The influence of societal behaviours and trends on mental health based applications: An environmental scan

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Harshdeep Dhaliwal, ¹ Uzhma Nagani, ¹ Sindi Mukaj, ¹ Tommy Vo, ² Jyotsna Berry, ³ Sherry Shu, ⁴ Tuba Buyuktepe, ⁵ Joy Xu ¹

¹ McMaster University, Hamilton, ON, Canada

² Wilfrid Laurier University, Waterloo, ON, Canada

³ University of British Columbia, Vancouver, BC, Canada

⁴ St. Robert Catholic High School, Thornhill, ON, Canada

⁵ University of Ottawa, Ottawa, ON, Canada

Contact Info: harshdeep569340@gmail.com

ABSTRACT

BACKGROUND

Within a decade, the expeditious evolution of technology has catalyzed digital advancements employed even at one's fingertips. Now a household item, smartphones host innumerable apps supporting users across the world. One of the rising market niches includes mental-health based applications, which further branch into topics of lifestyle, habit-building, and productivity.

METHODS

This systematic review explores quantitative and qualitative studies discussing variables of influence on social behaviours and trends for mental-health based applications. Searched databases include Science Direct, ProQuest, and Scopus with further supplementation of grey literature from Science Daily, Common Sense Media, and Extreme Networks. Extracted data precluded meta-analysis given the significant heterogeneity in study design, outcomes, and measurements. Studies were screened with a piloted tool and screening & extraction was completed independently among two authors. Disagreements following reconciliation between the two authors were settled by a third author.

RESULTS

Appraised articles identified trends & behaviors associated with app functionality, accessibility, and data/privacy security. The decline or absence of these features correlated with low user engagement.

CONCLUSION

Prevalent features were determined for enhanced functionality, accessibility, and database security, which may serve to bolster apps within mental-health and its niches.

KEYWORDS

Trends, apps, user behaviour, consumer, engagement, education, mental health, productivity, market research

INTRODUCTION

Over a million applications, also known as apps, have been developed with the advancement of modern technology [9]. Serving a myriad of purposes, these apps target specific demographics with diverse functionalities that could lie within 1 of 24 - 33 categories depending on the app store, with popular brackets in finance, lifestyle, utility, etc. The broad classifications reduce navigation-associated user confusion as the placement of apps are assorted by their main purpose & functions [32]. Within these categories, games and education-based apps account for 23.03% of all globally available apps and sum to over 400,000 apps according to recent Google Play store statistics [34]. The high volume of apps within these markets likely derive from target audience variance as multiple apps are often created under the same companies to cover several sets of demographics.

Prior to public availability and marketing, apps are created with careful consideration towards the characteristics of target demographics, including traits such as age, gender, location, education, and behaviour [15]. A process known as behavioural targeting enables user behaviours to be assessed by analyzing browser history to view searches and frequently visited websites to increase functional efficiency and user engagement [23]. Nearly all applications benefit through similar processes, but MHapps are especially attentive to these details to ensure effective support in usability without deleterious effects [10].

The National Institute of Mental Health (NIMH) classifies mental health-based apps (MHapps) into one of six categories on the basis of their function towards the consumer: self-management, cognition improvement, skills-training, social support, symptom tracking, and passive data collection [11]. Mobile apps represent an easily accessible method of delivery that requires low effort to implement with wide-spread impact on millions of users.

However, evidence on the effectiveness of apps as a low-cost mental health treatment alternative is ongoing. The Digital Mental Health Revolution Report concluded that there were at least 10,000 mental-health based apps on the market, yet only a small percentage of these apps used effective, proven strategies supported by psychological research in order to help users with common mental health issues [31]. Research has demonstrated that the accessibility of most psychological interventions are often limited by either cost or availability of a practitioner to provide these services [11]. Therefore, the rise of MHapps may also be explained from its potential role as an alternative to in-person therapies or as a means to treat subclinical conditions that do not qualify for a diagnosis or treatment.

In a meta-analysis of nine randomized controlled trials that researched the effects of MHapps on anxiety symptoms, it was determined that users experienced a significant reduction in their anxiety after using these MHapp interventions [11]. Due to the exponential rise of smartphone users globally, increasing efficacious MHapps on phones could potentially liberate scarce

face-to-face services in communities struggling to meet the demand by offering virtual interventions to address mild-to-moderate mental health problems [24]. This growing trend presents new opportunities for psychologists to connect with patients through mobile apps with three key benefits:

1. The therapeutic relationship between the provider and patient may be supplemented through recommended worksheets and tools outside of sessions
2. Patients may provide real-time symptom and activity monitoring to track behaviours while being reminded to use techniques learned in therapy sessions for long-term habit building
3. Patient awareness of disorders and symptoms may improve with constant logging, while also improving patient functioning through more accurate self-reporting measures [3].

The rapid increase of technological literacy elicits constant transformation of societal trends within modern society. To this extent, attitudes and trends are constantly conceived, transformed, and refined through dissemination of digital & physical interactions across a plethora of platforms. Findings within social psychology can explain the formation and effects of trends in our applicable strata.

The initiation of societal trends and behaviours often occurs once exposure to the stimuli is made [28]. Within this notion, the affective gauge of behavioural influence on the individual is determined by elements of reason and reward. Cognitive psychology implies that an individual will seek to understand how presented stimuli such as trends apply to themselves and their lifeworld. Through this, individuals will conceptualize aspects of reason and reward of assimilating and indoctrinating these behaviours and trends [14]. Upon weighing the subjective worth of a trend to the self, one can proceed to either dismiss or execute it accordingly.

Thereby, these societal trends and behaviours also affect one's mental health through stimuli of discourse, loneliness, social pressure, jealousy, shame, and other subjective affective justifications. These themes and emotions can measure self-esteem through a mental health assessment. The individual or researcher can then discern how one's mental health is influenced by society and conjecture the individual's behaviour or engagement through closer examination of psychological, social, and environmental factors. Biological factors can not be accounted for when determining one's susceptibility or inclination to social trends and behaviours because viewers can generally not surmise the internal. However, influential thematic factors can be used to analyze and gain an inference on a subject's susceptibility to engage in social trends and behaviours. Psychological, social, and environmental factors can be broken down into entailing criteria, to deduce a subject's mentality, social paradigm, and composition [18].

Psychological factors are subjective to individual-level processes and affective states. Social factors revolve around the concept of social dynamics and designations which include: gender nuances, social class, race, ethnicity, and more. Environmental factors that affect an individual

are found in variables that influence the subject by acting as a foundation; this can be explained through geographic culture, education, government policies, as well as environmental and demographic dynamics [1]. These thematic factors and their entailing variables can also be referenced for their impact in determining an individual's disposition towards being influenced by societal trends.

Many of these trends often arise from mental health stigma, which is often internalized by individuals. In his seminal work: *Stigma: Notes on the Management of Spoiled Identity* [1], Erving Goffman defines stigma as “an attribute that is deeply discrediting” that reduces an individual “from a whole and usual person to a tainted, discounted one” - similar to a spoiled identity [16, p. 3]. Mental health stigma has several implications for the social work profession, which encompasses mental health applications. In 2017, Our World in Data reported that an estimated 10.7% of the worldwide population is affected by a mental or behavioural disorder [30]. Though these conditions are highly prevalent, respective treatments have shown effectiveness in mitigating the issues to improve individual functioning in society. However, research suggests that those in need of care may not seek support, and those that do begin receiving care frequently stop prior to completion of the recommended treatment plan [12]. Plausible explanations for low participation rates in treatment may be associated with a lack of medical accessibility to diagnose or treat the condition due to a disability. The World Health Organization [38] also states that stigma is one of the greatest barriers to treatment engagement, despite its proven effectiveness in both high and low-income countries [38]. Nevertheless, the use of mental health mobile apps to treat conditions is growing, potentially indicating a gradual shift towards a more accepting and open mentality to mental health treatments.

The purpose of this environmental scan is to examine and identify how observable trends and behaviours within society may affect user engagement for mental-health based apps. These factors are viewed in the perspective of consumers to determine the social influences on app usage. By exploring present literature, a baseline can be drawn to outline current trends and behaviours available on this topic. Marketing analysts may also use this measure to enhance product promotion as consumers often rely on social media influencers in their decision-making process [2]. Examples of enhancing product promotion include adjusting app descriptions, UI/UX design, and accessibility; all of which apply to Felicity, a productivity-based application.

