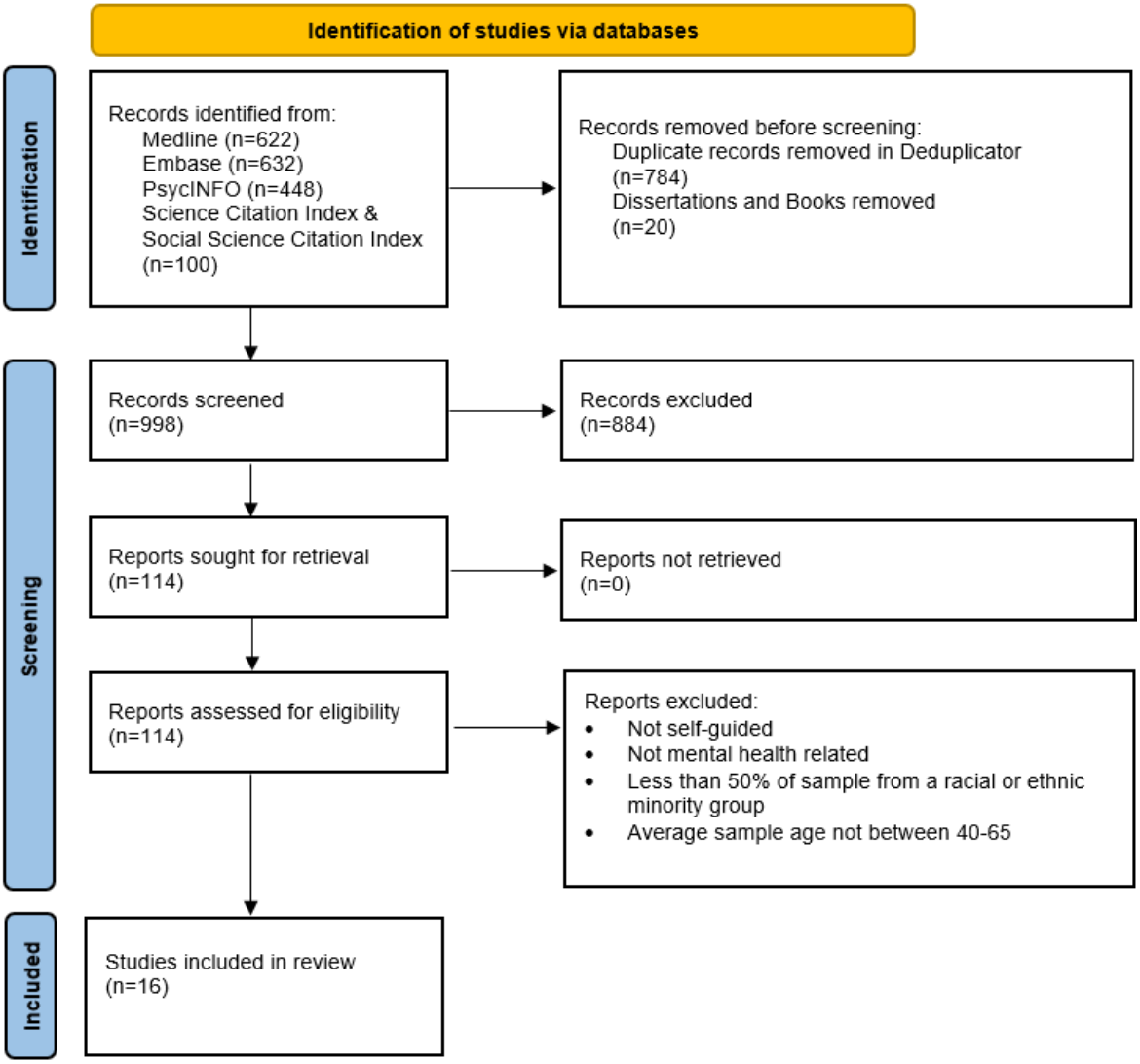
Data Analysis And Data Synthesis

The studies were charted to provide an overview of the body of evidence and the characteristics of the population and study designs. A thematic and content analysis was undertaken as outlined by Popay et al (38) to formulate a narrative summary. As this is a scoping review, a critical appraisal of evidence sources was not undertaken.

Results

Figure 2 shows that 998 items were screened from 4 databases. After screening titles and abstracts, 114 references were read as full texts. Most references were excluded because they did not contain a sample of participants, over 50% of whom were from a REMG, or the mean/median age was not between 40 and 65. Where information was unclear or missing, the publications authors were contacted, which resulted in the exclusion of 3 additional papers. A total of 16 papers were included.

Figure 2: Flowchart Highlighting Key Stages Of The Screening Process



Overview of Included Studies

The studies in Table 1 have been organised to cluster those related to the same mobile application, thereby enhancing clarity and comprehension. Of the 16 studies examined, 11 focused on 5 apps with additional secondary analysis of 4 primary datasets. Across these 11 studies, there were 477 participants, of whom 306 were app users. 4 studies reported on the My Guide and My Health apps (39-42), 3 studies on the Stay Strong app (43-45), 2 studies on the CASA-CHESS app (46, 47), and 2 on the FOCUS app (48, 49).

The Craving to Quit app (50) and Ohmage app (51) were each reported in individual studies. Three studies reported on prototype app development for specific roles, i.e., care workers (52), informal dementia caregivers (53), and suicide prevention gatekeepers (54). The cumulative number of participants across all 16 studies was 614.

Table 1 shows that 12 studies were conducted in the USA and 4 in Australia, with publication dates ranging from 2017 to 2022. Two papers employed a mixed methods approach, one utilised a multi-methods approach, four were qualitative studies, and nine were quantitative studies. Among the quantitative studies, three were randomised controlled trials, and one was a single-group pre-post study.

The mean/median ages ranged from 40 to 63.5 years. However, no studies reported that they intentionally focused on middle-aged people. A limited number of REMG were represented: Latinos, Hispanics, Non-Hispanic Blacks, African Americans, Chinese, Indigenous Australians, Aboriginal, and Torres Strait Islanders.

No studies differentiated whether the participants were first, second, or later-generation ethnic minorities. However, Wang et al noted that study participants had lived in the USA for an average of 20.4 years, and more than 63% spoke very little or no English (52). Yanez et al also reported that 71% were born outside the USA, with 64% having Mexican ancestry and preferring to communicate in Spanish (39).

Eleven articles studied apps in populations with co-existing health conditions: individuals with HIV (50), with chronic kidney disease (43), with co-occurring alcohol and other drug disorders (47), and breast cancer survivors (39).

Table 1: Characteristics Of Included Studies

Author and Year of Study	Name Of Mobile Application	Aim Of Study	Country	Research Design	Sample	Data Collection	Analysis	Outcome Measures
Yanez et al 2020 (39).	2 Apps studied: 1) My Guide 2) My Health	To establish the feasibility and preliminary efficacy of the My Guide and My Health apps among Latina breast cancer survivors	USA	Randomised control trial	78 female Latina participants. 37 used My Guide App intervention, and 38 used My Health App intervention. Average age 52.54	App usage data, questionnaires, and exit survey	Linear mixed effects modelling	Functional assessment of cancer therapy breast and health related quality of life App usage data
Baik et al 2020 (40).	2 Apps studied: 1) My Guide 2) My Health	To evaluate patient characteristics associated with health-related quality of life, breast cancer concerns, and cancer specific distress among Latina breast cancer survivors who participated in a psychosocial smartphone intervention to improve health related quality of life	USA	Quantitative	78 female Latina participants. 37 used My Guide App intervention, and 38 used My Health App intervention. Average age 52.54	Secondary analysis of baseline data collected in primary study by Yanez et al 2020 (39)	Descriptive statistics and hierarchical regression models using SPSS version 22	Functional assessment of cancer therapy breast and health related quality of life
Baik et al 2020 (41).	2 Apps studied: 1) My Guide 2) My Health	To explore the patterns of use of the My Guide and My Health app among Latina breast cancer survivors	USA	Quantitative	78 female Latina participants. 37 used My Guide App intervention, and 38 used My Health App intervention. Average age 52.54	Secondary analysis of baseline data collected in primary study by Yanez et al 2020 (39)	Descriptive statistics and linear regression analysis	Functional assessment of cancer therapy breast and health related quality of life App usage data

Author and Year of Study	Name Of Mobile Application	Aim Of Study	Country	Research Design	Sample	Data Collection	Analysis	Outcome Measures
Oswald et al 2021(42).	2 Apps studied: 1) My Guide 2) My Health	To examine the effects of My Guide and My Health apps on breast cancer knowledge, coping, and cancer related self-efficacy	USA	Quantitative	78 female Latina participants. 37 used My Guide App intervention and 38 used My Health App intervention. Average age 52.54	Secondary analysis of baseline data collected in primary study by Yanez et al 2020 (39)	Descriptive statistics and linear mixed effects models	Brief cope subscale, Communication, and attitudinal self-efficacy scale
Nagel et al 2020 (43).	Stay Strong	To adapt the Stay Strong app for people with chronic kidney disease and test its feasibility	Australia	Multi-methods	5 haemodialysis patients and carers identifying as Aboriginal and Torres Strait Islanders. All aged between 51 and 60	Pilot testing of app Individual and focus group interviews	Thematic analysis	Kessler distress scale (K10), patient health questionnaire, euroqol
Dingwell et al 2021 (44).	Stay Strong	To determine if the Stay Strong app improves mental health and wellbeing for Indigenous people receiving haemodialysis, relative to delayed treatment control groups and to assess whether benefits are maintained after 6 months	Australia	Randomised control trial	152 total participants. 62 used app intervention. All Aboriginal and Torres Strait Islanders. Mean age 55	App data Questionnaires	Intention to treat principle, linear mixed models and zero inflated poisson models	Kessler distress scale (K10), patient health questionnaire, euroqol

Author and Year of Study	Name Of Mobile Application	Aim Of Study	Country	Research Design	Sample	Data Collection	Analysis	Outcome Measures
Nagel et al 2022 (45).	Stay Strong	To explore the suitability of the Stay Strong App as a self management support for first nations people with chronic kidney disease	Australia	Qualitative	152 total participants, 62 used app intervention. All Aboriginal and Torres Strait Islanders. Mean age 55	Secondary analysis of data collected in primary study by Dingwell et al (44)	Combined quantitative and qualitative content analysis approach	Interventions received, participants' goals
Muroff et al 2017 (47).	CASA-CHESS	To examine the CASA-CHESS app usage data in the 4 months post-residential treatment for Latinos with co-occurring alcohol, drug conditions and mental disorders	USA	Quantitative	79 total participants. All used app intervention. 76 Spanish-speaking Latino/Hispanic participants. Mean age 41.1	App usage data	Univariate, bivariate, and regression analysis using SPSS 24	App usage data e.g services used and login timestamps
Muroff et al 2019 (46).	CASA-CHESS	To examine the alcohol, drug disorders and mental health outcomes for Latino/Hispanic persons using CASA-CHESS for 6 months post-residential treatment	USA	Single group, pre-post study	79 total participants. All used app intervention. 76 Spanish-speaking Latino/Hispanic participants. Mean age 41.1	Questionnaires. App usage data	Univariate, bivariate, and regression analysis using SPSS 25	Generalised anxiety disorder, patient health questionnaire (spanish language version), medical outcomes study social support scale

