

# Personalized Digital Solutions for Mental Health

Jorge ROPERO<sup>a,1</sup>, Kerstin DENECKE<sup>b</sup>, Octavio RIVERA-ROMERO<sup>a,c</sup> and Elia GABARRON<sup>d,e</sup>

<sup>a</sup>Department of Electronic Technology, Universidad de Sevilla, Seville, Spain

<sup>b</sup>Bern University of Applied Sciences, Bern, Switzerland

<sup>c</sup>Instituto de Investigación en Informática de la Universidad de Sevilla, Seville, Spain

<sup>d</sup>Department of Education, ICT and Learning, Østfold University College, Halden, Norway

<sup>e</sup>Norwegian Centre for E-health Research, Tromsø, Norway

ORCID ID: Jorge Ropero <https://orcid.org/0000-0001-5445-0646>, Kerstin Denecke <https://orcid.org/0000-0001-6691-396X>, Octavio Rivera-Romero <https://orcid.org/0000-0001-7212-9805>, Elia Gabarron <https://orcid.org/0000-0002-7188-550X>

**Abstract.** *Introduction:* Mental health is one of the major global concerns in the field of healthcare. The emergence of digital solutions is proving to be a great aid for individuals suffering from mental health disorders. These solutions are particularly useful and effective when they are personalized. The objective of this paper is to understand the personalization factors and the methods that have been used to collect information to personalize the digital mental health solutions. *Methods:* This paper builds on a previous review that analyzed the personalization of digital solutions in mHealth, and expands on the extracted information for the specific case of mental health. *Results:* Ten mental health digital solutions have been analyzed. The paper focuses on targeted conditions, personalization factors and the methods used for collecting personalization factors. *Discussion:* The analyzed mental health digital solutions cover a wide range of health conditions. It is remarkable that most articles do not explicitly mention the factors used to personalize the solution. Among the solutions that mention them, there is a great diversity of factors utilized, such as age, gender, user preferences, and subjective behavior. The authors point out the methods for obtaining data to personalize the solutions, including in-app questionnaires, self-reports, and usage data of the solutions. *Conclusions:* The analysis of current mental health digital solutions emphasizes the need to create guidelines for designing personalized digital solutions for mental health.

**Keywords.** Mental health; Personalized health; mHealth; Digital health

## 1. Introduction

The use of mobile health solutions such as apps or wearable devices for promoting wellbeing has significantly grown in last years. These mobile solutions have

---

<sup>1</sup> Corresponding Author: Jorge Ropero, Department of Electronic Technology, Universidad de Sevilla, Av. Reina Mercedes s/n, 41012 Sevilla, Spain, E-mail: [jropero@us.es](mailto:jropero@us.es).

characteristics and capabilities such as built-in sensors, ubiquity, communication, etc. that enable the provision of cost-effective just-in-time health services supporting individuals in real settings. However, users' adoption and engagement with these solutions are often low. Therefore, the implementation of personalization techniques might increase individual motivation and engagement with the use of these solutions [1,2]. The emergence of these personalized digital solutions could represent a great aid in mental health [3]. Mental health is one of the most important global health concerns: 1 in every 8 people worldwide live with a mental health disorder [4], and the burden of mental disorders is increasing worldwide [5]. However, there is limited information available on the personalization of digital mental health solutions, specifically about the personalization factors used or the methods used to collect such information.

The objective of this paper is to understand the personalization factors and the methods that have been used to collect information to personalize the digital mental health solutions.

## **2. Method**

In order to understand the personalization factors and methods used to personalize the digital mental health solutions we carried out a review. That review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [6]. This paper is a secondary analysis of a broader review that we previously conducted on personalized mHealth solutions. The broader review search was carried out across PubMed, ACM Digital Library, IEEE Xplore, and PsycInfo, and focused on research on the design or development of personalized mHealth solutions. Several keywords related to "personalization", "mHealth", and "design" were used in this review. For this paper, we have specifically focused on the digital mental health solutions that were identified in that review. The inclusion criteria used to select the mHealth solutions were the following: studies referring to digital solutions related to mental health (a mobile app, wearable, or mobile information and communication technology); papers must present an mHealth solution with details (e.g., functionalities); authors must explicitly mention that the mHealth solution was personalized; studies are published in English language; and access to full text is available.

## **3. Results**

A total of 10 references specifically focusing on personalized digital mental solutions were identified in the review. These references were published between 2017 and 2022. The solutions were created for different purposes: substances reduction or cessation [7-9]; promotion of emotional wellbeing, brain, and mental health [10-12]; stress management [13,14]; to improve motivation in people with schizophrenia [15]; and for behavioral activation in individuals with depressive disorder [16].