The assessment of the influence of societal behaviour and trends on the usage of mental health-based apps will be used for the marketing and promotion of the Felicity App. As this app utilizes an evidence-based approach for psychological-based interventions on improving productivity in an academic setting, the findings from this environmental scan will help predict the usage behaviour of Felicity. More specifically, the environmental scan will help identify the target audience and respective features appealing to this demographic. Thereby, this app may be marketed appropriately to those most in need of its proposed mental health support. Based on the

results of this environmental scan, social media platforms such as Instagram, TikTok, Facebook, Twitter, etc., will be used for promoting Felicity to the target audience. The use of advertisements may also be employed through platforms such as Google and Facebook ads to do the same. The analysis of consumer engagement and usage behaviour will further help in the development and finetuning of the Felicity app. Understanding how users interact with mental health-based apps will allow for the Felicity app to become more user-friendly while catering to the users' preferences. Assessing user interaction with other mental health-based apps will also help eliminate and avoid barriers that users have faced with similar apps in the past, making the Felicity app a competitive candidate among apps within this market niche.

METHOD

An environmental scan was performed to determine the influence of societal behaviour and trends on consumer usage of MHapps. The objective of this environmental scan was to search available literature to identify social trends impacting MHapp usage and engagement. Significant trends from this environmental scan will be evaluated and applied to the Felicity app after the screening and extraction of data in present literature. The selection procedure followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines.

Study Design & Setting

The purpose of this environmental scan is to understand how societal behaviour and trends influence the use of mental health based apps. This scan specifically focuses on assessing user engagement and behaviour when it comes to apps based on improving the mental health of their users. As the Felicity app is designed to specifically address academic productivity from a psychological perspective, the reviewed studies have a mental health and education focus. This targeted approach allows for the findings to be narrowed to the usage of apps similar to the Felicity App.

Studies were excluded for irrelevancy if there was no data concerning consumer engagement or if trends and/or behaviours were not addressed. The demographic of interest includes individuals of all genders and ethnicities located in North America, Asia, Australia, and Europe as the majority of technological users reside in these countries with devices compatible with the Felicity App. Of the global population, Asia accounts for the majority of internet usage, making up about 51.8% of internet users [7]. Furthermore, 90.3% of North Americans use the internet on a regular basis, and 87.2% of Europeans do the same. To account for the disparities in access to the internet, countries outside of North America, Asia, Australia, and Europe were excluded. The geographical exclusion further reduces variability to ensure that the participants in the reviewed studies share similar technological backgrounds and experiences.

Furthermore, the reviewed articles were limited to the years 2011-2021 as smartphones and the use of more advanced applications became more popular than dumbphones during this time,

largely influenced by the release of the first iPhone in 2008 [21]. Subsequently, the findings of the reviewed articles are more relevant to the Felicity App as it is a smartphone application. In addition, a mixed methods design was used for this environmental scan as it assesses both qualitative and quantitative studies to establish breadth and depth [33]. The credibility, context, and utility of the studies are assessed sufficiently when using a qualitative analysis for mixed methods data [37].

Search Strategy & Criteria

A diverse selection of literature, which included grey literature, was reviewed based on a predetermined inclusion/exclusion criteria. The criteria was established prior to the search and validated the contextual and scientific relevance of the data by developing a standardized expectation for the literature's content and experimental purpose.

Online databases searched in this systematic review include Science Direct, Scopus, and ProQuest from June 6, 2021, to June 15, 2021, utilizing search strategies composed of key words related to the following: user engagement, mental health, behaviour, consumer, and application (refer to Appendix 1 for the search strategy). Regarding grey literature, the snowballing method was employed to identify and review the following online sources: Science Daily, Common Sense Media, and Extreme Networks. A list of keywords that were used to enhance searches include: "behaviour", "engagement", "customer", and "trends" (refer to Appendix 2). Searches were further filtered to ensure relevance based on its date of production, as studies were set within the publication date range of January 1, 2011 to June 2, 2021.

The search strategy was developed by using keywords with booleans and truncations according to the sample, phenomenon of interest, design, evaluation, and research type (SPIDER) criteria. Specifically, "engag*", "behav*", "mental health", "educat*", "customer", "consum*", and "applic*" aided in the extraction of published literature. All of the keywords were used for a majority of our searches. A comprehensive set of sources were further processed using advanced search features to optimize relevance. Database-specific filters such as full-text, peer-reviewed, and journals were applied, when applicable. The last search was conducted on June 15, 2021.

Inclusion & Exclusion

Eligible studies included systematic reviews, meta-analyses, non-randomized, randomized control trials (RCTs), and grey literature that were published in English between 2011 to 2021 within the field of psychology to provide a consistent baseline for searches by ensuring the relevance, accessibility, and quality of the preliminary literature. The populations of interest included general populations residing in developed countries within North America, Europe, Australia, and Asia. Since students in South America and Africa have significantly less access to the Internet and smart devices than those in the regions of interest, excluding these regions inhibited the wide discrepancy of resources from influencing the research conducted. The

geographical exclusion created a control amongst acquired material. The focus of these studies was to explore the influence of social behaviour and trends on mental health app usage and engagement through the use of qualitative and quantitative data. Articles which were overly specific in their analysis of app effectiveness, mentioned cultural influences on app usage, and/or included studies or references unavailable online were excluded. The inclusion and exclusion criteria were predetermined. Refer to Fig. 1 for SPIDER analysis.

Fig. 1 Structural outline of SPIDER components that will be analyzed in this environmental scan

Data Collection and Abstraction

An abstract screening tool, consisting of 10 questions, was created and developed using the inclusion and exclusion criteria. These questions prompted the authors to analyze the literature's purpose, experimental design, methods, results, usage of consumer app engagement and societal trends, and possible applications. The database search results were combined, and duplicate articles were removed manually using Endnote (versions 8 & 20) prior to the full text screening phase.

Identification of Relevant Studies and Data Extraction

Using the abstract screening tool, SM and JB independently reviewed 573 articles, which included study abstracts and grey literature to determine suitability of studies for inclusion. The literature was screened based on its title, abstract, and summary, when applicable. Disagreements between the two independent screeners were reconciled by a third author HD followed by the

full-text screening of eligible literature from the abstract screening phase. The abstract and grey literature screening took place between June 16, 2021 - June 22, 2021. Duplicates were removed before full text screening. Full text screening took place between June 29, 2021 - July 2, 2021. A list of excluded studies is shown in Appendix 3.

Data Extraction

Two authors (SS and UN) independently extracted data from the finalized list of studies that met the inclusion criteria from July 6, 2021 - August 3, 2021. Data on study design, trend type, participant information, type of data collected, and significance of the trend were recorded (for study characteristics, refer to Appendix 4). The two authors resolved any disagreements during reconciliation and disagreements were resolved by a third author when necessary.

Fig. 2 Structural diagram of the completed screening and study selection processes

RESULTS

Study Selection

The study selection and screening process is outlined in Fig. 2. 573 papers were identified from the database search; 79 were grey literature, 432 were published studies, and 62 were duplicates. Out of the 432 published studies 264 were retrieved from Science Direct, 163 from ProQuest, and 5 from Scopus. From the 79 grey literature, 34 were retrieved from Science Daily, 22 were retrieved from Common Sense Media, and 23 were retrieved from Extreme Networks. The published and grey literature articles both underwent abstract screening and full-text screening. After abstract screening, 115 articles remained, out of which 103 were published studies and 12 were grey literature. After full-text screening, a total of 57 articles were left, with 52 being published studies and 5 being grey literature.

Study Characteristics

From the 52 published studies that are included in this review, 25 are qualitative, 11 are quantitative, 16 are mixed methods. Also, of the 52 articles, 18 are observational studies, 4 are randomized control studies (RCT), 11 are literature reviews, 2 are non-randomized control studies, 2 are questionnaire-based, 4 are experimental, 6 are data analysis-based, and 5 are systematic reviews and meta-analyses. Many studies are a combination of these data types and are included in the above values. Furthermore, there were many studies that were found to be irrelevant to our research question despite meeting our inclusion criteria. From the 52 published articles, 41 were found to be relevant to our research question and 11 irrelevant.

Out of 52 published studies included, 15 were from the United States of America; 8 from Australia; 6 from the United Kingdom; 4 from Canada; 2 from China, Germany, and Spain; and 1 from Italy, Portugal, Korea, Malaysia, Denmark, the Netherlands, Ireland, Turkey, France, Slovenia, Taiwan, Bangladesh, and Japan.