Author and Year of Study	Name Of Mobile Application	Aim Of Study	Country	Research Design	Sample	Data Collection	Analysis	Outcome Measures
Dror Ben-Zeev et al 2018 (48).	FOCUS	To assess a smartphone intervention (FOCUS) compared to a clinic-based intervention for people with a serious mental illness	USA	Randomised control trial	163 participants. 82 used app intervention. 65% African American. 9% Other or more than 1 race. 27% White. Mean age 49	App usage data, self-reported questionnaires, and clinical outcomes	Intention to treat analysis, linear mixed-effects models, and non-linear Poisson hurdle mixed model	Symptom checklist 9, secondary clinical outcomes such as depression, psychosis, recovery, and quality of life
Dror Ben-Zeev et al 2019 (49).	FOCUS	To evaluate whether patient characteristics and current use of antidepressant medication impact the effects of the FOCUS app on depressive symptoms	USA	Quantitative	163 participants. 82 used app intervention. 65% African American. 9% Other or more than 1 race. 27% White. Mean age 49	Secondary analysis of data collected in primary RCT study by Dror Ben- Zeev et al 2018 (48)	Mixed effects models	Beck depression inventory-second edition, psychotic symptom rating scales
Farmer et al 2017 (51).	Ohmage	To report stressful events using a Smartphone Ecological Momentary Assessment application (Ohmage) in people living with Human Immunodeficiency Virus (HIV)	USA	Mixed Methods	32 participants living with HIV. All received app intervention. 47% African American, 19% Latino, 3% Native American, 3% Mixed Ethnicity, 28% White. Median age 46	Smartphone, stress and stressful event reports and user experience qualitative interviews	Thematic coding methods using Dedoose Programme	Stressful events survey using the CDC-HRQOL measure, user experience survey

Author and Year of Study	Name Of Mobile Application	Aim Of Study	Country	Research Design	Sample	Data Collection	Analysis	Outcome Measures
Asfar et al 2022 (50)	Craving to Quit	To tailor and optimise multicomponent mindfulness training-based smoking cessation app content and design for people living with HIV	USA	Qualitative	59 participants living with HIV. All used app. 67.8% Non-Hispanic Black. 18.6% Hispanic. 11.9% White. 79.7% of participants aged between 40-59	Focus groups	Thematic analysis using Nvivo	Focus groups based on tailored health communications framework
Brown et al 2020 (54).	INSIST	To understand how an app could be used to support suicide prevention gatekeepers in Indigenous communities	Australia	Qualitative	12 participants, health workers or community members. 7 Indigenous Australians, 3 Undisclosed, 2 Non-Indigenous. Mean age 40	Participatory design workshops	Thematic analysis	Thematic maps
Wang et al 2021 (52).	App Prototype	To evaluate the content of a prototype app designed for Chinese immigrant care workers based on the Body Mind Spirit Model	USA	Qualitative	22 Chinese participants. Average age 60.5	Participatory design workshops and interviews	Thematic analysis using Nvivo	Thematic analysis
Lucero et al 2022 (53).	App User Interface Prototype	To assess perceptions and preferences of Hispanic dementia caregivers on features and functions of an app user interface prototype to support self-management activities	USA	Mixed methods – participatory design	12 Hispanic participants. 7 English and 7 Spanish speaking. Mean age 63.5 years	Direct observation of participants using app, and questionnaires	Descriptive content analysis	Usability evaluation

Purpose And Design Of Mobile Applications

Table 2 describes the purpose and app design variations for the 7 existing apps and 3 app prototypes within the included studies. The 7 existing apps ranged from simple self-help tools (50) to more complex, personalised therapy solutions (49). The only app addressing a clinically diagnosed mental disorder was the FOCUS app, which was designed for people with a serious mental illness (48).

Design features included: digital voice services, text messaging, web access, global positioning system, voice recognition, video capabilities, links to resources such as social support, tools (relaxation exercises, appointment reminders), and information services (47).

Some apps included features to help manage stress and support emotional wellbeing. These included Ohmage, Craving to Quit, Stay Strong, My Health, My Guide, and CASA-CHESS. Four of these apps were culturally tailored or explicitly developed for a REMG: the Stay Strong App (for Aboriginal and Torres Strait Islander people), the My Guide App and My Health App (for Latina females), and CASA-CHESS (for Latino/Hispanic people).

Three studies reported participatory design approaches to iteratively tailor app prototypes for a specific REMG. The INSIST app was intended to support Indigenous Australian gatekeepers with suicide prevention efforts. The other two studies focused on caregivers (Chinese and Hispanic) and the potential for apps to be developed that could improve self-care, mental wellbeing, and self-management behaviours.

Table 2: Purpose, Design Features Of Mobile Applications And Key Stakeholders

Name of mobile application and study	Purpose and design features of mobile application	Key Stakeholders
My Guide and My Health. Yanez et al 2020 (39) Baik et al 2020 (40) Baik et al 2020 (41) Oswald et al 2022 (42)	The My Guide app is designed to reduce symptom burden and enhance health-related quality of life among Latina breast cancer survivors. Features include content on stress management, coping, and optimising social support. The My Health app is designed to promote health and wellbeing through content focussing on healthy lifestyle behaviours, including nutrition, physical activity, etc.	Latina breast cancer survivors The latina breast cancer association, a community organisation Apps developers from the Center for Behavioural Intervention Technologies at Northwestern University Feinberg School of Medicine. Researchers from Northwestern University Feinberg School of Medicine, Northeastern Illinois University, University of Illinois at Chicago, the University of Miami, and the Moffitt Cancer Center Bilingual telecoaches Clinical psychologist Funding agencies-National Institutes of Health and National Cancer Institute
Stay Strong Nagel et al 2020 (43) Dingwell et al 2021 (44) Nagel et al 2022 (45)	The purpose is to promote mental health and provide a holistic wellbeing intervention for Aboriginal and Torres Strait Islander people. It uses problem-solving therapy and motivational interviewing. Sections include a review of family strengths, worries, and wellbeing tips, followed by setting goals for change. The process is assisted by help text and audio instructions. It is designed to be visually appealing and culturally relevant, using metaphors like trees and football fields to represent strengths and goals.	Indigenous australians undergoing haemodialysis Nine-member panel with diverse expertise in renal health and Indigenous culture Purple house (a First Nations owned and operated dialysis service based in Alice Springs) Aboriginal interpreter service Researchers from Menzies School of Health Research at Charles Darwin University Funding agencies-National Health and Medical Research Council

Name of mobile application and study	Purpose and design features of mobile application	Key Stakeholders
CASA-CHESS Muroff et al 2017 (47) Muroff et al 2019 (46)	The purpose is to improve sustained participation in ongoing treatment for alcohol/drug disorders, enhance quality of life, and reduce the societal burden of chronic relapse. It is based on self-determination theory and cognitive behavioural relapse prevention. Features include social support tools, messaging, discussion boards, guided relaxation, meeting locators, panic buttons, daily check-ins, medication adherence components, and personal stories/podcasts. These services help users manage their recovery process by providing continuous access to resources, information, and social support.	Latina individuals with alcohol and other drug disorders Clinical and support staff at Casa Esperanza, a health facility that specialises in supporting the Latina community Team of app developers at the Center for Behavioural Intervention Technologies at the University of Wisconsin-Madison Researchers at Boston University School of Social Work and the Center for Health Enhancement Systems Studies, University of Wisconsin-Madison Funding agency- Substance Abuse and Mental Health Services Administration
FOCUS Dror Ben- Zeev et al 2018 (48) Dror Ben- Zeev et al 2019 (49)	The purpose is to provide a self-management intervention for people with serious mental illness. Features include daily self-assessment prompts and on-demand functions available at all hours. Content includes behavioural activation, relaxation techniques, health and wellness psychoeducation, and sleep hygiene. Content can be accessed via video or audio clips, written material, and images. A clinician dashboard and mobile health support specialist are additional components.	Individuals with serious mental illness Clinical staff and support specialists from a large mental health agency in Chicago Mobile health support specialist Researchers from the University of Washington and Dartmouth College Funding agency-Patient Centered Outcomes Research Institute
Ohmage Farmer et al 2017 (51)	Ohmage is an open-source participatory sensing technology for data capture on smartphones. It can support people living with HIV to manage and report stressful events. Features include phone use security locks and customised time-based alarms for surveys at schedules that fit with participants' daily routines. Prompts are provided 4 times a day for participants to complete surveys on sadness, anxiety, depression, and mental health-related quality of life. Participants also have the option to initiate stressful event reports, which includes perceived stress levels using a Likert scale and an open-ended free text entry component.	People living with HIV Researchers from the University of California, Los Angeles (UCLA), AIDS Project Los Angeles, and the Los Angeles Gay and Lesbian Center Funding agencies- National Institute of Mental Health, the National Institutes of Health, the Center for HIV Identification, Prevention, and Treatment, the District of Columbia Developmental Center for AIDS Research, the UCLA Center for AIDS Research, and the William T. Grant Foundation

Name of mobile application and study	Purpose and design features of mobile application	Key Stakeholders
Craving to Quit Asfar et al 2022 (50)	The purpose of this mindfulness training smoking cessation intervention is to increase an individuals awareness of their thoughts and emotions. It includes 22 modules for use over 22 days. Audio, video, and animated lessons teach mindfulness techniques, including body scanning, loving kindness and breath awareness, and RAIN (recognise, accept, investigate, and note how cravings feel). One new module can be accessed daily, and the following days are locked to prevent skipping ahead. The app also includes social support (tip of the week and quit friend sign-ups), an activity feed to monitor interactions with the app, and the ability to track morning smoking status using "my morning stats."	People living with HIV Healthcare providers Researchers from various departments at the University of Miami Funding agencies- Miami Center for AIDS Research, the National Cancer Institute, and the Sylvester Comprehensive Cancer Center
INSIST Brown et al 2020 (54)	The purpose is to support gatekeepers in indigenous communities with suicide prevention efforts. Participants suggested various design features for inclusion in a new app. These included an application that could be used on mobiles and tablets, a telephone helpline, an online community map or directory of services forum, and a Facebook group with a messenger function. Participants wanted a user-friendly, aesthetically pleasing design that had increased visuals, including indigenous artwork and indigenous language for more remote communities. They also wanted an app that was easy to navigate, read, and interactive (e.g touch screen, user online status shown, and notifications).	Indigenous health workers and community members Researchers from Queensland University of Technology and The University of Queensland Funding agencies- National Health and Medical Research Council and the Australian Government Department of Health

Name of mobile application and study	Purpose and design features of mobile application	Key Stakeholders
App Prototype Wang et al 2021 (52)	The purpose is to enhance caregivers self-care and caregiving practices by offering a comprehensive training curriculum based on the Body-Mind-Spirit model. This model addresses holistic needs, including physical health, mental wellbeing, and spiritual care. The content includes language considerations, cultural values such as filial piety, and traditional health practices. Self-care modules cover a wide range of topics from diet, exercise, sleep, and medication management to stress management, problem-solving skills, and spiritual care. Videos featuring indoor physical exercises, self-massage techniques, breathing and relaxation exercises, and meditation are included. An inventory of national and local resources for self-care and caregiving, such as organisations, e.g., Alzheimers Association and Family Caregiver Alliance, is available.	Chinese immigrant caregivers Independent expert, a certified usui/holy fire reiki master, and practitioner of dharma and meditation from Gongsang Buddha Center in Los Angeles Multidisciplinary team of researchers and clinicians from various fields, including social work, nursing, gerontology, and engineering Funding agencies- Southern California Clinical and Translational Science Institute and the Department of Adult Mental Health and Wellness, Suzanne Dworak-Peck School of Social Work
App User Interface Prototype Lucero et al 2022 (53).	The purpose of the mobile health app user interface prototype is to motivate and enable Hispanic dementia caregivers self-management behaviours. Features included easy-to-use designs with automated functions such as drop-down lists, drag and drop, and voice query rather than manual entry. These facilitated faster searching and approaches to meeting self-management goals. Participants liked designs with a real-world feel that were attractive, personally meaningful, and incorporated expert advice.	Hispanic informal dementia caregivers Researchers from various institutions, including the School of Nursing at the University of California, Los Angeles, and the Vagelos College of Physicians and Surgeons at Columbia University Irving Medical Center Funding agencies- New York City Hispanic Dementia Caregiver Research Programme and National Institute of Health

Key Stakeholder Groups Involved In App Development

Table 2 shows that the key stakeholders involved in app development varied. Notably, most sources omitted information about the app technology developers. The development of the Stay Strong App involved a team comprised of nonindigenous members with expertise in mental health and kidney research in Aboriginal and Torres Strait Islander settings (43). Aboriginal research officers, a cultural consultant, an Aboriginal elder, and a transplant recipient were also involved (43). A member expert panel with renal physicians, nurses, and dieticians and an Aboriginal interpreter service also assisted in the development process (43).