Gender was the most commonly reported personalized factor of these digital mental solutions [10,11,14], followed by age [11,14], subjective behavior [8,10]; and users' preferences [8,11]. Other reported personalized factors were solution usage [10]; location [10]; time [10]; motivation level [11]; and user feedback [11]. In six among the ten identified solutions the personalized factors were not clearly specified in the articles [7,9,12,13,15,16]. Regarding the methods that were used for collecting the

personalization factors, the most commonly reported methods were the use of questionnaires [9,12,14]; the use of self-reporting of behaviour or mood [7,8,10]; and the users' evaluation [11,13,16]. Other methods that were used to personalize the solutions were through the use of sensors, including geolocation and accelerometer data [10]; use of phone metadata [10]; and users' selection of their own goals [15]. The features of the identified personalized solutions for mental health are presented in Table 1.

**Table 1.** Personalized digital mental health solutions

Author, year	Solution name	Targeted condition	Personalization factors	Methods used for collecting personalization factors
Cerrada et al, 2017 [8]	MyQuit USC	Smoking cessation	User preferences; Subjective behavior	Self-reported tobacco consumption
Schlosser et al, 2018 [15]	PRIME (personalized real-time intervention for motivational enhancement)	Schizophrenia	Not specified	Users self-selected long-term goals from a 36-item list; users' selection of their interests, goals, and symptoms
Ghandeharioun et al, 2019 [10]	EMMA	Emotional wellbeing	Gender; Solution usage; Subjective behaviour; Location; Time	Mood self-reports based on users answers to experience sampling five times a day using a visual grid; captured geolocation and detailed activities, accelerometer data, calls and messages metadata, and calendar events
Bell et al, 2020 [7]	Drink Less	Alcohol reduction	Not specified	Self-reported alcohol consumption
Rohani et al, 2020 [16]	MUBS	Depressive disorder	Not specified	Ratings provided by the patient on the app once an activity is completed (Activities among a 384-activity catalog)
Moreno-Blanco et al, 2021[11]	ICA (Intelligent Coaching Assistant)	Brain health	Age; Gender; Motivation level; User preferences; User feedback	The system takes the user feedback given through the app, so it learns from previous user's performance and opinion to increase the personalization
Na et al, 2022 [13]	MEndorphins	Stress management	Not specified	Users self-evaluate the suggested behaviors they have implemented
Peek et al, 2021 [9]	My QuitBuddy	Smoking cessation	Not specified	Questionnaire included in the system
Nicolaidou et al, 2022 [14]	Student Stress Resilience	Stress management	Age; Gender	Questionnaire included in the system
Stiles-Shields et al, 2022 [12]	ENERGY (Emotional Needs Evaluation and Resource Guide for You)	Mental health	Not specified	Questionnaire included in the system

#### 4. Discussion

A total of 10 digital solutions related to mental health have been analyzed in this paper to identify personalization factors used. One of the digital solutions addresses mental health in a general sense. Additionally, digital solutions for managing alcohol and tobacco addictions have been implemented as well as solutions targeting stress and emotional state management. Last, some solutions have been designed for specific diseases, such as schizophrenia and depression.

#### *4.1. Personalization factors and methods for collecting personalization factors*

Regarding the factors used to personalize the solutions, it is remarkable that a significant number of papers do not mention which factors are used for personalization. Although no specific standards or guidelines on how to report on personalized digital health solutions currently exist, we consider this as a fact to be improved in the reporting of mental health digital solutions. Among the solutions that explicitly mention personalization factors, gender, age, user preferences, and subjective behavior stand out, although there is no factor that is universally used. The identified personalization factors fit among the four dimensions identified in a previous review aimed at identifying the factors that facilitate behavior change (i.e., users, information, system functionalities, and app properties)<sup>17</sup>. Reporting details on the personalization strategies used for digital solutions are crucial for ensuring transparency, reproducibility, and trust. Such information is needed to relate clinical outcomes to the chosen methodology and to be able to judge and assess possible contraindications or adverse events caused by the chosen technology. There is still limited to no knowledge about which personalization strategies in digital health solutions cause which effects. A reporting of these aspects is therefore crucial for the progress of personalization in digital health field. Furthermore, there are different methods for obtaining personalization factors. User self-reports and questionnaires filled out by users to personalize the solution are prominent, while other solutions gather data about users' behavior by collecting usage data, ratings, or feature selection within the solution. The method of obtaining data for personalizing the solution is explicitly indicated in all the analyzed articles.

#### *4.2. More research and better reporting are needed in the field of personalized digital mental health*

Our work shows that the emerging paradigm of personalized medicine has not yet arrived in the development of personalized mental health solutions. Personalized solutions are needed to better match patient characteristics with custom-tailored treatment approaches. This conflicts with the increasing need for high-quality digital solutions in mental health given the shortage of psychologists and psychotherapists and the huge number of people suffering from mental health disorders<sup>4,5</sup>. This work shows that there is a huge need for more research in the field of personalized digital mental health. Technologies are available such as artificial intelligence for individual predictions<sup>18</sup>. However, it seems that these technologies are either not yet implemented or tested, or their use is not clearly described. The recent review by Hornstein et al. also concludes that future implementations of digital mental health solutions could provide a more personalized experience and could benefit from machine learning models<sup>3</sup>. They also confirm our observation that further evidence of the benefits of personalization in digital mental health solutions is urgently needed.