Findings and Outcomes

Recent trends indicate that MHapps can improve the psychological treatment of patients, especially alongside the provision of clinical treatment. MHapps have been applied in trials to treat depression, sleep issues, anxiety, and stress, with positive self-reported results. MHapps have also helped users with mindfulness, meditation, and habit-building. The studies also displayed that users tended to prefer and consistently use apps that had a well-designed and simplistic user interface, personalized experience, and offered an array of features. The initial attitude of users toward the app also affected their engagement with the app and the benefits derived. User analytics and user data have a high potential to be incorporated into app treatments, with data privacy becoming a significant area of focus for app developers. More research regarding the effectiveness of MHapps needs to be conducted since many apps currently on the market are not based on research from well-designed studies and thus may not be effective. A summary of the findings and outcomes are located in Table 1.

Table 1. Findings and outcomes of articles that were relevant and answered the research question

Article	Finding	Outcome
McColl, L. D., et al. Peer support intervention through mobile application: An integrative literature review and future directions [25]	Peer support based apps have potential for decreasing stress on individuals.	There are positive outcomes of technology based peer support such as phone calls, texting, and online groups.
White, B. K., et al. Designing evaluation plans for health promotion mHealth interventions: a case study of the Milk Man mobile man [35]	Challenges for mHealth interventions include privacy and data security	Lack of data security and privacy can decrease the number of app users and hinder app promotion
Wright, C. J. C, et al. Barriers and opportunities in the translation of mobile phone and social media interventions between research and health promotion practice in Australia: a qualitative study of expert perspectives [39]	Translations are prioritized by both researchers and practitioners	A successful app must be accessible to large audiences
Mirzaei, T., & Esmaeilzadeh, P. Engagement in online health communities: Channel expansion and social exchanges [26]	Patient willingness to share and seek information is affected by health status	Social support may increase members' engagement and information exchange in OHCs
Bauer, M., et al. Smartphones in mental health: a critical review of background issues, current status and future concerns [5]	Patients prefer different types of consumer technologies	Psychiatry based technology should focus on automating functions that will provide patients with a variety of methods to access and use the technology to best fit the patients' lifestyles and budget
Birkmeyer, S., et al. Determinants of mHealth success: An empirical investigation of the user perspective [6]	User satisfaction has a strong positive influence on the continuous usage of MHapps	User's general attitude towards mHealth over all affects the success of the app
Li, M., et al. Meaningful	The use of a visual impact	Gamified psychological

gamification for psychological empowerment: exploring user affective experience mirroring in a psychological self-help system [22]	metaphor-based (VIM) system was considered more empowering, allowing users to gain more control over their emotional well-being.	self-help systems that could echo the user's facial expressions in real time are efficient.
Bucci, S., et al. Early Psychosis Service User Views on Digital Technology: Qualitative Analysis [8]	DHIs were perceived as destigmatizing, overcoming barriers of traditional interventions, facilitating communication and empowering to users.	Users believed DHIs to be a progressive and modern platform to help with mental support. Some users were concerned about having privacy and data security being breached
Qu, C., et al. Functionality of Top-Rated Mobile Apps for Depression: Systematic Search and Evaluation [29]	Available apps for depression provide a wide array of functionality in order to help users across a range of age group	Need for guidelines to ensure that privacy and safety are protected while using the apps.
Hartin, P. J., et al. The Empowering Role of Mobile Apps in Behavior Change Interventions: The Gray Matters Randomized Controlled Trial [17]	Increased app exposure had a significant effect on clinical measurements	Promoting apps to clinicians/professionals increases the app's success
Mitchell, M., et al. Uptake of an Incentive-Based mHealth App: Process Evaluation of the Carrot Rewards App [27]	Findings show that loyalty points may promote the usage of mHealth apps among female users	The use of incentives in promoting healthy habits is a possibility for the future
Widnall, E., et al. User Perspectives of Mood-Monitoring Apps Available to Young People: Qualitative Content Analysis [36]	Findings show that users prefer apps that personalize their needs, have a simple design, have an accurate representation and review of fluctuating moods	Eight themes discovered in positive user reviews include accessibility, flexibility, recording and representation of mood, user requests, reflecting on mood, technical features, design and health promotion
Dennison, L., et al. Opportunities and Challenges for Smartphone Applications in Supporting Health Behavior Change: Qualitative Study [13]	Participants believed that accuracy and legitimacy, security, effort required, and immediate effects on mood would affect their app usage	Improving the identified factors can increase user engagement (i.e. increase ability to record and track behavior, as well as record goals and learn new

		information)
Zhao, J., et al. Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review [40]	Found that too much interaction can inhibit positive health behaviours and that there is a lack of dynamic tailoring, interactive education, and self-monitoring interventions	Some features make apps better, such as less time consumption, user-friendly design, real-time feedback, individualized elements, detailed information, and health professional involvement.
Hicks, J. L., et al. Best practices for analyzing large-scale health data from wearables and smartphone apps [19]	Men are affected by the performance of other men and women, but women are affected only by the performance of other women	75% of users re-engage with apps after extended periods of dormancy and are more interactive with apps when networked with opposite sex users
Aydin, G., & Silahtaroglu, G. Insights into mobile health application market via a content analysis of marketplace data with machine learning [4]	Apps that mention a privacy policy or provide videos in description lead to higher user scores. Free apps with in-app purchase possibilities, (social networking, sharing features, and feedback mechanisms) lead to higher number of downloads	In-app purchases, increased privacy, and high accessibility increase user ratings and engagement
Iowa State University. Mobile apps and online reviews influence consumer behavior [20]	More than half of apps downloaded are deleted after one use	Product reviews and social media posts have an impact on the perception of apps and its brand

DISCUSSION

This environmental scan provides an in-depth analysis of the societal trends and behaviours that are present in current literature, with regard to mental health-based app usage. The data, which consists of observational, qualitative, mix-method, quantitative, experimental, systematic review, and self-report measures, suggests that trends and behaviours are dictated by several factors. The majority of studies (n = 17) mentioned data security, app functionality, and accessibility to be areas of concern for mental health-based app users (refer to appendix 4). Therefore, the reduction and improvement of these issues into the Felicity App will be assessed.

I. Data Security

Challenges for mHealth interventions include privacy and data security. Due to the sharing of health history and personal information on such apps, the lack of data security and privacy can decrease the number of app users and hinder app promotion. Numerous studies ($n = 8$) discussed privacy and data security within the app because users were worried about personal data breaches. To eliminate such concerns, several data security controls can be embedded to provide a greater sense of security to concerned users and increase consumer attraction. These controls can include enabling data encryption or data masking software, which would provide more confidentiality since data becomes difficult to read for unauthorized users. Besides integrating these controls into its app designs, Felicity can also mention its privacy policy through marketing measures to increase app users [4]. Ensuring data privacy and security will benefit Felicity since consumers are more likely to engage and be attracted to applications with secure databases.

II. App Functionality

Multiple studies ($n = 7$) displayed a correlation between engagement and app design. For instance, users are more likely to engage with apps that mimic the layout or style of popular apps. User satisfaction also has a strong positive influence on the continuous usage of mHealth apps. Since social networking, sharing features, and feedback mechanisms, are implemented for higher user engagement because of social media's influence on modern society. Findings further showed that users prefer personalizable apps that are simple in design, have an accurate representation, and range of moods. Moreover, improving factors, such as the ability to record and track behavior, record goals, and learn new information can increase user engagement. Accordingly, Felicity will ensure that the application includes accessibility, flexibility, representation of mood, user requests, technical features, design, and health promotion, for user satisfaction.

III. Accessibility

Translating mobile phone and social media interventions, including mHealth applications, is prioritized by researchers and practitioners ($n = 2$). It is a necessary component for the advancement of research, health promotion, and applications since a successful app must be accessible to large audiences. For this reason, as a mental health aid application, Felicity will be translated into French, Spanish, Arabic, and Turkish to cater to a broader audience. Since mental health is not limited to a single nation or country but an issue across continents, Felicity will aim to expand its translations to reach global communities. Additional languages may be added in the future, depending on the application's growth.