For adaptation of the CASA-CHESS App, a team of bilingual and bicultural Spanish speakers was included (47). A certified translator and cultural expert added culturally relevant resources (47). Latino staff and clients also amended the resources to ensure cultural and linguistic accessibility (47).

The App Prototype included researchers and clinicians from engineering, nursing, social work, and gerontology to inform ongoing development (52). An independent expert in Asian-based spirituality also reviewed the content to ensure it was culturally appropriate (52). This was then tested with Chinese immigrant caregivers through interviews conducted by researchers who were native Mandarin speakers (52).

The App User Interface Prototype included 11 experts associated with the visualisation design studio at Columbia University School of Nursing Precision in Symptom Self-Management Centre (53). They had experience in nursing and informatics, and their opinions about user interface designs were sought at monthly meetings until a consensus was reached (53).

Accessibility, Acceptability, Cultural Tailoring, Sensitivity, And Uptake Of Interventions

Table 3 provides information about the 7 apps and 3 prototypes. Not all studies were included separately because relevant information on these themes was missing.

Accessibility and Acceptability

Overall, perceptions regarding the accessibility of apps were positive. Participants who used the Craving to Quit app indicated a high interest in using the app and found it helpful, supportive, and motivating (50). They felt that mindfulness training could help them reduce stress and deal with difficult situations (50).

Both the My Health and My Guide Apps were acceptable to participants during the 6-week study period (39). This was demonstrated by the satisfaction ratings and improvements in breast cancer wellbeing post-intervention (39). It is feasible that participants implemented behaviour changes which resulted in improved wellbeing (39). However, the authors acknowledge that whilst apps could be used following breast cancer treatment to engage Latinas in psychosocial care, the sample size was relatively small, and that larger effect sizes would possibly be seen in larger samples (39).

Several studies used participatory design approaches to understand users potential needs and preferences (52-54). Workshops to inform the INSIST app resulted in recommendations to support acceptability and usage (54). Suggestions included a user-friendly and aesthetically pleasing interface, incorporating visuals, indigenous artwork, and indigenous language for remote communities (54). Participants wanted resources to be easy to read, quick to navigate, and interactive, with functionalities like notifications, touch screen capabilities, and user online status indicators (54).

Participants wanted content features that included prompts for completing interventions (e.g., guidance on questions to ask), role-play videos, direct access to emergency helplines, and local geographical maps (54). Brief intervention outcome surveys, the ability to alert a gatekeeper buddy for peer support, service feedback on at-risk individuals, reminders to refresh training, a directory of contact numbers, including the gatekeeper network, and functionality for case notes were also recommended (54).

Cultural Tailoring and Sensitivity

The inclusion of culturally tailored content was highly valued but limited to a few studies. Participants in the study by Wang et al recommended the inclusion of elements of traditional Chinese medicine, such as spiritual and natural healing methods and healing sounds for relaxation (liu zi jue) and bringing energy exercises (Zhao fu qi) in the prototype for Chinese caregivers (52). Natural healing methods included “hugging trees, going outside for a 2 minute sunbath and relaxing with bare feet on the grass as well as acupuncture point practices to stimulate energy flow” (52). Participants also stated that where the app directed/signposted to other support websites or organisations, there was a need for language translation and linguistically appropriate community resources e.g. community resource websites in Chinese, largely due to challenges with navigating the american health and social care system (52).

The content of the My Guide and My Health Apps were culturally informed by using Latina values and beliefs such as Marinismo/Machism, fatalism, and external locus of control (39). Apps were available in Spanish and English, and content was accessible through audio and video recordings (39). All images reflected the diversity of Latina women (39). Secondary analysis of all high users of the app during the RCT showed increased religious coping and positive reframing (42).

The CASA-CHESS app was also available in Spanish and incorporated terms and adages commonly used in Puerto Rico, Central America, and the Dominican Republic (47). The materials also addressed sociocultural factors such as acculturation, stigma and discrimination, and the prominent role of family in Latinos (47).

Uptake of Interventions

One RCT undertaken over 3 months included 163 people with serious mental disorders (48). Participants reported high satisfaction ratings and that the FOCUS app was enjoyable, interactive and supported them to feel better (48). App users were more likely to engage fully in treatment for a minimum of 8 weeks (56% versus 40%) compared to those who used a Wellness Recovery Action Plan clinic-based intervention (48). Participants were exposed to treatment content more often and for a longer period through the FOCUS app compared to the clinic-based intervention (48). No adverse events were noted in either trial arm (48).

The app uptake during an RCT involving Latina breast cancer survivors showed that, on average, participants used their app for more than 1 hour per week, with an average use of 8.66 hours for the My Guide app and 7.28 hours for the My Health app over the 6 week study period (41).

The uptake of the CASA-CHESS app was good, with 73.4% of the 79 users being active on the app for 4 or more months (47). The participants had on average 105.5 app usage days (47). In addition, on average, the 79 participants accessed 1736.8 pages during the 4-month study (47). For those who used the app for more than 4 months, the average number of pages accessed was 4410 (47). The most used services included surveys, discussion boards, and messages (47).

Table 3: Description Of Accessibility, Acceptability, Cultural Tailoring And Sensitivity, And Uptake

Name of mobile application and study	Accessibility	Acceptability	Cultural Tailoring and Sensitivity	Uptake of Interventions
My Guide App and My Health App Yanez et al 2020 (39)	Over 90% satisfaction with the My Guide and My Health apps. Both apps were accessible via smartphones, and Latinas widely use them for health information.	High satisfaction with both the apps, with participants using them for more than 1 hour per week on average. The interventions were well-received.	Both apps were culturally informed and available in English and Spanish. They included audio features and integrated Latina cultural values throughout the content. This tailoring made the intervention highly relevant and acceptable to Latina breast cancer survivors.	High recruitment (79%) and excellent retention (>90%). The study noted a temporary decrease in symptom burden and improved wellbeing over time, with high participant engagement and satisfaction.
Stay Strong Dingwell et al 2021(44)	App adapted for remote Indigenous communities and integrated audio translations in 11 local Indigenous languages for better comprehension.	Participants received culturally adapted content well. Positive feedback on ease of use and engagement.	Wording and images were revised to reflect Indigenous cultural context better. Concepts of family and community support were also included.	Out of 150 participants, 147 (94%) attended the Stay Strong sessions. Only 12 participants (8%) attended one session, 80 participants (54%) attended two sessions, 14 participants (10%) attended three sessions, and 41 participants (28%) completed all four sessions.
CASA-CHESS Muroff et al 2017(47)	Android phones were provided to all participants. Adapted and translated content for Spanish-speaking Latino users. Added culturally relevant resources and links to Spanish websites.	High usage of messages, discussion boards, and surveys.	Culturally relevant content, including stories, sayings, and resources. Materials adapted using common phrases from Puerto Rico, Dominican Republic, and Central America.	Of the 79 participants who received the app after completing residential treatment, 73.4% used it for four or more months.

Name of mobile application and study	Accessibility	Acceptability	Cultural Tailoring and Sensitivity	Uptake of Interventions
FOCUS Dror Ben- Zeev et al 2018 (48)	Increased accessibility through mobile delivery.	High satisfaction and engagement: 90% of participants commenced use, with 56% remaining engaged for eight weeks.	Tailored to needs of individuals with serious mental illness. Features included medication adherence support and symptom tracking.	56% of participants used the app for at least eight weeks and five out of seven days each week.
Ohmage Farmer et al 2017 (51)	All participants were provided with smartphones with the app preloaded. Research assistants trained participants on how to use the app.	The app was acceptable to users, with positive feedback on its relevance and usefulness in daily activities.	No cultural tailoring of app.	During the study, 32 participants reported a total of 849 stressful events, with an average of 26.5 reports per person, ranging from 1 to 142 reports. This shows that participants actively used the apps self-reporting feature, with some consistently documenting their stressors.
Craving to Quit Asfar et al 2022 (50)	Participants noted the app was easy to use, convenient, and required minimal time commitment.	Well accepted due to ease of access and minimal time commitment required. Favoured features included goal setting, the ability to interact with others, and tracking features.	No cultural tailoring of app.	Participants tried the features of the app. Their feedback was that they were highly interested in using the app and found it helpful and supportive, but the app was only used within the focus group setting.

Name of mobile application and study	Accessibility	Acceptability	Cultural Tailoring and Sensitivity	Uptake of Interventions
INSIST Brown et al 2020 (54)	Accessibility is unknown as the app is in development. Potential barriers were identified, and technology features were recommended.	There was support for an app as part of a comprehensive suicide prevention programme.	Indigenous perspectives were included at all stages to address cultural sensitivity, i.e., design, recruitment, group facilitation, etc.	Information is not available as the app is in the development phase.
App Prototype Wang et al 2021 (52)	Accessibility is unknown as the app is in development. However, suggested changes, such as links to websites in Chinese, were incorporated during the app testing process.	There was support for the app, with many suggestions for culturally relevant content and virtual support features.	Suggestions included adapting content to include Chinese language resources and content related to Chinese medicine and Chinese specific beliefs about relationships and decision-making.	Information is not available as the app is in the development phase.
App User Interface Prototype Lucero et al 2022 (53)	Accessibility is unknown. However, participants noted features to increase accessibility, such as incorporating interactive elements with a real-world feel and automated functions for ease of use.	There was support for the prototype, particularly user-friendly designs, and simple, clear, easy-to-navigate interfaces.	Culturally tailored content used real-world imagery and culturally relevant examples to increase relevance for Hispanic caregivers.	The study does not directly address the app prototype uptake as the app is in the design phase. However, it highlights the importance of user-centered design and suggests that the incorporated features and design choices could potentially lead to positive uptake among Hispanic caregivers. .

Barriers to Mobile Application Use

Table 4 summarises the key barriers and facilitators for each app and prototype apps. Studies are not all included separately, as some lacked relevant information. Prominent emerging themes included the following:

Digital Literacy

A lack of digital skills or limited experience with smartphone technology made it challenging for some users to navigate and effectively use the apps (50). One participant remarked, “You know I’m old, I don’t know too much about technology, my son could help me”(50). There was also a perception that older individuals or those with lower levels of technological proficiency may be reluctant to use digital technology (54).

Functional Literacy

Muroff et al noted that “Approximately 44% of Hispanic individuals register scores below the basic literacy threshold according to the National Adult Assessment of Literacy”(47). Low functional literacy levels may be exacerbated by various conditions, including alcohol use disorder, and is likely to have affected the use of some features within the CASA-CHESS app (47). Therefore, future iterations will include audio materials (47)**.**

Smartphone Issues

Some people may possess mobile phones that are not smartphones or lack internet connectivity (54). Other potential obstacles encompassed financial constraints, such as the inability to afford a smartphone or sufficient data plans (54). Furthermore, occupational restrictions could pose challenges, including using work phones that do not support applications, restricted access to certain websites, and limited time availability due to work commitments (54).