## **5. Conclusions**

The analysis of existing digital solutions for mental health underscores the need for more research and improved reporting routines. The existence of standards or guidelines that support in the design and reporting of personalized digital solutions for mental health could greatly benefit this research field.

## References

- [1] Jakob R, Harperink S, Rudolf AM, Fleisch E, Haug S, Mair JL et al. Factors influencing adherence to mHealth Apps for prevention or management of noncommunicable diseases: Systematic review. *J Med Internet Res* 2022;24:e35371. doi: 10.2196/35371
- [2] Wei Y, Zheng P, Deng H, Wang X, Li X, Fu H. Design features for improving mobile health intervention users engagement: Systematic review and thematic analysis. *J Med Internet Res* 2020;22:e21687. doi: 10.2196/21687
- [3] Hornstein S, Zantvoort K, Lueken U, Funk B, Hilbert K. Personalization strategies in digital mental health interventions: a systematic review and conceptual framework for depressive symptoms. *Front Digit Health* 2023;5:1170002. doi: 10.3389/fgth.2023.1170002
- [4] World Health Organization. Mental disorders. Key facts. 2022. Available at: <https://www.who.int/news-room/fact-sheets/detail/mental-disorders>
- [5] GBD 2019 Mental Disorders Collaborators. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Psychiatry* 2022;9(2):137-150. doi: 10.1016/S2215-0366(21)00395-3
- [6] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;n71. doi: 10.1136/bmj.n71
- [7] Bell L, Garnett C, Qian T, Perski O, Williamson E, Potts HW. Engagement With a Behavior Change App for Alcohol Reduction: Data Visualization for Longitudinal Observational Study. *J Med Internet Res* 2020;22:e23369. doi: 10.2196/23369
- [8] Cerrada CJ, Dzubur E, Blackman KCA, Mays V, Shoptaw S, Huh J. Development of a Just-in-Time Adaptive Intervention for Smoking Cessation Among Korean American Emerging Adults. *Int J Behav Med* 2017;24:665–72. doi: 10.1007/s12529-016-9628-x
- [9] Peek J, Hay K, Hughes P, Kostellar A, Kumar S, Bhikoo Z, et al. Feasibility and Acceptability of a Smoking Cessation Smartphone App (My QuitBuddy) in Older Persons: Pilot Randomized Controlled Trial. *JMIR Form Res* 2021;5:e24976. doi: 10.2196/24976
- [10] Ghandeharioun A, McDuff D, Czerwinski M, Rowan K. EMMA: An Emotion-Aware Wellbeing Chatbot. 2019 8th Int. Conf. Affect. Comput. Intell. Interact., IEEE; 2019, p. 1–7. doi: 10.1109/ACII.2019.8925455
- [11] Moreno-Blanco D, Solana-Sánchez J, Sánchez-González P, Jiménez-Hernando M, Cattaneo G, Roca A, et al. Intelligent Coaching Assistant for the Promotion of Healthy Habits in a Multidomain mHealth-Based Intervention for Brain Health. *Int J Environ Res Public Health* 2021;18. doi: 10.3390/ijerph182010774
- [12] Stiles-Shields C, Batts KR, Reyes KM, Archer J, Crosby S, Draxler JM, et al. Digital Screening and Automated Resource Identification System to Address COVID-19-Related Behavioral Health Disparities: Feasibility Study. *JMIR Form Res* 2022;6:e38162. doi: 10.2196/38162
- [13] Na H, Jo M, Lee C, Kim D. Development and Evaluation: A Behavioral Activation Mobile Application for Self-Management of Stress for College Students. *Healthc (Basel, Switzerland)* 2022;10. doi: 10.3390/healthcare10101880
- [14] Nicolaidou I, Aristeidis L, Lambrinos L. A gamified app for supporting undergraduate students' mental health: A feasibility and usability study. *Digit Heal* 2022;8:20552076221109059. doi: 10.1177/20552076221109059
- [15] Schlosser DA, Campellone TR, Truong B, Etter K, Vergani S, Komaiko K, et al. Efficacy of PRIME, a Mobile App Intervention Designed to Improve Motivation in Young People With Schizophrenia. *Schizophr Bull* 2018;44:1010–20. doi: 10.1093/schbul/sby078
- [16] Rohani DA, Quemada Lopategui A, Tuxen N, Faurholt-Jepsen M, Kessing L V., Bardram JE. MUBS: A Personalized Recommender System for Behavioral Activation in Mental Health. *Proc. 2020 CHI Conf. Hum. Factors Comput. Syst.*, New York, NY, USA: ACM; 2020, p. 1–13. doi: 10.1145/3313831.3376879
- [17] Gosetto L, Ehrler F, Falquet G. Personalization dimensions for mHealth to improve behavior change: A scoping review. *Stud Health Technol Inform* 2020;275:77-81. doi: 10.3233/SHTI200698
- [18] Lueken U, Hahn T. Chapter 17 – Personalized mental health: Artificial intelligence technologies for treatment response prediction in anxiety disorders. In Bernhard T. Baune: *Personalized Psychiatry*. Elsevier, Academic Press 2020. doi: 10.1016/C2016-0-04578-3