Strengths and Limitations

There were some limitations to the environmental scan conducted. Firstly, a limited amount of useful grey literature was found through the scan which fit the inclusion and exclusion criteria

provided, and explored the use of mental health-based apps. Grey-literature can be useful in obtaining research which can give in-depth information on the topics being explored.

Another limitation was the lack of accessible peer-reviewed research in the field. Since mental-health based apps are a part of an up-and-coming market, there is a limited number of research articles that have been published so far. Until further research is conducted on the practicality and effectiveness of these apps relative to more traditional treatment methods, its usefulness remains provisional and subject to change in the future. In addition, it was difficult to find research articles and grey literature that disclosed all the criteria outlined in the Screening Tool. In the Full-Text Screening process, it became apparent that important information, such as therapeutic intervention used or size of treatment population, were not being stated in the research articles.

The environmental scan includes studies from North America, Europe, Australia, and Asia. There were a total of 21 studies from North America, 17 from Europe, 8 from Australia, and 8 from Asia. Data were extracted from several countries within these regions to understand the influence of social and behavioural trends on mental health-based applications. The included studies were limited to the regions listed above to have an accurate representation of the targeted population for the Felicity App. However, studies that were in any language other than English were excluded from the environmental scan, thus limiting the scope of the literature collection.

Another limitation is the lack of longitudinal studies that researched the long-term effects of social trends and behaviours on mental health-based applications. The majority of the included studies ranged from a few hours to a month. However, many studies theorized that mental health-based applications will increase in popularity in the future.

CONCLUSION

The demand for virtual mental health-based apps is evident in the rise of app downloads to phones and other electronic devices. However, only a small portion of available apps on the current market are effective treatments for mental health issues, signifying that there is room for developing novel apps backed by research for proven psychological techniques and strategies. Hence, an environmental scan was performed to analyze the trends and behaviours that influence digital mental health-based apps user engagement. By implementing subtle improvements, such as creating a stronger user interface, improving data safety, and increasing app accessibility and services, app developers, such as Felicity, can design an app to be an effective mental health tool for its users. These results were identified in 17 studies and can be used in the future marketing and promotion of the Felicity App in June 2022.

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Availability of data and material:

Available upon request.

Abbreviations:

mHealth: Mobile Health

RCT: Randomized Control Trial

MHapp: Mental Health-Based app

Code availability:

N/A

Authors' contributions:

HD and UN conceptualized the environmental scan and designed the protocol. HD, JB, SM, SS, TV, and UN conducted the database search. JB and SM completed preliminary and full-text screenings, SS and UN completed the data extraction and analysis. HD created figures and computed numerical data. HD, JB, SM, SS, TB, TV, and UN equally wrote the manuscript. JX underwent several rounds of revisions, secured funding acquisition and managed the publishing process. All authors reviewed the final manuscript.

Appendix 1

Database Searches

June 6, 2021 to June 15, 2021

Database	Search	Results
Science Direct	"personal" AND "behav" AND "consumer" OR "customer" AND "usage" AND "mental health" AND "application" AND "engagement"	264

Scopus	"consumer" OR "customer" AND "usage" AND "mental health" AND "application" AND "engagement"	5
ProQuest	trends AND behaviour AND (user engagement) AND consumer AND app AND (mental health) AND usage	163

Appendix 2

Grey Literature Searches

June 15, 2021

Database	Search	Results
Science Daily	affect AND behaviour AND usage AND customer AND engagement	34
Common Sense Media	n/a	22
Extreme Networks	user engagement trends app and educate	23

Appendix 3

List of Excluded Files from Full Text Screening

Author	Title
Yuliando, H., & Purnasari, H.	How Relationship Quality on Customer Commitment Influences Positive e-WOM
Schnall, R., et al.	Efficacy, Use, and Usability of the VIP-HANA App for Symptom Self-management in PLWH with HANA Conditions
Zhang, Q., et al.	Measurement and Assessment of Physical Activity by Information and Communication Technology
Attwood, S., et al.	Using a mobile health application to reduce alcohol consumption: a mixed-methods evaluation of the drinkaware track & calculate units application
Duncan, M. J., et al.	Balanced: a randomised trial examining the efficacy of two self-monitoring methods for an app-based multi-behaviour intervention to improve physical activity, sitting and sleep in adults

Ahmad, N. A., et al.	Willingness, perceived barriers and motivators in adopting mobile applications for health-related interventions among older adults: a scoping review protocol
Beames, J. R., et al.	Protocol for the process evaluation of a complex intervention delivered in schools to prevent adolescent depression: the Future Proofing Study
Matthews, L., et al.	Study protocol for the ‘HelpMeDoIt!’ randomised controlled feasibility trial: an app, web and social support-based weight loss intervention for adults with obesity
Samhan, B., et al.	The Trajectory of IT in Healthcare at HICSS: A Literature Review, Analysis, and Future Directions
Helm, R., et al.	The effects of a lack of social recognition on online communication behavior
Ibrahim, N. F., et al.	Exploring the effect of user engagement in online brand communities: Evidence from Twitter
Fu, X., et al.	User segmentation for retention management in online social games
Tobon, S., et al.	Gamification and online consumer decisions: Is the game over?
Wilkinson, C. R., & Angeli, A. D.	Applying user centred and participatory design approaches to commercial product development
Xu, F., et al.	What affects the user stickiness of the mainstream media websites in China?
Calvaresi, D., et al.	EREBOTS: Privacy-Compliant Agent-Based Platform for Multi-Scenario Personalized Health-Assistant Chatbots
Gilal, F. G., et al.	The role of organismic integration theory in marketing science: A systematic review and research agenda
Huang, Y. T., & Su, S. F.	Motives for Instagram Use and Topics of Interest among Young Adults
Franco, C., et al.	A fuzzy and bipolar approach to preference modeling with application to need and desire
Celino, I., & Calegari, G. R.	Submitting surveys via a conversational interface: An evaluation of user acceptance and approach effectiveness
Eisingerich, A. B., et al.	Hook vs. hope: How to enhance customer engagement through gamification
Athilingam, P., et al.	A Mobile Health Intervention to Improve Self-Care in Patients With Heart Failure: Pilot Randomized Control Trial
Militello, L., et al.	Delivering Perinatal Health Information via a Voice Interactive App (SMILE): Mixed Methods Feasibility Study

Chen, J., et al.	The Most Popular Smartphone Apps for Weight Loss: A Quality Assessment
Choo, C. C., & Burton, A. A.	Mobile Phone Apps for Behavioral Interventions for At-Risk Drinkers in Australia: Literature Review
Dallinga, J., et al.	Analysis of the Features Important for the Effectiveness of Physical Activity–Related Apps for Recreational Sports: Expert Panel Approach
Hassandra, M., et al.	An mHealth App for Supporting Quitters to Manage Cigarette Cravings With Short Bouts of Physical Activity: A Randomized Pilot Feasibility and Acceptability Study
Hauser-Ulrich, S., et al.	A Smartphone-Based Health Care Chatbot to Promote Self-Management of Chronic Pain (SELMA): Pilot Randomized Controlled Trial
Hoepfner, B. B., et al.	Leveraging Positive Psychology to Support Smoking Cessation in Nondaily Smokers Using a Smartphone App: Feasibility and Acceptability Study
Thomas, J. G., & Wing, R. R.	Health-E-Call, a Smartphone-Assisted Behavioral Obesity Treatment: Pilot Study
Jongierius, C., et al.	Research-Tested Mobile Apps for Breast Cancer Care: Systematic Review
Kim, B. Y., & Lee, J.	Smart Devices for Older Adults Managing Chronic Disease: A Scoping Review
Simons, D., et al.	A Smartphone App to Promote an Active Lifestyle in Lower-Educated Working Young Adults: Development, Usability, Acceptability, and Feasibility Study
Roosan, D., et al.	Artificial Intelligence–Powered Smartphone App to Facilitate Medication Adherence: Protocol for a Human Factors Design Study
Alalwan, A. A., et al.	Examining the impact of mobile interactivity on customer engagement in the context of mobile shopping
Campbell, W., et al.	Overcoming Addictions, a Web-Based Application, and SMART Recovery, an Online and In-Person Mutual Help Group for Problem Drinkers, Part 2: Six-Month Outcomes of a Randomized Controlled Trial and Qualitative Feedback From Participants
Khoong, E. C., et al.	The Use of Technology for Communicating With Clinicians or Seeking Health Information in a Multilingual Urban Cohort: Cross-Sectional Survey
Yeung, D.	Social Media as a Catalyst for Policy Action and Social Change for Health and Well-Being: Viewpoint