Cost of Apps

Some participants felt the apps were expensive and should be provided for free or have a months free trial before buying them (50). One app user noted, “I don’t think anybody in here is going to download an app and pay $25.00 a month”(50).

Interface With Other Services

For those with preexisting health conditions, there were concerns that using the app may mean that they did not receive support from their healthcare providers in person (50). Study participants wanted to combine in-person group counselling with the app to receive support and share experiences and feelings (50).

Privacy and Confidentiality

Participants noted concerns over privacy and confidentiality (50, 54) and the security of their information if their phones were stolen (50). The study by Muroff et al showed that during the trial, some smartphones were lost, stolen, or damaged and needed to be replaced (47).

Study Design Processes

There were indications that the study process was sometimes arduous, with comments such as “a lot to answer, too long and feel too tired with related body language during the session such as standing up, answering the phone and walking away”(50). Participant fatigue or boredom related to the length of assessments and repetition within outcome measures was also noted (50).

Facilitators of Mobile Application Use

Technical Support

Ongoing technical support and training assisted users in engaging with the apps and overcoming technical barriers more effectively. For the My Guide and My Health Apps, telecoaching calls were provided to all participants during the first two weeks and the final week to support them with any barriers (41). On average, My Guide users received 3.72 telecoaching calls, and My Health users received 4.10 calls over the 6-week study period (41). Calls were recorded and reviewed by a clinical psychologist weekly to confirm fidelity (41). For participants using the FOCUS app, support was provided weekly by a mobile health support specialist (48).

Before leaving residential care, participants were required to demonstrate their understanding of using the CASA-CHESS app. They were also encouraged to use the mobile provided as their personal phone for the study (47). The CHESS team consistently maintained the mobile software for the CASA-CHESS App to ensure compatibility with Android software updates. When mobiles were stolen or lost, access to the mobile services was instantly suspended to protect confidentiality (47). Following the study periods, participants could keep their mobiles and were guided on how to take financial responsibility for their mobile plan and keep their number (47).

Unlimited Mobile Data Plans

As part of the study of the CASA-CHESS app, participants were provided with mobiles where the app was preloaded and with pre-paid unlimited text, voice calls in the USA, and data plans for 8 months (47).

Content In Different Formats

The My Guide and My Health Apps were available in English and Spanish - participants' preferred languages (41). To address literacy concerns all content was also offered in audio format (41). Content could be accessed anytime, at their own pace, based on their interests (41).

The FOCUS app included daily prompts and tailored interventions (49). For example, people with depression could be provided with mood focussed prompts (49). All content was available at all hours (49).

Portability

FOCUS app users could hear, read, or view self-management demonstrations and suggestions relevant to challenges they encountered as they went about their daily lives, rather than having to retain and recall clinicians' advice (48). Users could access their "pocket therapist" as soon as needed, which was like a "friend checking in on them" (48).

Financial Incentives

Some studies provided financial incentives to participate. For example, participants were given $30 per assessment at baseline, 3 and 6 months during the RCT involving the FOCUS app (49).

Table 4: Barriers And Facilitators To Mobile Application Use

Name of mobile application and study	Barriers to Application Use	Facilitators to Application Use
My Guide and My Health. Yanez et al 2020 (39)	The study did not report barriers to use.	A telecoaching protocol was included to promote adherence, with bilingual telecoaches trained in motivational interviewing and cultural sensitivity.
Stay Strong Dingwell et al 2021 (44)	Miscommunication and fatigue can occur, especially when researchers require multiple outcome measures to be completed in a structured and consistent manner. Patients speak multiple languages and dialects.	The app contains culturally adapted content. It employs concise text in plain English, uses pictorial elements and relevant metaphors, and emphasises family and community. This approach reflects a holistic understanding of well-being.
CASA-CHESS Muroff et al 2017 (47)	Some participants had low functional literacy, which led to difficulties understanding some aspects of the app.	Culturally relevant content tailored to users. Phone software maintained by a team.
FOCUS Dror Ben- Zeev et al 2018 (48)	The study did not report barriers to use.	The app was tested previously in multiple diagnostic groups. A mobile health support specialist provided remote support weekly to help with the technical and clinical aspects of the app. The app was easy to use and initiate.
Ohmage Farmer et al 2017 (51)	The study did not report barriers to use.	Technical support and training provided. Relevance of app content adapted to users daily activities. Flexibility in usage time. Participants incentivised $70 to participate in the study. The application was password protected, and data was stored on a cellular network with encrypted protocols for additional safety.
Craving to Quit Asfar et al 2022 (50)	Concerns were raised about the cost and lack of experience with technology. Participants also expressed worries about confidentiality if phones were stolen. Additionally, there were concerns about reduced access to in-person contact with healthcare professionals.	Mindfulness training was helpful for reducing stress. Participants were incentivised $100 to participate in focus groups. They stated a gift card or cash of $25-$50 per week would incentivise future use.

Name of mobile application and study	Barriers to Application Use	Facilitators to Application Use
INSIST Brown et al 2020 (54)	Participants expressed concerns about potential issues with phone and internet access in certain areas. Users also raised privacy and confidentiality concerns. Additionally, the need for physical support resources and varying levels of technology competence were highlighted.	Widespread access to smartphones and the internet among the target population. The app features a user-friendly and aesthetically pleasing design, along with support for regular training refreshers and updates. Interactive elements have been added to enhance user engagement.
App Prototype Wang et al 2021 (52)	Language barriers hinder usability and comprehension, while unfamiliarity with the complex american social and healthcare systems adds further challenges. The fragmented access to information complicates the delivery of holistic care.	Enhanced content accessibility by incorporating Chinese language resources. The app now integrates comprehensive community resources and includes features designed to improve virtual communication and provide social support for caregivers.
App User Interface Prototype Lucero et al 2022 (53)	English and Spanish-speaking caregivers have distinct design preferences, especially in navigation styles (hamburger button vs. navigation tab) and scrolling habits. This highlights the necessity of accounting for cultural and linguistic factors during the design process.	Users identified infographics, automated functions, and a "real-world feel" as key design features that resonated with them. Automated functions were seen as time-saving and helpful in achieving their self-management goals.

Intervention Outcomes

Table 5 summarises the outcomes of all studies. Mental health-related outcomes included self-reported stressful events (51), mental health-related quality of life (51), social and emotional wellbeing (39), psychosocial distress (43), depression symptoms (43) (49), clinical symptoms, recovery, and quality of life associated with serious mental illness (48). Outcomes varied, and some studies also encompassed broader health-related outcomes.

The intervention outcomes for an RCT involving participants with serious mental disorders showed that users of the FOCUS app had significant improvements in recovery at the 6-month follow-up (48). The findings also showed that FOCUS may address moderate to severe depressive symptoms in people with diverse mental illnesses, and can be used as a transdiagnostic intervention, meaning it can be effective for various mental health conditions, not just one specific diagnosis (49).

FOCUS use was associated with sustained and significant reductions in depression both in people taking antidepressants and those who were not (49). A higher level of education, greater engagement, and weeks of daily smartphone use were linked to higher recovery post-intervention (48). Mental health support specialists reviewed the participants daily self-assessments to understand their experiences (48). This was discussed in their weekly check-in calls, which is likely to have enhanced the feeling that someone was attentive to their status and informed more tailored care (48). This model was engaging and helpful for some participants (48).

The intervention outcomes for an RCT involving Latina breast cancer survivors showed that, on average, participants used their app for more than 1 hour per week, with an average use of 8.66 hours for the My Guide app and 7.28 hours for the My Health app over the 6 week period (41). My Guide users clicked on 6368 webpages or links in total, and My Health users clicked on 7164 (41). The most clicked domains related to managing emotions, lifestyle behaviours, and physical symptoms (41). Sociodemographic factors (except for employment status) did not predict usage of the app, which suggests that scalability is possible (41). Although the 6 week intervention and 2 week follow-up established feasibility, the duration was not long enough to determine efficacy (41).

Table 5: Intervention Outcomes

Mobile Application and Study	Intervention Outcomes
My Guide and My Health Yanez et al 2020 (39).	Over 90% of participants reported satisfaction with the culturally relevant content. Temporary decreases in symptom burden and improved overall wellbeing were noted over the intervention period. Findings suggest apps may facilitate engagement in care following breast cancer treatment.
My Guide and My Health Baik et al 2020 (40).	Increasing patient cancer-relevant self-efficacy appears to significantly improve overall health-related quality of life, well-being, symptom burden, and cancer-specific distress among Latina breast cancer survivors. This improvement is observed regardless of the patients language preference, marital status, or ancestry.
My Guide and My Health Baik et al 2020 (41).	My Guide and My Health participants most frequently accessed content related to common physical and emotional symptoms experienced by breast cancer survivors and nutrition and physical activity advice.
My Guide and My Health Oswald et al 2021 (42).	The My Guide and My Health applications promoted adaptive coping behaviours, with frequent users reporting an increase in religious coping. This form of coping is prevalent among Latina populations and is linked to positive health behaviours, such as adherence to cancer screenings. Both applications were intentionally designed with Latina cultural values in mind, potentially reinforcing this coping strategy.
Stay Strong Nagel et al 2020 (43).	The research team and an expert panel adapted the app for renal patients by selectively revising the words and images. Pilot testing revealed challenges in administering the well-being measures, which led to modifications in wording and the addition of prompts. This involved incorporating audio translations in 11 local Indigenous languages into an interactive Outcome Measures App and updating the research protocol accordingly.
Stay Strong Dingwell et al 2021 (44).	When focusing on participants with moderate to severe distress or depression at baseline, both the Stay Strong app and the Hep B Story control app demonstrated significant reductions in psychological distress (K10) and depressive symptoms (PHQ-9) scores. These findings suggest that both applications could be beneficial for individuals experiencing elevated levels of distress or depression.
Stay Strong Nagel et al 2022 (45).	Almost all participants (147, 94%) engaged in a Stay Strong session, with 135 (92%) attending at least two sessions and 83 (56%) establishing multiple well-being goals. Thirteen goal categories emerged, with the most common being connecting with family or others, spending time outdoors, and returning home or being in the country. These goals encompassed three primary themes: social and emotional well-being, physical health, and cultural connection.
CASA-CHESS Muroff et al 2017 (47).	Of the 79 participants, 73.4% remained active users for four or more months. The most used services were messaging and discussion boards, emphasising the importance of social support in recovery. The study demonstrated the feasibility and acceptability of CASA-CHESS in supporting recovery post-residential treatment.
CASA-CHESS Muroff et al 2019 (46).	Participants who continued using CASA-CHESS for at least 4 months post residential treatment maintained their low baseline rates of substance use and experienced fewer anxiety and depression symptoms compared to those who discontinued use within the first four months. This suggests that sustained app use may help maintain the treatment gains achieved.