Pisani, A. R., et al.	Human Subjects Protection and Technology in Prevention Science: Selected Opportunities and Challenges
Dong, Y., et al.	A Scenario Interaction-centered Conceptual Information Model for UX Design of User-oriented Product-service System
Wellsandt, S., et al.	Qualitative Comparison of Requirements Elicitation Techniques that are Used to Collect Feedback Information about Product Use
Ribeiro, N., et al.	Happy: Cancer Prevention Using Smartphones
Vos, S., et al.	From Problem to Solution: Developing a Personalized Smartphone Application for Recreational Runners following a Three-step Design Approach
Castellacci, F., & Tveito, V.	Internet use and well-being: A survey and a theoretical framework
Suh, A., & Li, M.	Digital Tracing during the COVID-19 Pandemic: User Appraisal, Emotion, and Continuance Intention
Murillo-Zegarra, M., et al.	The Effects of Mobile Advertising Alerts and Perceived Value on Continuance Intention for Branded Mobile Apps
Youssef, A. B., et al.	Digitalization of the economy and entrepreneurship intention
Liu, S., et al.	Social support, belongingness, and value co-creation behaviors in online health communities
Zhang, X., et al.	Exploring short-form video application addiction: Socio-technical and attachment perspectives
Manne, K.	How social media impacts consumer spending
Columbia Business School.	Social networks may inflate self-esteem, reduce self-control
Williams, A.	Enhancing knowledge crucial to improving energy-saving behaviors
University of Pennsylvania Annenberg School for Communication.	Social networks can motivate people to exercise more
Endert, T. V., & Mohr, P.	Smartphone screen time linked to preference for quicker but smaller rewards
Odgers, C. & Robb, M. B.	Tweens, Teens, Tech, and Mental Health: Coming of Age in an Increasingly Digital, Uncertain, and Unequal World, 2020
Adam, D., & Nicholson, T.	The Digital Journey

Appendix 4

Study Characteristics

Author. Date. Title of study	Country	Study design, duration , and participants	Type of data	Identified social trends/behaviour towards apps - Outcome	Relevant
Graham, A.K. et al. 2020. Implementation strategies for digital mental health interventions in health care settings	USA	Mixed-method	Non-randomized controlled Trials Subjective phone engagement Smartphone users	Digital mental health interventions (DMHIs) have been found to be effective and efficient within healthcare if implemented properly. Various implementation strategies and features are suggested, including navigation tools, user interface simplicity, and therapeutic consumer suggestion.	Yes
Schueller, S. M., & Torous, J. 2020. Scaling evidence-based treatments through digital mental health.	USA	Quantitative	Non-randomized studies	Digital mental health implementation is denoted to have a large amount of unrealized potential. 82% of America has a smartphone. Evidence based treatments have potential if digital health implementation strategies have continuous growth/research. It is identified that if DHMI is combined with implementation science there is greater potential and a higher efficacy rate for DHMIs. The implementation nuances and execution gauges the quality of the mental health service delivery including device compatibility, technological literacy, user interface, etc.	Yes

McColl, L. D., et al. 2014. Peer support intervention through mobile application: An integrative literature review and future directions	Canada	Qualitative: 116 articles were found through searches out of which 23 articles were included and reviewed.	Integrative Literature Review	There are positive outcomes of technology based peer support such as phone calls, texting, and online groups. Findings showed that peer support based apps have potential for decreasing stress on individuals. The combination of peer support apps and face-to-face interventions have potential for more positive outcomes, as compared to using only one. However, results also suggest that peer support based apps are not sufficient enough to replace face-to-face interventions and other direct interventions.	Yes
Wood, A.E., et al. 2017. Reduction of Burnout in Mental Health Care Providers Using the Provider Resilience Mobile Application	USA	Mixed-method. 30 mental health care professionals used the Provider Resilience app for a month.	Experimental study: answered questionnaire based on the System Usability Scale; Provider Resilience Scale was used for measuring acceptability of the app. Professional Quality of Life-Revised IV (a 30-item self-reporting measure) was used to measure the effectiveness	After the usage of the Provider Resilience app for 1 month, participants appeared to be psychologically healthier, had lower levels of burnout, and average levels of Compassion Satisfaction and Compassion Fatigue/Secondary Trauma. The app was given a 79.7 score for usability on the System Usability Scale. The Professional Quality of Life Scale showed significant decreases on the Burnout and Compassion Fatigue subscales. Initial data for the Provider Resilience app suggests efficacy of digital tools in reducing burnout and compassion fatigue.	Yes

			s of the app. There were three subscales in this tool: Burnout, Compassion Fatigue/Secondary Trauma, and Compassion Satisfaction.		
Kolenik, T., & Matjaž, G. 2021. Intelligent Cognitive Assistants for Attitude and Behavior Change Support in Mental Health: State-of-the-Art Technical Review	Slovenia	Qualitative: 10 papers reviewed	State-of-the-Art Technical Review of Intelligent Cognitive assistant (ICA) technology used for attitude and behaviour change for people with stress, anxiety and depression (SAD).	The most successful systems of approach for eliciting attitude and behaviour change in users expressing SAD are: Comprehensive user models, classification-based assessment, personalized intervention, and dialogue tree conversational models.	Yes
Hsiao, M. H. 2018. A conceptual framework for technology-enabled and technology-dependent user behavior toward device mesh and mesh app	Taiwan	Qualitative	Literature review Conceptual framework to understand the use of the mesh device and app	Mesh apps are able to predict people's needs by gathering contextual data on personal daily patterns. The app is then able to provide info or services across devices. The use of such apps is affected by the motivation levels of such users and not only the technology.	No

Alqahtani, R., & Orji, F. 2020. Insights from user reviews to improve mental health apps	Canada	Qualitative: 106 mental health apps from App store and google play were considered. 13 549 reviews were analyzed.	Literature review of user reviews of mobile apps for mental health issues	Users preferred apps with more user interface and friendliness, and a variety of options, functionalities and content to choose from. Poor usability was the most prominent cause for preventing usage of mental health apps. Lack of content variety, personalization, customer service, trust, security and privacy issues were other reasons for lack of usage. Future technology may offer the potential to predict the mental health needs of users ahead of time.	Yes
White, B. K., et al. 2016. Designing evaluation plans for health promotion mHealth interventions: a case study of the Milk Man mobile man	Australia	Qualitative	Case Study; Randomized Control Trial	Challenges for mHealth interventions include privacy and data security; more evidence for the effectiveness of the intervention and sustainability of the intervention beyond funded projects. The incorporation of a comprehensive analysis of such interventions will allow for a greater understanding of how mHealth can be best used. Evaluation plans are needed to help guide health promotion practitioners working in mHealth to ensure effectiveness of apps.	Yes
Naar, S., et al. 2018. Innovative study designs and methods for	USA	Qualitative, methods used at 2-day health	Literature review The paper is based on a workshop.	New and more effective approaches to drive behavioural change needs to be developed and tested in real-world settings. Currently effective and	Yes

optimizing and implementing behavioral interventions to improve health		workshop		proven interventions need to be more widely implemented in clinical practice and community. The use of hybrid designs for trials can reduce the science-practice gap. Integrating clinical trials in real-world settings can help decrease this gap. There are three types of hybrids that have varying priorities; Type 1 hybrid prioritizes effectiveness primarily and implementation secondarily; Type 2 hybrid prioritizes effectiveness and implementation equally; Type 3 hybridization prioritizes implementation primarily and effectiveness secondarily.	
Wright, C. J. C, et al. 2019. Barriers and opportunities in the translation of mobile phone and social media interventions between research and health promotion practice in Australia: a qualitative study of expert perspectives	Australia	Qualitative: 9 technology based experts and 9 health promotion experts	Observational study: interviews with experienced researchers in technology based interventions and health promotion experts	For technology-based prevention interventions to succeed, it is vital that translation is prioritized by both researchers and practitioners. Competing priorities, resource limitation and organisational capacity are important for the use of evidence in program planning, engagement in translation and evaluation practice.	Yes
Li, M., et al. 2017. Expert	China	Qualitative: 120	Experimental Study	The virtual advisor identity influences the cognitive and	Yes

or peer? Understanding the implications of virtual advisor identity on emergency rescuer empowerment in mobile psychological self-help services		emergency rescuers; A tool developed to help emergency rescuers through using a mobile psychological self-help tool.	with three phases: watching a video describing the virtual ERMS, demonstrating rescuers how to use virtual advisory system, and completing a questionnaire	emotional state of the rescuer through empowering them. It does this through providing them with a stronger sense of social presence and a better feeling of inner resonance.	
Mirzaei, T., & Esmailzadeh, P. 2021. Engagement in online health communities: Channel expansion and social exchanges	USA	Qualitative; survey data from 348 participants	Observational study: survey data analysis perceived channel richness, social support, and willingness to exchange information on online health communities (OHC).	Perceived channel richness positively influences OHC engagement. This is due to the positive effects of OHC on the expectation of information support and the expectation of emotional support. Patient willingness to share and seek information is affected by health status. Engagement in OHCs enhances self-care efficacy and perceived health outcomes. Social support may increase members' engagement and information exchange in OHCs. Administrators of OHCs need to improve the usefulness and credibility of the health information exchange and highlight emotional and informational support from others.	Yes
Dini, G., et al. 2014.	Italy	Qualitative	Literature Review	Findings show that the pure Q & A interface is the most	No

Social and Q&A interfaces for app download				effective in minimizing users' incoherent behaviours and the difference in reputation rankings significantly influence users.	
Bauer, M., et al. 2020. Smartphones in mental health: a critical review of background issues, current status and future concerns	Germany	Qualitative	Literature Review	Psychiatry based technology should focus on automating functions that will provide patients with a variety of methods to access and use the technology to best fit the patients' lifestyles and budget. Patients prefer different types of consumer technologies.	Yes
Hwang, W. J., et al. 2020. Research Trends on Mobile Mental Health Application for General Population: A Scoping Review	Korea	Quantitative; 14 studies analyzed; 13 experimental with 71.4% randomized control trials.	Systematic scoping review; the effects and results of mental health mobile apps for the general adult population were examined	Stress, anxiety and depression decreased when using mental health apps. Apps based on theoretical knowledge and well-designed research are lacking. Most developed apps for mental health are designed to target subjects who already have mental health problems or to support clinical treatments. There is a lack of research on the lasting effects of mobile app interventions. The rate of prolonged use of mHealth apps was low, ranging from two weeks to six months. The development of mHealth apps was driven by commercial and economic motives rather than scientific ones.	Yes
Birkmeyer,	Germany	Qualitative	Observation	The user's general attitude	Yes

S., et al. 2021. Determinants of mHealth success: An empirical investigation of the user perspective		ve; survey data from 263 users from an internet forum were collected	Study: Users of the mHealth app, MyFitnessPal, were surveyed	towards mHealth overall affects the success of the app. The user satisfaction, which is driven by the design of the app also impacts the success. Social networking has a moderate effect on user satisfaction. Overall user satisfaction has a strong positive influence on the continuous usage of mHealth apps.	
Li, M., et al. 2021. Meaningful gamification for psychological empowerment: exploring user affective experience mirroring in a psychological self-help system	China	Mixed-method; 27 participants	Semi-structured interviews, experience sampling experiment and user bio data triangulations	Users preferred a gamified psychological self-help system that could echo the user's facial expressions in real time. They were perceived as more trustworthy, empathetic and capable of providing better advice. The use of a visual impact metaphor-based (VIM) system was considered more empowering, allowing users to gain more control over their emotional well-being. The system improved stress and increased perceived level of happiness.	Yes
Grace-Farfaglia, P. 2019. Social Cognitive Theories and Electronic Health Design: Scoping Review	USA	Qualitative: 161 web-based interventions reviewed from January 2006 to April 2016.	Systematic scoping review: studies were analyzed for quality and coded for type of social design	"Less than half of the studies looked at social support and motivational needs (43.8%), with most relying on the internet for the delivery of tailored content for individual participants. Many studies did not recommend expressive interaction tools, like goal setting or user-centred design." 48.6% of studies reviewed	Yes

				<p>had expressive interaction tools which were categorized as a strong tool. 43.8% of studies addressed participant social support and motivational needs. 100% of studies relied on the web for providing informational aid. 75.9% of the studies tailored content for the individual participant.</p>	
<p>Stiles-Shields, C., et al. 2017. Exploring User Learnability and Learning Performance in an App for Depression: Usability Stud</p>	USA	Mixed-method; 20 participants	<p>Experimental data: 20 participants did an in-lab usability testing of the Thought Challenger app, which is a skill-building app that is an intervention in cognitive therapy. Learnability and performance was measured. Comparison was drawn between individuals with no or mild depression with those with moderate to severe depression.</p>	<p>The app elicited thought record entries that met the standard of accurately reflecting Cognitive Therapy thought records. 75% of the entries met this standard. The app was further able to impact learning without requiring users to read or engage with didactic content. CT knowledge and skills improved after Thought Challenger usage ($P=.009$). Thus, Thought Challenger was successful in helping users with cognitive restructuring. This reasoning can be generalized to all apps, proving that apps can provide users with the ability to learn intervention skills.</p>	Yes

Bruehlman-Senechal, E., et al. 2020. Smartphone App to Address Loneliness Among College Students: Pilot Randomized Controlled Trial	USA	Mixed Method; 221 first-year college student	Randomized control study; Intention-to-treat analyses were used to compare self-assessed loneliness, depressive symptoms, and other mental health issues at week 0 and then week 4.	There were no significant effects of the application on participants' levels of loneliness, mental health issues or college adjustment difficulties. The app had a significant effect on students with an elevated risk for loneliness and depression by preventing them from experiencing mid-semester depressive symptoms and loneliness. It also protected against poor sleep quality, reduced social support and reduced belonging on campus. Students with no elevated risk of depression or loneliness did not elicit significant benefits from the Nod app. However, there is still some initial evidence of the app's benefit for vulnerable students.	Yes
Bucci, S., et al. 2018. Early Psychosis Service User Views on Digital Technology: Qualitative Analysis	United Kingdom	Qualitative: 21 semi-structured interviews with individuals who registered for early intervention for psychosis services.	Framework analysis was done with collected data. Things that were analyzed included: acceptability of technology for treating psychosis and mental health issues, increasing access to mental health	The users' were mostly positive about the use of DHIs, and believed it was a progressive and modern platform to help with mental support. Some users were concerned about having privacy and data security being breached, so those are areas that can continue to be developed. Findings show that DHIs were perceived as destigmatizing, overcoming barriers of traditional interventions, facilitating communication and empowering to users.	Yes

			support using technology, barriers to adopting digital health interventions (DHI), and safety and security concerns. The blending of digital health interventions with face-to-face interventions and empowerment through these mediums were also considered.		
Wesselman, L. M., et al. 2019. Web-Based Multidomain Lifestyle Programs for Brain Health: Comprehensive Overview and Meta-Analyses	Netherlands	Mixed-method, meta-analysis of studies describing Web-based lifestyle programs	Meta-analysis of studies describing Web-based lifestyle programs User evaluations Program characteristics (target population, duration, frequency, tailoring, platform, availability) Results of	There were 14 Web-based multidomain lifestyle programs discovered that were focused on optimizing brain health. Even though the programs were heterogeneous in nature, they all were able to positively influence brain health outcomes and were able to contribute to the prevention of dementia.	Yes

			program evaluations (effectiveness, user evaluations, and adherence)		
Lo, B., et al. 2020. Surveying the role of analytics in evaluating digital mental health interventions for transition-aged youth: Scoping review	Canada	Mixed-method: review of current literature regarding digital mental health innovations	Systemic Review	There was variability and heterogeneity helps to evaluate digital mental health interventions for youth. There is an increasing trend of user analytics being added into the apps. There are still existing gaps related to selecting metrics to measure user engagement, which will be investigated in future studies. Current papers that look at analytics for mHealth apps are not looking at the adoption of technology into interventions. Real world engagement with mHealth apps is relatively low and thus understanding adoption will help with this.	No - results are not useful in understanding social perceptions of the app
Parsons, C. E., et al. 2020. Smartphone Monitoring of Participants' Engagement With Home Practice During Mindfulness-Based Stress Reduction: Observational	Denmark	Mixed-method, 25 participants used a new smartphone app designed to present participants with home practice guides (e.g.	Observational Study	Participants listened to a median of 3 of the 6 total practice sessions and didn't have a routine or regular time. They would practice most frequently in the morning, whereas the peak practice time was in the evening for weekends. In the future, it is feasible to integrate a monitoring approach into mindfulness interventions in order to provide user insights.	Yes