Mobile Application and Study	Intervention Outcomes
FOCUS Dror Ben-Zeev et al 2018 (48).	FOCUS app users and WRAP (a clinic-based intervention) received similarly high participant satisfaction ratings. Participants in both groups found the interventions enjoyable, interactive, and helpful. Both interventions led to significant improvements in general psychopathology and depression, with no significant differences observed between the groups. FOCUS demonstrated effectiveness comparable to that of WRAP in the treatment of serious mental illness.
FOCUS Dror Ben-Zeev et al 2019 (49).	FOCUS led to significant reductions in depression. The findings showed that the app is helpful for the treatment of moderate to severe depressive symptoms in individuals with schizophrenia spectrum disorders, bipolar disorder, and major depressive disorder. It can be used alongside antidepressant medications or independently, effectively addressing both those with and without active psychotic symptoms.
Ohmage Farmer et al 2017 (51).	During the 6-week study, 849 stressful events were reported, averaging 26.5 for each participant. Approximately 60% of participants expressed distress about their health and comorbidities. 40% noted partner-related stress, e.g., physical or mental abuse, breakups, or arguments. 28% noted finance as a stressor. Depression, worry, and anxiety were also commonly reported. The findings highlighted the need to address a range of issues experienced by people living with HIV.
Craving to Quit Asfar et al 2022 (50).	Focus groups identified that participants found the app easy to use and the mindfulness training useful in reducing stress. Most participants wanted app support as well as group in-person counselling. Results will inform optimisation of a future app to address multiple needs and barriers related to smoking cessation in people living with HIV.
INSIST Brown et al 2020 (54).	There was support for an app as part of a broader comprehensive suicide prevention programme. The need for culturally appropriate training in Indigenous suicidology factors e.g. stressors and enablers, was identified. Learning will inform future iterations of the INSIST app
App Prototype Wang et al 2021 (52).	Participants approved existing content and suggested more information on depression, coping with negative emotions, and managing life stresses. They also requested more information on self-care, social networks, and social events e.g. the caregiver union.
App User Interface Prototype Lucero et al 2022 (53).	English and Spanish-speaking participants favoured similar features e.g. personally meaningful, attractive designs, and voice queries to search the app. Applying Persuasive System Design principles, such as primary tasks, dialogue, system credibility, and social support, has the potential to significantly improve personalised self-management. This approach supports users in identifying problems, setting goals, making decisions, and planning actions.

Discussion

Principal Findings

This scoping review reveals a lack of studies that focus explicitly on self-guided SAMHW for middle-aged people from REMG. The findings do provide valuable and rich insights into the use and outcomes of smartphone-based interventions for specific mental health concerns among certain REMG in the USA and Australia. However, the concentration on a limited number of REMG from 2 countries in the Global North restricts the reviews scope, inevitably missing variations present in a more diverse sample of studies.

The research synthesised findings from 16 peer-reviewed studies published between 2017 and 2022. The cumulative number of participants across all 16 studies was 614. Of these, 397 were app users, and 46 were involved in studies of app prototypes. These studies exhibited significant variability in methodology, reporting, and analysis. Several articles focused on the development and testing of mobile applications designed for individuals with chronic health conditions and co-existing mental health issues.

The reviewed research reflects the diverse stages of development in digital health interventions, with some apps in preliminary prototype stages and others undergoing testing phases. Participatory design methodologies were used to meet the needs of specific subgroups, such as caregivers (52) and individuals involved in suicide prevention efforts (54). The focus on specific subgroups underscores the potential of mobile health interventions to provide tailored support and resources.

The applications had diverse objectives, including enhancing well-being, reducing psychological stress, alongside addressing broader health parameters such as breast cancer recovery (39) and smoking cessation for individuals with existing health conditions (50).

Notably, only two studies focused explicitly on individuals with diagnosed mental health disorders. These studies examined the FOCUS app, which was designed to support people with severe mental illness (48). The transdiagnostic nature of FOCUS aligns with the paradigm shift in mental health care towards precision medicine- tailoring treatments based on individual needs rather than solely relying on diagnostic categories. This approach is particularly relevant given the heterogeneity within diagnostic categories and the lack of effective ontologies of mental illness (55).

Four applications (My Guide, My Health, Stay Strong, and CASA-CHESS) were explicitly designed for REMG. Other studies were included in the analysis because over 50% of their participants were from REMG, with a mean age ranging between 40 and 65.

Overall, the acceptability of mobile applications was high, with REMG participants finding them helpful and supportive. Users particularly valued the flexibility, ease of access, safety, reliability, and minimal time commitment required by these apps. They were also a useful method for collecting patient information, providing insights for care providers to tailor care (48).

Multilevel barriers to applications were identified, including technology-specific issues, e.g., lack of internet connectivity (54), user-specific challenges, e.g., insufficient digital and functional literacy (47), and intervention-specific limitations, e.g., need for improved cultural tailoring (52). Barriers to the research process were also multifaceted and included participant fatigue and engagement issues (50).

Comparisons Of Results With Existing Literature

Stakeholder Input

This review shows that different stakeholders, cultural experts, and community members can provide essential insights into cultural practices, traditions, cultural meanings, and expressions. They can also offer information on values that need to be respected and integrated into app designs to help avoid the use of stereotypes. Mitchel et al argue that a "one-size-fits-all" approach to providing resources and support to REMG is ineffective, and ethnic "stereotyping" poses challenges (18). There is a greater need for recognition of gendered and ethnocultural intersections and solutions, which account for the fact that not all REMG, men and women share the same generational experiences (18).

Participatory Design Approaches

This review highlighted the strengths of using participatory designs with users to inform app development. These user-centric approaches provided perspectives on issues that might not be apparent to developers, such as confusing features or navigation difficulties. Sarker et al agree that without a dedicated initial focus on usability, it is unreasonable to anticipate the adoption of mobile technology by diverse populations (56).

Cultural Tailoring and Sensitivity

Cultural tailoring emerged as a critical factor for the success of mobile health interventions (47). However, despite the potential advantages of culturally adapting behavioural intervention technologies such as SAMHW, this process is often complex, time-intensive, and expensive (57). It may not be sustainable in under-resourced environments (57).

Application developers frequently prioritise business models that favour economies of scale and broad market appeal (58). This approach perpetuates a cycle of exclusion, wherein the absence of culturally relevant content results in lower engagement from REMG users, which in turn reinforces the focus on the majority demographic (58).

Ramos et al argue that while it is useful to acknowledge the significance of incorporating cultural variables to enhance treatment engagement and outcomes among REMG, it remains difficult to ascertain the necessity of culturally adapting each at this juncture (57). Given the limited number of studies that have utilised behavioural intervention technologies with REMG, it is presently challenging to establish "evidence-based" guidelines for their application within these populations (57).

Accessibility

This review showed a high interest in using apps by participants. The findings revealed that access to smartphones, internet connectivity, and digital literacy levels vary among REMG, affecting their ability to use and benefit from mobile apps. However, the research demonstrated that REMG users, even those affected by severe mental illness, can learn relatively quickly how to use mobile app support (48).

A study by Sarker et al revealed similar themes amongst REMG, e.g., an interest in using technology to support self-management for health conditions but limited confidence with technology and difficulties with design features and navigation (56). The authors concluded that existing tools are not consistently usable for diverse REMG (56). This suggests a need for tailored support mechanisms to ensure sustained engagement across diverse user demographics.

Relatedly, many existing digital health platforms have not been explicitly designed for individuals with lower levels of digital literacy (59). Often, the complexity and abundance of features on these platforms are challenging for users with less digital and health literacy (59). To address this, it is essential to incorporate inclusive design principles that prioritise equity, simplicity, error tolerance, and supportive scaffolding approaches (60).

The Global Strategy on Digital Health 2020-2025, published by the World Health Organisation, highlights a critical issue that the digital determinants of health, such as proficiency in information and communication technologies, along with accessibility to devices, broadband, and the internet, will assume increased significance as digital health modalities become more prevalent globally (34). Lyles et al elaborate on this concept stating that to attain digital health equity, it is essential for public health and healthcare systems not only to secure sufficient funding and infrastructure but also to foster leadership and create a culture that encourages innovation (59).

Surprisingly, mental health stigma was only mentioned in 2 studies within the reviewed papers (50) (48). This is in contrast to other studies (61) (62) and an umbrella review (63) which demonstrated that mobile applications offer a discreet means of helping to circumvent the negative stigma associated with seeking mental health care (63).

Uptake of Interventions

The duration of app use in most studies was limited, with periods ranging from the study duration itself to a maximum of six months (44). High initial engagement and uptake were observed in an RCT using the FOCUS app for 3 months, but long-term sustainability remains uncertain (48).

The study by Yanez et al showed that 92% of participants in the My Guide group and 84% in the My Health group expressed a desire to continue using their assigned application (39). Furthermore, most participants in both groups indicated a strong propensity to recommend their respective applications to other women with breast cancer, with 97% endorsing My Guide and 92% endorsing My Health (39). This suggests that apps that can effectively meet users needs and provide tangible benefits are more likely to be used beyond the study period and recommended to others.

Torous et al have determined that currently direct evidence explaining the low real-world uptake and engagement with SAMHW is limited (64). Several hypotheses have been proposed. These include the notions that such apps (i) are not designed with a user-centric approach, (ii) are perceived as unreliable sources of mental health information (64), (iii) lack user-friendliness, (iv) are less effective or accessible during critical emergency situations, and (v) fail to adequately protect user privacy (59).

Balancing Digital and Traditional Therapeutic Approaches

Concerns regarding mental health applications supplanting traditional therapeutic support were noted (50). Some critiques of mental health apps have also raised concerns about the potential erosion of the therapeutic alliance due to the absence of face-to-face interactions, particularly among more collectivistic REMG, who traditionally emphasise the importance of interpersonal relationships (57). This highlights the need to consider the balanced integration of SAMHW with conventional therapy methods for those with clinically diagnosed mental health disorders. It also underscores the importance of developing digital tools that enhance rather than replace the human elements critical to the therapeutic process.

Research Implications

Studies in Middle-Aged Populations

As noted earlier, this scoping review reveals a lack of studies focusing explicitly on self-guided SAMHW for middle-aged people from REMG. Other researchers have similarly highlighted that research on this pivotal period of life is sparse compared to other age groups (14). For example, Gondek et al argue that while mental health and wellbeing at older age receives substantial attention, there is hardly any research on middle-age (9). Possible explanations for this vary; however, some researchers have not included middle-aged adults due to research recruitment challenges, given their busy lifestyles with multiple demands of work and family (14).

Disparities in Research and Inclusive Recruitment Strategies

Despite no restriction on the year of publication or geographical location, and extensive use of REMG-related search terms, studies were predominantly from the USA, with four from Australia. Notably, none of the studies originated from the UK, Europe, or low and middle-income countries. This is particularly surprising given that ethnic disparities in access, outcomes, and experiences of mental healthcare have been documented in the UK for over 50 years (21). Saad et als' scoping review of self-guided mental health apps, targeting REMG aged 14- 36 globally, also found that most studies were from the USA (10 out of 15 included studies) (27).

König et al criticise that “Digital health research is predominantly conducted in Western, Educated, Industrialized, Rich, and Democratic (WEIRD) countries, with the majority of studies originating from North America, Europe, Australia, and New Zealand”(65). More international, cross-cultural, and multigenerational perspectives will be required to understand how our current knowledge base can be generalised across time and place.

Strategies to address recruitment challenges within middle-aged REMG could include: bilingual research teams, leveraging existing community partnerships, offering multiple options e.g. online recruitment methods, and adjusting protocols to meet participants needs, e.g., using alternatives to in-person visits or less/shorter visits (66). More convenient methods for data collection, e.g., phone, mail, and video conferencing, could also be beneficial (66).

Balancing Data Collection and User Burden

While comprehensive data collection is valuable for health insights, a balance must be struck to prevent overwhelming users. Apps should aim to collect essential data while offering options for automated tracking where possible.

Farmer et al found that monitoring and assessment burdens resulted in fewer participants during the final stages of the Ohmage app study (51). Ensuring the number of questions, domains, or prompts per day is appropriate could help to extend the duration of acceptable participation in studies (51). This suggests that optimising the frequency and complexity of interactions within these studies is crucial for maintaining participant engagement over time.