Study		body scan, seated meditation, and yoga)			
Qu, C., et al. 2020. Functionality of Top-Rated Mobile Apps for Depression: Systematic Search and Evaluation	United Kingdom	Quantitative	Systematic review of top-rated mobile apps for depression, with a look at app functionality and the app intervention techniques	Currently available apps for depression provide a wide array of functionality in order to help users across a range of age groups. There is still the need for guidelines to ensure that users' privacy and safety are protected while using the apps. This may include making clear the target population, or considering potential risks like non validated tools and the expression of negative emotions. Most of the apps have evidence based interventions while a few apps use clinical input.	Yes
Rubanovich, C. K., et al. 2017. Health App Use Among Individuals With Symptoms of Depression and Anxiety: A Survey Study With Thematic Coding	USA	Qualitative, survey of 176 people, largely white middle-aged females from the Midwest region of the US regarding the usage of health apps. Participa	Observational Study	Over 3/4 (about 77.8%) of participants had at least one of 285 reported health app on their devices, with the top 3 being exercise, fitness, and heart rate monitors (52.8%); diet, food, or calorie counting apps (36.9%); and mental health/wellness apps (26.1%). The mean number of apps was 2.15 (SD 3.195). 92.8% of the apps were free. 62.6% of the participants reported using health apps on a daily basis. Tracking health related data was the most common reason for using such apps.	Yes

		nts complete d online questionn aires on depressio n and anxiety, mental health treatment seeking behaviou r, mobile device use, and use of mHealth apps.		Training and habit building was the most common reason for using mental health apps.	
Hartin, P. J., et al. 2016. The Empowering Role of Mobile Apps in Behavior Change Interventions: The Gray Matters Randomized Controlled Trial	Ireland	Quantitat ive; 102 participa nts in experime ntal group; 42 in control group; interventi onal randomiz ed controlle d trial with random assignme nt into a treatment and control group measurin g user behaviou	Randomized control trials; experimenta l group used an app to encourage and help with behaviour change to prevent Alzheimer's disease	The app was successful in being a medium for intervention. It was able to use educational intervention material while also monitoring and encouraging positive behaviour change. Increased app exposure had a significant effect on clinical measurements.	Yes

		r on a "Gray Matters" mobile app			
Huberty, J., et al. 2019. Characteristic s and usage patterns in a convenience sample of paid subscribers to calm meditation app: Cross-section al survey	USA	Quantitat ive survey of 12151 paying Calm subscribe rs between 18-96 years old. Question naires relating to user engagem ent, reasons for using calm, and the effects of the app. Sleep issues, chronic health issues and demogra phics were also assessed.	Observation al Study	The top reason for using calm is mental health and sleep issues. The sleep stories and meditations are the most popular features of the app. Findings showed the frequency of using Calm was associated with changes in outcomes.	Yes
Iribarren, S. J., et al. 2021. Effectiveness of Mobile Apps to Promote	USA	Quantitat ive, literature search was conducted	Systematic Review and Meta-analysis	There is an increase in the evaluation of apps aimed at modifying behaviour to promote health. However, there is currently low evidence that these apps	Yes

Health and Manage Disease: Systematic Review and Meta-analysis of Randomized Controlled Trials		d in 7 databases , extracted the study characteristics		can truly improve health outcomes.	
Mitchell, M., et al. 2017. Uptake of an Incentive-Based mHealth App: Process Evaluation of the Carrot Rewards App	Canada	Quantitative; data was collected over a 3 month period; the data of 67, 464 users was analyzed	Observational Study	The majority of app users were female. Findings show that loyalty points may promote the usage of mHealth apps. Therefore, the use of incentives in promoting healthy habits is a possibility for the future. An issue with mHealth apps is the development of personalized interventions that can help individuals maintain healthy lifestyles.	Yes
Widnall, E., et al. 2020. User Perspectives of Mood-Monitoring Apps Available to Young People: Qualitative Content Analysis	United Kingdom	Qualitative content analysis; 53 mood monitoring apps were analyzed	Systematic Review	<p>Eight themes discovered in positive user reviews include accessibility, flexibility, recording and representation of mood, user requests, reflecting on mood, technical features, design and health promotion. These are likely to be the main features of engagement for mood-monitoring apps appropriate for young people under the age of 18.</p> <p>Findings show that users prefer apps that personalize their needs, have a simple design, have an accurate representation and review of fluctuation moods. The</p>	Yes

				reviews on the app store were found to be a valuable resource to understand user engagement feedback. 20% of users see mood-monitoring apps positively but also mention that there is room for improvement.	
Kelly, P. J., et al. 2020. Feasibility of a Mobile Health App for Routine Outcome Monitoring and Feedback in Mutual Support Groups Coordinated by SMART Recovery Australia: Protocol for a Pilot Study	Australia	Mixed-Method: subjects receiving a nonrandomized, prospective, single-arm trial of the Smart Track app; 100 participants; 2 week and 2 month follow-up	Observational Study ROM data collected from group participants via the Smart Track app Data analytics summarizing user interactions with Smart Track Quantitative interview and survey data of group participants (baseline, 2-week follow-up, and 2-month follow-up) Qualitative interviews with group participants (n=20) and facilitators (n=10).	This paper describes a stage 1 pilot study designed to examine the acceptability of mHealth routine outcome monitoring and feedback app.	No

Alam, M. M. D., et al. 2021. Factors influencing mHealth adoption and its impact on mental well-being during COVID-19 pandemic: A SEM-ANN approach	Bangladesh	Mixed Method	Observational Study	Performance expectancy, effort expectancy, social influence, hedonic motivation and facilitating conditions have a positive effect on the behavioural intention. Health consciousness has an effect on intention to use and actual usage behaviour as well. Overall, the use of mHealth based interventions has a meaningful impact on the mental well-being of its users.	No
Tuarob, S., et al. 2017. How are you feeling?: A personalized methodology for predicting mental states from temporally observable physical and behavioral information	USA	Mixed Method machine learning system to predict user mental states	Observational Study Questionnaire to measure attributes to represent measures of mental and physical conditions of human participants (e.g. hours of sleep)	The study is a first step in developing medical applications that could automatically gauge the mental state of individuals.	No
Wasil, A. R., et al. 2020. Reassessing evidence-based content in popular smartphone apps for depression and anxiety: Developing and applying user-adjusted	USA	Mixed method	Observational Study	Mental health apps' impact on mental health may be best evaluated through a combined tally of evidence-based content with data on the content users are actually accessing. Given wide variation in the popularity of MH apps, findings weighted by usage data may differ markedly from findings based on raw tallies alone.	Yes

analyses				The top 2 apps on Apple store and Play store had 90% of the monthly active users. 37% of all mental health apps included mindfulness but it reached 96% of mental health app users; 22% of apps had cognitive restructuring interventions but it only reached 2% of its users; 7% of apps had exposure but it reached only 0.0004% of the users	
Dennison, L., et al. 2013. Opportunities and Challenges for Smartphone Applications in Supporting Health Behavior Change: Qualitative Study	United Kingdom	Qualitative; 19 university students and staffs participated in 4 focus groups	Observational Study	Participants believed that accuracy and legitimacy, security, effort required, and immediate effects on mood would affect their app usage, as well as the ability to record and track behavior + goals and learn new information. There is some interest in using apps that support health-related behaviour change. Context sensing and social media features were perceived negatively.	Yes
Kennedy, C. M., et al. 2012. Active Assistance Technology for Health-Related Behavior Change: An Interdisciplinary Review	United Kingdom	Qualitative interdisciplinary literature review	Literature review	There are potential risks and capabilities of assistant technologies that still need to be explored in the behaviour change research. How dynamic and adaptive information processing is being used for behavior change interventions	Yes
Zhao, J., et al. 2016. Can	Australia	Quantitative	Literature Review	Some features make apps better, such as less time	Yes

Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review		evidence review; 41 articles included in the review	Studies that report statistically significant effects towards behavior change	consumption, user-friendly design, real-time feedback, individualized elements, detailed information, and health professional involvement. Empathy and relational behaviour are major research themes for behaviour change research. These factors have been shown to have a positive effect on behaviour. However, it was found that too much interaction can inhibit positive health behaviours. The review also found that there are not many interventions focusing on dynamic tailoring, interactive education, and self-monitoring.	
Hicks, J. L., et al. 2019. Best practices for analyzing large-scale health data from wearables and smartphone apps	USA	Qualitative	Observational Study	Majority of users- 75% - re-engage with apps after extended periods of dormancy. The health status of these users after re-engagement returned to the same as when they first started using the app. Users were categorized on their app usage into occasional, basic and power users. Power users showed the most changes. For social network challenges and competitions, findings show that men are affected by the performance of other men and women, but women are affected only by the performance of other women. Users were also	Yes

				more likely to lose weight when they more networks with members of the opposite sex.	
Anderson, K., et al. 2016. Mobile Health Apps to Facilitate Self-Care: A Qualitative Study of User Experiences	Australia	Qualitative Study; 22 participants who used Health apps	Observational Study; semi-structured interviews. Apps monitored diabetes, asthma, depression, celiac disease, blood pressure, chronic migraine, pain management, menstrual cycle irregularity, and fitness.	Findings show that self-management can be improved through the use of health apps for chronic conditions. However, self-management through apps requires constant stimulation to accommodate changing requirements and well-being. Some users with chronic conditions such as diabetes, depression, weight and sleep management issues were recommended only fitness apps and not disease specific apps. Benefits of using gamification have also been reported.	Yes
Aydin, G., & Silahtaroglu, G. 2021. Insights into mobile health application market via a content analysis of marketplace data with machine learning	Turkey	Quantitative; investigating 1000 apps	Observational Study	The findings suggest that apps that mention a privacy policy or provide videos in description lead to higher user scores, whereas free apps with in-app purchase possibilities, social networking and sharing features and feedback mechanisms lead to higher number of downloads.	Yes
Champion, L., et al. 2018. The efficacy of a	United Kingdom	Quantitative randomized	Randomized Control Study; Experiment	The use of the mindfulness meditation app (MM) "Headspace" led to positive satisfaction with life, stress,	Yes

brief app-based mindfulness intervention on psychosocial outcomes in healthy adults: A pilot randomised controlled trial		controlled trial of 38 students for experimental group and 36 for control group. Study was done for a period of 10 or 30 days.	al study	and resilience, and protected against perceived stress by the 10th day. There were more improvements by the 30th day. The rate of improvement was the highest on the 10th day as well and dropped by the 30th day. Users that found the app the easiest to interact with had the highest self-reported benefits.	
Cor, E., & Zwolinski, P. 2014. A Procedure to Define the Best Design Intervention Strategy on a Product for a Sustainable Behavior of the User	France	Mixed method; the energy and water consumption during the use phase of 36 espresso coffee machine users were measured , as well as environmental knowledge, attitude, and habits	Experimental user data measured from the use of coffee machines experiencing different design intervention strategies	The environmental impacts slowly decrease with new usage of the product.	No

Lee, S. K. A. 2018. Classification of SmartMental Tech Services and Application for Comprehensive Mental Healthcare Stepped-Care Model (CMHSCM): Health Psychological Approach	Japan	Quantitative research method through distribution of a QR code to SmartMentalTech users; 264 participants; 2 months duration	Observational Study Survey questionnaire data	SmartMentalTech can be used as a readily accessible user technology, especially in locations like South Korea and Japan where traditional mental health systems are not accessible due to social stigma. Apps like this can be used as interventions for mental health problems until professional help can be substituted. Additionally, it can influence caregivers' decisions to implement the tech in a stepped-care system. South Korean participants preferred wearable devices, big data, AI and robots. Big data and e therapy were preferred by Japanese. Findings show that users do not know the best technology for their problems. Overall, the study claims that Smart Mental Health Technology needs to be promoted as a readily accessible solution for users.	Yes
Almeida, A. M. P., et al. 2018. Mobile solutions in depression: enhancing communication with patients using an SMS-based intervention	Portugal	Qualitative research method testing a Short Message Service (SMS) method to improve communication	Observational Study	There is a demand for improving clinical communication between patients and health professionals, and mobile solutions like SMSs can help patients with depression access personalized interventions. However, personal support and contact should be used in conjunction with these digital tools. The study claims that	Yes

		with patients that have depression. There were 4 stages; 1st stage had 36 patients and 11 health professionals; stage 2 had 15 patients with depression; stage 3 had 143 physicians.		complementary approaches that allow better communication between physicians and patients are useful. The pairing of mobile interventions and face-to-face support is beneficial.	
Shafinah, K., et al. 2013. Determinants of User Behavior Intention (BI) on Mobile Services: A Preliminary View	Malaysia	Qualitative experiment	Methodology	The most important factors for mHealth applications are the ease of use, cost, risk/security, and trust.	No
Clough, B. A., & Casey, L. M. 2015. Smart designs for smart technologies: Research challenges and emerging solutions for	Australia	Mixed methods	Methodology, Single Case Research (SCR) design	No outcomes relevant to our research question. The development of e-mental health requires a greater diversity of flexible, time-effective research designs. These strategies within this paper can help patients receive mental health interventions that are backed with evidence, as	No

scientist-practitioners within e-mental health				well as a variety of treatment methods (e.g. CBT, acceptance and commitment therapy, depression, anxiety, substance use).	
Clough, B. A., & Casey, L. M. 2015. The smart therapist: A look to the future of smartphones and mHealth technologies in psychotherapy	Australia	Qualitative	Literature Review	Findings show that users want to engage in mHealth interventions, however there is only a limited number of evidence based mHealth interventions. SMS have been shown to have a positive effect on the continuation of treatment benefits once the treatment program is finished. Ecological momentary assessment techniques also show high rates of acceptability and feasibility for interventions.	Yes
Marshall, J. M., et al. 2020. Smartphone psychology: New approaches towards safe and efficacious mobile mental health apps	Australia	Qualitative, involves the proposal of a new approach to incorporate multiple baseline single-case designs to guide larger-scale randomized controlled trials	Literature Review	The dependency of current research on the ratings and reviews from the application stores is not reliable. There are also a lot of mental health apps that don't derive their interventions from evidence based psychology that can be ineffective and harmful. There exists a need for mental health app users to be able to identify safe and effective solutions. Thus, research into effectiveness and safety needs become more visible.	Yes

Fuentes-Blasco, M., et al. 2014. Effect of customer heterogeneity on the relationship satisfaction–loyalty	Spain	Mixed method, analyze heterogeneous shopping patterns with statistical methods	A quantitative investigation and questionnaire	Study is not relevant to our research question. The paper discusses customer behaviour in retail settings.	No
Bailon, C., et al. 2019. Smartphone-Based Platform for Affect Monitoring through Flexibly Managed Experience Sampling Methods	Spain	Mixed method, analyze the time of questionnaire response as well as the affective states of app users	Observational study	Study is not relevant to our research question. The response rate to surveys about affective states increases throughout the day, as does the amount of time participants take to open the survey. The app tested in this experiment is highly usable as a result of good user interface and accessible app options.	No
Lin, X., & Kishore, R. 2021. Social media-enabled healthcare: A conceptual model of social media affordances, online social support, and health behaviors and outcomes	USA	Qualitative	Literature Review	The paper suggests that there are three different types of social support: informational support, emotional support, and experiential support. Social media fosters social support; User interaction fosters emotional support; social learning fosters experiential support. Self-care is impacted by informational support and experiential support. Psychological health is affected by informational and emotional support.	Yes
Iowa State University. 2015. Mobile	USA	Qualitative	Science Daily News article	More than half of apps downloaded are deleted after one use, making first	Yes

apps and online reviews influence consumer behavior				impressions an important feature. Product reviews and social media posts have an impact on the perception of apps and their brand.	
Common Sense. 2021. Coping with COVID-19: How Young People Use Digital Media to Manage Their Mental Health	USA	Mixed-method	Common sense media report	No outcomes relevant to our research question	No
Extreme Marketing Team. 2021. Mobile User Engagement Apps – Trends and Requirements	N/A	Mixed-method	Extreme network news article	The most desirable feature for apps are those that involve information sharing.	No
Nilsson, B. 2018. How apps can increase student engagement	N/A	Qualitative	ecampus news article	Information sharing is the most desirable feature for apps.	No
O'Dowd, E. 2017. How to Build a Successful Healthcare Mobility Solution	N/A	Qualitative	Hit Infrastructure news article	No outcomes relevant to our research question	No