Public Health Implications

The findings of this research have some broader public health implications:

1. Barriers to mental health care for REMG are extensively documented (1, 16, 67). Although no single approach can reduce obstacles, SAMHW and other digital mental health technologies offer a significant paradigm shift that could lessen unmet mental health care needs (57). Utilising cutting-edge advancements in transdiagnostic approaches, ecological momentary assessment, real-time analysis, digital phenotyping, virtual reality, artificial intelligence, and blended decision-making, combined with data-driven insights and innovative SAMHW, offers the synergistic potential to enhance mental health care significantly (55).
2. Digital inequalities encompass a broad spectrum of factors, including education level, health literacy, socioeconomic status, immigration status, geographical location, and age (68). These disparities are closely linked with social determinants of health (68). Consequently, as the adoption of digital health solutions accelerates, these digital inequities can potentially intensify existing health disparities for REMG (68).
3. From a public mental health perspective, a deeper understanding and more investment in the mental health and wellbeing of middle-aged people could yield positive cross-over effects on the wellbeing of those dependent on their support e.g. children, grandchildren, and ageing parents (9). Promoting the mental health of middle-aged people could enhance the overall wellbeing of families and communities, ultimately contributing to broader public health goals.

Implications For Policy And Practice

Policymakers must recognise the significant voids in global literature and provide targeted funding and support for research and development in this area. It is imperative to create policies that encourage the development and evaluation of culturally tailored SAMHW.

Policymakers should incentivise collaborations, infrastructure development, and training between technology developers, healthcare providers, researchers, community organisations, and users. To enhance the potential effectiveness and uptake of interventions, cultural tailoring should extend beyond mere language translation (68). It is essential to integrate cultural values, norms, and references, ensuring that the content is relevant and resonant with the target audiences cultural context (68).

Investing in education and training programmes to improve digital and functional literacy among middle-aged REMG users is also crucial. Such initiatives could empower these individuals to utilise preventive health information, resources, and services more successfully, ultimately enhancing their overall well-being.

Stakeholders, such as app developers, researchers, and healthcare providers, should adopt more inclusive, co-design, and user-centered design practices and actively involve REMG during the development, testing, and evaluation phases. Outcomes including cost, fidelity, adoption, and uptake, are vital to evaluate (68). Building on existing research and synthesising information from diverse disciplines will also be critical (68). By assimilating and leveraging learning, stakeholders can contribute to a better understanding of the nuances of app use, maximise their real-world effectiveness, and tap into a potentially underserved market.

Strengths And Limitations

The strengths of this review include that it was conducted using a systematic, comprehensive methodology and searched large databases covering diverse disciplines. Search terms were developed with expert advice from an information specialist. Preliminary test searches were conducted in four databases, results were analysed, and the terms were iteratively refined.

Two reviewers independently screened 998 articles, conducting a full-text review of 114. When an article lacked sufficient information to determine its inclusion (e.g., participant age), the authors were contacted for further details. Data extracted by one author was meticulously cross-checked by a second researcher. These rigorous procedures were implemented to minimise biases, including selection and reviewer biases. Equally, it is essential to acknowledge that the processes of selecting studies, extracting data, and interpreting findings are inherently subject to publication bias and an unavoidable degree of subjectivity.

This review was limited by the small number of studies located, the geographic concentration of these studies in the USA and Australia, the narrow focus on specific REMG, and the relatively small sample sizes. Therefore, the results are not readily generalisable to other countries or cultures, and much remains unknown about other REMG.

Most included studies examined mental health or wellbeing as a secondary or tertiary aim of their analysis. The scarcity of research with a primary aim of investigating SAMHW for REMG has implications for the strength of the included evidence. This review focused exclusively on studies published in English, potentially overlooking relevant papers in different languages. Nonetheless, it is likely that there is limited published research addressing this specific review question.

Additional reasons for the failure to identify more studies include the following:

- 50% of the study participants needed to belong to a REMG to be included. This was consistent with an earlier study, which set a precedent for a cut-off at 50% and focused on SAMHW for a younger cohort (27). Some studies with useful information may, therefore, have been excluded.
- There is likely to be a lack of explicit funding allocated for research focusing on REMG and middle-aged populations. Research funding often goes towards broader topics.
- Even when research has been undertaken, it may not have been submitted for publication due to time or resource constraints.
- Including grey literature would expand the available information sources, as there are over 10,000 mental health apps (30).

Scoping reviews can quickly become outdated in fast-moving fields like digital health. New studies are continuously published, and the evidence can change rapidly. Therefore, this scoping reviews findings represent a snapshot in time and should be updated when appropriate based on factors such as the pace of innovation, the emergence of new evidence, guideline updates, and stakeholder requirements.

This scoping review encompassed study designs ranging from randomised controlled trials to qualitative studies. While this inclusivity provided a more comprehensive picture, it also introduced heterogeneity, making it intrinsically challenging to synthesise and compare findings. However, a broad overview of the interventions, outcomes, and gaps has been provided, which offers valuable and novel insights and a strong case for further research in this area.

Recommendations For Future Research

1. **Need for Diverse Geographic Studies**: Studies conducted in diverse geographic locations, including low and middle income countries, are essential. Research limited to high income countries may not be generalisable to low and middle income countries due to differences in cultural, economic, and health system factors.
2. **Inclusion of Multiracial and Mixed Ethnic Backgrounds**: Studies did not specifically address individuals of multiracial or mixed ethnic backgrounds or capture information on whether participants were from first, second, or later-generation REMG. Future studies should include these distinctions to better understand the diverse experiences and challenges faced by REMG across different generations.
3. **Transferability of SAMHW Across REMG**: Understanding the extent to which SAMHW can be successfully transferred across REMG would enhance the current research. It remains unknown whether an intervention delivered to and/or tailored for a specific sample population can be generalised to others within the same race or ethnic group, such as Hispanic Americans in different geographic regions, or with varying levels of acculturation, or across mixed backgrounds.
4. **Exploration of Differential Effects**: Further research is warranted to explore the factors contributing to differential effects observed in real-world contexts. This includes examining nativity, acculturation levels, immigration status, mental health stigma, literacy, and technological proficiency. In addition, cross-over effects e.g. on children, grandchildren, and ageing parents, could also be explored.

5. **Need for Robust, High-Quality Studies**: There is a paucity of robust, high-quality studies evaluating the efficacy of these apps, particularly those employing randomised controlled trials or longitudinal designs. Novel methodologies such as sequential, multiple assignment, randomised trials (SMART), and Multiphase Optimisation Strategy could be used to better understand the clinical and real-world effectiveness of SAMHW (68). Studies should assess not only short-term outcomes but also examine the long-term sustainability of mental health improvements. This approach will provide robust evidence on the efficacy of SAMWB applications and inform best practices for their development and deployment.
6. **Barriers and Effectiveness in REMG**: Research on barriers to use, effectiveness, engagement, and attrition among REMG using SAMHW is particularly important, given the significant barriers to accessing traditional face-to-face therapy. Researchers need to empirically examine whether these approaches fulfill their promise of making mental health care widely available to underserved populations.
7. **Usability and Efficacy Evaluation Efforts**: Greater efforts should be made to examine the usability and efficacy of apps with evidence-based components. Rating platforms such as PsyberGuide, ORCHA, and MindTools, provide information on empirical evidence, user experience, and data security (57). However, none of these platforms currently include information on usability and efficacy across different REMG.
8. **Dynamic Cultural Tailoring in App Development**: While cultural tailoring has been beneficial, there is insufficient exploration of the dynamic and evolving nature of culture in app development. Future research should adopt a more iterative and participatory approach, engaging users in the co-design process to ensure ongoing cultural relevance.

9. **Ethical Considerations of Data Privacy and Security**: Ethical considerations, including data privacy and security in SAMHW, were not addressed in the included studies and require more rigorous examination. This is especially important given the sensitive nature of mental health data and the varying levels of digital literacy among users.
10. **Enhancing Digital and Functional Literacy**: Future research should explore the most effective methods for delivering education and training to enhance digital and functional literacy.
11. **Integration of SAMHW into Healthcare Systems**: Integrating SAMHW into existing healthcare systems remains an underexplored area. Seamless integration and robust pathway designs could enhance holistic care experiences and potentially reduce healthcare costs, particularly for people with co-existing health conditions. Multicultural, multi-method approaches are essential to understand and meet the multidimensional needs across diverse global environments.

Conclusions

This scoping review showed a paucity of studies relating to SAMHW to support middle-aged people from REMG. It serves as an initial step towards encouraging more focused research and proactive measures in this vital area. While there have been successes, particularly in terms of positive impacts on mental health outcomes, acceptability, and initial user engagement, this review highlights diverse research-specific and application-specific barriers. It underscores the critical need for a greater focus on developing culturally tailored, evidence-based, and user-friendly interventions.

Although SAMHW hold promise as accessible and scalable tools, critical gaps remain in utility, effectiveness, ethical perspectives, long-term sustainability, and comprehensive healthcare integration. By addressing barriers such as cost, digital and functional literacy, privacy, confidentiality, and accessibility, these apps can play a significant role in enhancing mental health care and outcomes for this demographic. While these barriers are not exclusive to REMG, they can be significantly more pronounced due to the intersectionality and cumulative impacts of cultural, linguistic, socioeconomic, and systemic factors.

Understanding and addressing the complex intersections of mental health, middle-age, and REMG status requires multifaceted approaches and synergistic collaborations that examine the contextual, social, cultural, and economic factors at play. Multidimensional approaches and strategies involving policy support, research, inclusive development practices, community engagement, and educational initiatives are essential to bridge the existing gaps.

Longitudinal and larger scale studies, iterative co-design processes, and robust healthcare integration strategies will be essential in realising the full potential of SAMHW. Future research should prioritise these areas to develop more effective, culturally sensitive, and sustainable SAMHW capable of meeting the diverse needs of REMG populations.

Reflections

Embarking on an MSc in Global Healthcare Leadership has been an extraordinarily transformative experience, profoundly influencing both my personal and professional life. This journey has enriched my understanding of global health systems, leadership principles, and the complexities of healthcare delivery in diverse cultural contexts.

Personal Growth and Development

From the outset, the rigorous academic curriculum challenged me to expand my intellectual boundaries. The comprehensive coursework covered a wide array of topics, from health economics and policy to advanced leadership and management strategies. Each module demanded critical thinking and a deep engagement with current global health issues, fostering a robust analytical skillset. This academic rigour not only honed my ability to analyse and synthesise complex information for this dissertation, but also instilled a strong sense of discipline and perseverance.

The programmes strong emphasis on reflective practice allowed me to introspect and evaluate my leadership styles and capabilities. Through diverse assignments and discussions, I gained insights into my strengths and areas for improvement. This self-awareness has been invaluable, enabling me to evolve into a more effective and empathetic leader.

Professional Advancement

Professionally, the MSc programme provided unparalleled opportunities for networking and collaboration. Interacting with a diverse cohort of peers, including healthcare professionals from various parts of the world, enriched my perspective on global health challenges and solutions. These interactions facilitated a deeper appreciation of the socio-cultural, political, and economic factors influencing health outcomes across different regions.

One of the programmes most transformative aspects was the ongoing exposure to real-world case studies and practical applications of theoretical knowledge.

Enhanced Leadership Skills

The leadership training embedded within the programme was instrumental in shaping my approach to leading teams and organisations. The modules on leadership provided a nuanced understanding of different leadership styles and their impacts on organisational culture and performance. My role as the team leader allowed me to practice these skills, resulting in a cohesive and high-performing team. Moving forward, I plan to continue developing my personal toolkit of leadership practices, skills, and emotional intelligence, aiming to create a more inclusive and supportive team environment.

Dissertation

The dissertation process has taught me valuable skills in research, critical thinking, and time management. I developed expertise in my chosen topic, deepening my understanding through extensive literature review and data analysis. I learned to navigate challenges, from refining methodologies to addressing unexpected results. My dissertation work has revealed the vast potential for further exploration and contribution in this field.

Broader Impact and Future Aspirations

This MSc programme has significantly broadened my worldview. Looking forward, I am inspired to leverage my expertise to drive positive change in global healthcare systems. Whether through policy advocacy, research, or direct healthcare delivery, I am committed to making a meaningful impact on global health. The transformative experience of this programme has not only prepared me to tackle the complex challenges of global healthcare but also ignited a lifelong passion for learning and leadership in this field. The programmes emphasis on critical thinking, methodological rigour, and innovative problem-solving solidified my desire to delve deeper into research, contribute original insights, and pursue a DPhil programme at the University of Oxford in the future.

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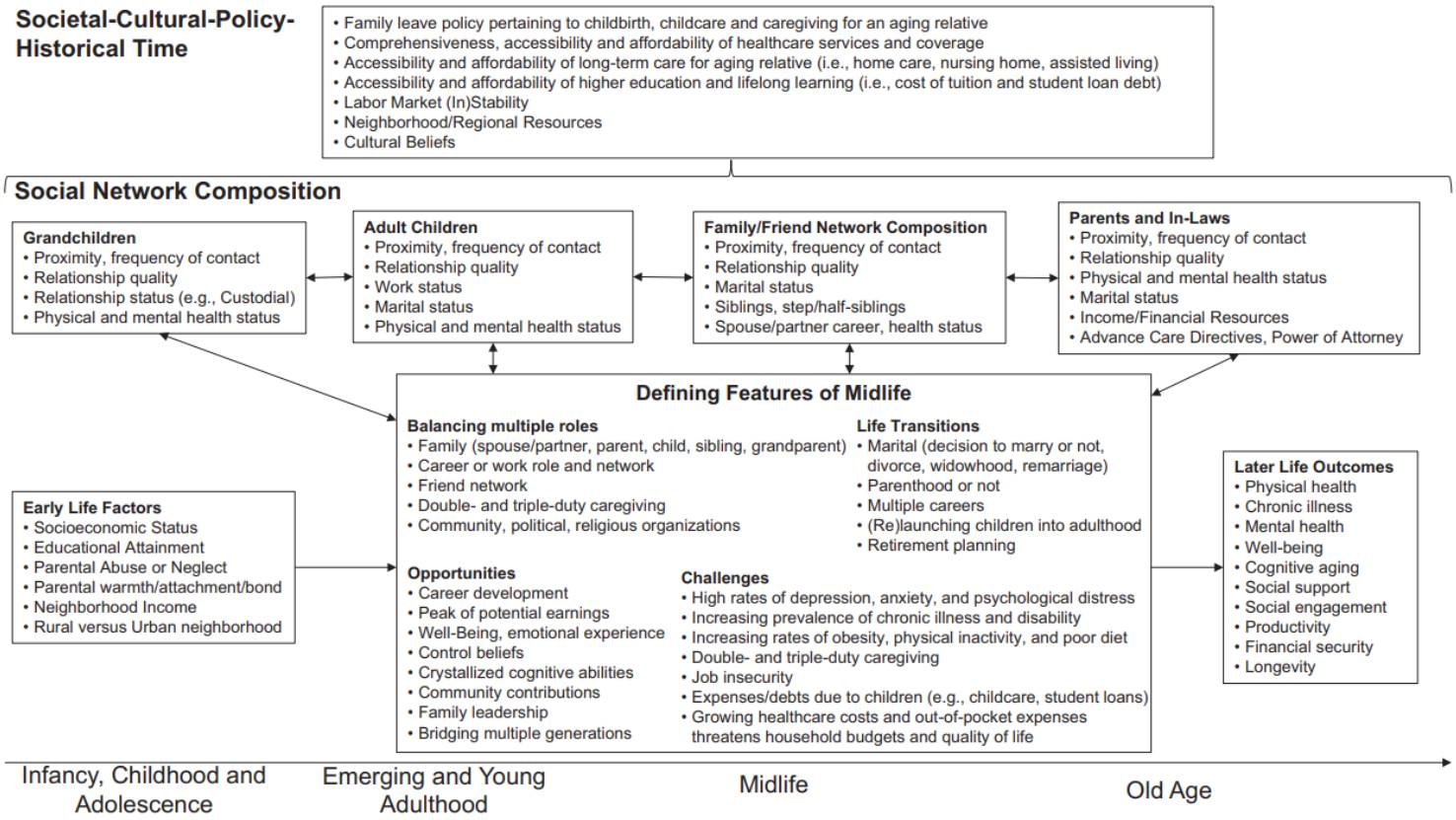
Conflicts of Interest

The author declares that there were no conflicts of interest regarding the research.

Appendices

Appendix 1: Conceptual Framework For Pivotal Role Of Midlife



Source: Infurna FJ, Gerstorf D, Lachman ME. Midlife in the 2020s: Opportunities and challenges. American Psychologist. 2020;75(4):470 (6).

Appendix 2: Search Strategy For Medline Database 1806-Present

Number	Search Query	Results
1	Mobile Applications/	2965
2	mobile devices/ or exp mobile phones/ or tablet computers/ or mobile health/	13582
3	(app or apps).ti,ab.	12211
4	((online or web or internet or digital*) adj3 (based or application* or intervention* or program* or therap*)).ab.	35467
5	(phone* or telephone* or smartphone* or cellphone* or smartwatch*).ti.	12060
6	((phone* or telephone* or smartphone* or cellphone* or smartwatch*) adj3 (based or application* or intervention* or program* or therap*)).ab.	6429
7	(mobile health or mhealth or m-health).ti.	1030
8	((mobile health or mhealth or m-health) adj3 (based or application* or intervention* or program* or therap*)).ab.	960
9	(mobile* adj3 (based or application* or intervention* or device* or technolog*)).ti,ab.	9452
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	71639
11	ethnic identity/ or ethnic diversity/ or racial identity/ or "racial and ethnic differences"/	55942
12	exp "racial and ethnic groups"/	159941
13	minority groups/	18961
14	exp immigration/	27977
15	refugees/ or exp asylum seeking/	9621
16	cross cultural differences/ or cross cultural communication/ or cultural diversity/	60133
17	(ethnic* or race or racial or bme or bame).ti. or ((ethnic* or race or racial or bme or bame) adj3 (minorit* or group? or people or population? or communit*)).ab. or (ethnicity or ethnicities).ab.	111441
18	((african or asian or chinese or korean or vietnamese or south american) adj (ethnic* or background?)).mp.	1113
19	(african american? or black american? or afrocaribbean or afro-caribbean or black british or ((black or african or caribbean) adj2 (women or female? or people or population? or communit* or diaspora))).mp.	76053
20	(chinese american? or korean american? or asian american? or british asian? or british indian? or british pakistani? or british bangladeshi? or ((asian or chinese or korean) adj2 (women or female? or people or population? or communit* or diaspora))).mp.	25739
21	(hispanic? or latino? or latina? or latinx or mexican american?).mp.	67900
22	(native american? or indigenous american? or maori? or aborigin* or torres strait or (indigenous adj2 (women or female? or people or population? or communit*))).mp.	19148
23	(roma or gypsy or traveller?).ti. or ((roma or gypsy or traveller) adj2 (women or female? or people or population? or community)).ab.	747
24	(immigrant? or migrant? or refugee? or asylum seeker?).ti. or ((immigrant or migrant or refugee or asylum seek*) adj2 (women or female? or people or population? or communit*)).ab.	28817
25	(((ethnic or cultur* or linguistic* or language) adj2 divers*) or (crosscultur* or cross-cultur*)).mp.	105776
26	11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25	398152

Number	Search Query	Results
27	well being/	64022
28	(wellbeing or well being).mp.	141798
29	mental health/	96053
30	exp mental disorders/	1108010
31	stress/ or acute stress/ or posttraumatic stress/ or psychological stress/ or exp trauma/	169111
32	(mental* ill* or mental health or mental disorder?).tw.	343140
33	(mood? or anxious or anxiet* or depress* or stress* or distress*).tw.	839586
34	27 or 28 or 29 or 30 or 31 or 32 or 33	1818423
35	middle adulthood/ or older adulthood/	21984
36	(aged 65 yrs older or middle age 40 64 yrs or very old 85 yrs older).ag.	691791
37	elderly.tw.	70207
38	geriatric*.tw.	20768
39	senior.tw.	25128
40	(older adj (adult? or m#n or wom#n or person? or people)).tw.	92854
41	(mid* age? or midlife or mid life).tw.	24880
42	Geriatrics/	13180
43	(Age? adj3 (over or older) adj2 (4# or 5# or 6# or 7# or 8# or 9#)).tw.	19040
44	(sexagenarian or septuagenarian or octogenarian or nonagenarian or centenarian).tw.	377
45	gerontolog*.tw.	7227
46	(">=4# years old" or ">4# years old").tw.	2067
47	(">=5# years old" or ">5# years old").tw.	2059
48	(">=6# years old" or ">6# years old").tw.	3476
49	(">=7# years old" or ">7# years old").tw.	1727
50	(">=8# years old" or ">8# years old").tw.	1383
51	(">=9# years old" or ">9# years old").tw.	563
52	or/35-51	770229
53	10 and 26 and 34 and 52	448

Appendix 3: Search Strategy For Embase Database 1974 to present

Number	Search Query	Results
1	Mobile Application/	23580
2	exp mobile phone/	51184
3	(app or apps).ti,ab.	63400
4	((online or web or internet or digital*) adj3 (based or application* or intervention* or program* or therap*)).ab.	113674
5	(phone* or telephone* or smartphone* or cellphone* or smartwatch*).ti.	33791
6	((phone* or telephone* or smartphone* or cellphone* or smartwatch*) adj3 (based or application* or intervention* or program* or therap*)).ab.	24155
7	(mobile health or mhealth or m-health).ti.	5561
8	((mobile health or mhealth or m-health) adj3 (based or application* or intervention* or program* or therap*)).ab.	4532
9	(mobile* adj3 (based or application* or intervention* or device* or technolog*)).ti,ab.	28970
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	255987
11	exp *ethnic group/ or exp *ancestry group/	124961
12	exp *"ethnic or racial aspects"/	59540
13	*migrant/ or exp *forced migrant/ or exp immigrant/	35567
14	cultural diversity/	3500
15	(ethnic* or race or racial or bme or bame).ti,kf. or ((ethnic* or race or racial or bme or bame) adj3 (minorit* or group? or people or population? or communit*)).ab. or (ethnicity or ethnicities).ab.	284336
16	((african or asian or chinese or korean or vietnamese or south american) adj (ethnic* or background?)).ti,ab,kf.	6241
17	(african american? or black american? or afrocaribbean or afro-caribbean or black british or ((black or african or caribbean) adj2 (women or female? or people or population? or communit* or diaspora))).ti,ab,kf.	152280
18	(chinese american? or korean american? or asian american? or british asian? or british indian? or british pakistani? or british bangladeshi? or ((asian or chinese or korean) adj2 (women or female? or people or population? or communit* or diaspora))).ti,ab,kf.	102831
19	(hispanic? or latino? or latina? or latinx or mexican american?).ti,ab,kf.	136658
20	(native american? or indigenous american? or maori? or aborigin* or torres strait or (indigenous adj2 (women or female? or people or population? or communit*))).ti,ab,kf.	42561
21	(roma or gypsy or traveller?).ti,kf. or ((roma or gypsy or traveller) adj2 (women or female? or people or population? or community)).ab.	6332
22	(immigrant? or migrant? or refugee? or asylum seeker?).ti,kf. or ((immigrant or migrant or refugee or asylum seek*) adj2 (women or female? or people or population? or communit*)).ab.	45247
23	(((ethnic or cultur* or linguistic* or language) adj2 divers*) or (crosscultur* or cross-cultur*)).ti,ab,kf.	36374
24	11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23	706294
25	wellbeing/ or emotional wellbeing/ or psychological wellbeing/ or social wellbeing/	125082
26	(wellbeing or well being).tw,kw.	188900
27	exp mental disease/	2791453

Number	Search Query	Results
28	mental stress/ or emotional stress/ or life stress/	133786
29	(mental* ill* or mental health or mental disorder?).tw,kw.	379929
30	(mood? or anxious or anxiet* or depress* or stress* or distress*).tw,kw.	2448461
31	25 or 26 or 27 or 28 or 29 or 30	4677657
32	exp aged/ or Middle aged/	5124537
33	elderly.tw,kw.	431562
34	geriatric*.tw,kw.	105780
35	senior.tw,kw.	63230
36	(older adj (adult? or m#n or wom#n or person? or people)).tw,kw.	241442
37	(mid* age? or midlife or mid life).tw,kw.	98737
38	Geriatrics/	34557
39	(Age? adj3 (over or older) adj2 (4# or 5# or 6# or 7# or 8# or 9#)).tw.	95287
40	(sexagenarian or septuagenarian or octogenarian or nonagenarian or centenarian).tw,kw.	5323
41	gerontolog*.tw,kw.	12647
42	(">=4# years old" or ">4# years old").tw.	36850
43	(">=5# years old" or ">5# years old").tw.	38041
44	(">=6# years old" or ">6# years old").tw.	58375
45	(">=7# years old" or ">7# years old").tw.	35525
46	(">=8# years old" or ">8# years old").tw.	21488
47	(">=9# years old" or ">9# years old").tw.	7086
48	or/32-47	5475233
49	10 and 24 and 31 and 48	867
50	conference*.pt. or conference abstract/	5892956
51	49 not 5	632

Appendix 4: Search Strategy For PsycINFO Database 1806 to present

Number	Search Query	Results
1	Mobile Applications/	2965
2	mobile devices/ or exp mobile phones/ or tablet computers/ or mobile health/	13582
3	(app or apps).ti,ab.	12211
4	((online or web or internet or digital*) adj3 (based or application* or intervention* or program* or therap*)).ab.	35467
5	(phone* or telephone* or smartphone* or cellphone* or smartwatch*).ti.	12060
6	((phone* or telephone* or smartphone* or cellphone* or smartwatch*) adj3 (based or application* or intervention* or program* or therap*)).ab.	6429
7	(mobile health or mhealth or m-health).ti.	1030
8	((mobile health or mhealth or m-health) adj3 (based or application* or intervention* or program* or therap*)).ab.	960
9	(mobile* adj3 (based or application* or intervention* or device* or technolog*)).ti,ab.	9452
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	71639
11	ethnic identity/ or ethnic diversity/ or racial identity/ or "racial and ethnic differences"/	55942
12	exp "racial and ethnic groups"/	159941
13	minority groups/	18961
14	exp immigration/	27977
15	refugees/ or exp asylum seeking/	9621
16	cross cultural differences/ or cross cultural communication/ or cultural diversity/	60133
17	(ethnic* or race or racial or bme or bame).ti. or ((ethnic* or race or racial or bme or bame) adj3 (minorit* or group? or people or population? or communit*)).ab. or (ethnicity or ethnicities).ab.	111441
18	((african or asian or chinese or korean or vietnamese or south american) adj (ethnic* or background?)).mp.	1113
19	(african american? or black american? or afrocaribbean or afro-caribbean or black british or ((black or african or caribbean) adj2 (women or female? or people or population? or communit* or diaspora))).mp.	76053
20	(chinese american? or korean american? or asian american? or british asian? or british indian? or british pakistani? or british bangladeshi? or ((asian or chinese or korean) adj2 (women or female? or people or population? or communit* or diaspora))).mp.	25739
21	(hispanic? or latino? or latina? or latinx or mexican american?).mp.	67900
22	(native american? or indigenous american? or maori? or aborigin* or torres strait or (indigenous adj2 (women or female? or people or population? or communit*))).mp.	19148
23	(roma or gypsy or traveller?).ti. or ((roma or gypsy or traveller) adj2 (women or female? or people or population? or community)).ab.	747
24	(immigrant? or migrant? or refugee? or asylum seeker?).ti. or ((immigrant or migrant or refugee or asylum seek*) adj2 (women or female? or people or population? or communit*)).ab.	28817
25	(((ethnic or cultur* or linguistic* or language) adj2 divers*) or (crosscultur* or cross-cultur*)).mp.	105776
26	11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25	398152

Number	Search Query	Results
27	well being/	64022
28	(wellbeing or well being).mp.	141798
29	mental health/	96053
30	exp mental disorders/	1108010
31	stress/ or acute stress/ or posttraumatic stress/ or psychological stress/ or exp trauma/	169111
32	(mental* ill* or mental health or mental disorder?).tw.	343140
33	(mood? or anxious or anxiet* or depress* or stress* or distress*).tw.	839586
34	27 or 28 or 29 or 30 or 31 or 32 or 33	1818423
35	middle adulthood/ or older adulthood/	21984
36	(aged 65 yrs older or middle age 40 64 yrs or very old 85 yrs older).ag.	691791
37	elderly.tw.	70207
38	geriatric*.tw.	20768
39	senior.tw.	25128
40	(older adj (adult? or m#n or wom#n or person? or people)).tw.	92854
41	(mid* age? or midlife or mid life).tw.	24880
42	Geriatrics/	13180
43	(Age? adj3 (over or older) adj2 (4# or 5# or 6# or 7# or 8# or 9#)).tw.	19040
44	(sexagenarian or septuagenarian or octogenarian or nonagenarian or centenarian).tw.	377
45	gerontolog*.tw.	7227
46	(">=4# years old" or ">4# years old").tw.	2067
47	(">=5# years old" or ">5# years old").tw.	2059
48	(">=6# years old" or ">6# years old").tw.	3476
49	(">=7# years old" or ">7# years old").tw.	1727
50	(">=8# years old" or ">8# years old").tw.	1383
51	(">=9# years old" or ">9# years old").tw.	563
52	or/35-51	770229
53	10 and 26 and 34 and 52	448

Key references to published search filters:

- **Mobile Apps** – adapted from: Ayiku L, Hudson T, Glover S, Walsh N, Adams R, Deane J, et al. The NICE MEDLINE and Embase (Ovid) health apps search filters: development of validated filters to retrieve evidence about health apps. International journal of technology assessment in health care. 2020;37:e16. https://www.ncbi.nlm.nih.gov/pubmed/33107420
- **Ethnic Minority Groups** – used in previous review by Nia Roberts, as yet unpublished
- **Older Adults** – adapted from: Wright, Judy and Jones, Daniel (2021) Search strategies to investigate decision making by older adults and appraisal by GPs following cancer symptoms.University of Leeds. [Dataset] https://doi.org/10.5518/1034 https://archive.researchdata.leeds.ac.uk/904/

Appendix 5: Search Strategy For Science Citation Index & Social Science Citation Index Database via Web of Science Core Collection

Number	Search Query	Results
1	(TI=(app OR apps) OR AB=(app OR apps)) OR (TI=((online OR web OR internet OR digital*) NEAR/3 (based OR application* OR intervention* OR program* OR therap*)) OR AB=((online OR web OR internet OR digital*) NEAR/3 (based OR application* OR intervention* OR program* OR therap*))) OR TI=(phone* OR telephone* OR smartphone* OR cellphone* OR smartwatch*) OR AB=((phone* OR telephone* OR smartphone* OR cellphone* OR smartwatch*) NEAR/3 (based OR application* OR intervention* OR program* OR therap*)) OR TI=("mobile health" OR mhealth OR m-health) OR AB=(("mobile health" OR mhealth OR m-health) NEAR/3 (based OR application* OR intervention* OR program* OR therap*)) OR (TI=(mobile* NEAR/3 (based OR application* OR intervention* OR device* OR technolog*)) OR AB=(mobile* NEAR/3 (based OR application* OR intervention* OR device* OR technolog*)))	348071
2	TI=(ethnic* OR race OR racial OR bme OR bame) OR AB=((ethnic* OR race OR racial OR bme OR bame) NEAR/3 (minorit* OR group$ OR people OR population$ OR communit*)) OR AB=(ethnicity OR ethnicities) OR TS=((african OR asian OR chinese OR korean OR vietnamese OR "south american") NEAR/0 (ethnic* OR background$)) OR TS=("african american$" OR "black american$" OR afrocaribbean OR afro-caribbean OR "black british" OR ((black OR african OR caribbean) NEAR/2 (women OR female$ OR people OR population$ OR communit* OR diaspora))) OR TS=("chinese american$" OR "korean american$" OR "asian american$" OR "british asian$" OR "british indian$" OR "british pakistani$" OR "british bangladeshi$" OR ((asian OR chinese OR korean) NEAR/2 (women OR female$ OR people OR population$ OR communit* OR diaspora))) OR TS=(hispanic$ OR latino$ OR latina$ OR latinx OR "mexican american$") OR TS=("native american$" OR "indigenous american$" OR maori$ OR aborigin* OR "torres strait" OR (indigenous NEAR/2 (women OR female$ OR people OR population$ OR communit*))) OR TI=(roma OR gypsy OR traveller$) OR AB=((roma OR gypsy OR traveller) NEAR/2 (women OR female$ OR people OR population$ OR community)) OR TI=(immigrant$ OR migrant$ OR refugee$ OR "asylum seeker$") OR AB=((immigrant OR migrant OR refugee OR "asylum seek*") NEAR/2 (women OR female$ OR people OR population$ OR communit*)) OR TS=(((ethnic OR cultur* OR linguistic* OR language) NEAR/2 divers*) OR (crosscultur* OR cross-cultur*))	753414
3	TS=("mental* ill*" OR "mental health" OR "mental disorder$") OR TS=(mood$ OR anxious OR anxiet* OR depress* OR stress* OR distress*) OR TS=(wellbeing OR "well being")	3666782
4	TS=(older NEAR/0 (adult$ OR m?n OR wom?n OR person$ OR people)) OR TS=("mid* age$" OR midlife OR "mid life") OR TS=(sexagenarian OR septuagenarian OR octogenarian OR nonagenarian OR centenarian) OR TS=gerontolog* OR TS=geriatric*	594676
5	#4 AND #3 AND #2 AND #1	101
6	#4 AND #3 AND #2 AND #1 and Proceeding Paper (Exclude – Document Types)	100

Appendix 6: Data Extraction Tool

Scoping Review Details	
Title	
Objectives	
Questions	
Inclusion/Exclusion Criteria	
Population	
Concept	
Context	
Evidence Source Details and Characteristics	
Citation Details	
Title	
Author(s)	
Publication Year	
Country of Origin	
Type of Study/Document	
Study Descriptor (if applicable)	
Study Location	
Participant Numbers/Population Size	
Population Descriptor, e.g., first, second, or third generation, and what communities/ethnic heritage they represent.	
Percentage of racial/ethnic minorities comprising the sample	
The mean/median of the sample	
Recruitment setting	
Attrition rate	
Purpose of mobile application	
Design and features of mobile application	
Details/Results Extracted from Source Evidence	
Issue(s) targeted/discussed	
Stakeholders involved in application development	
Single intervention, multiple interventions, or programme	
Services which are linked to or are components of the smartphone application (if applicable)	
Complementary interventions (if applicable)	
Strategies for cultural adaptation	
Other strategies or approaches used	
Notes on effectiveness, acceptability, accessibility, cultural tailoring and sensitivity and uptake of intervention	
Facilitators	
Barriers	
Outcomes reported	
Gaps in literature	

Source: Data Extraction Tool modified from the "JBI template source of evidence details, characteristics and results extraction instrument" (35)

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