

Toward Precision Psychiatry: A Scoping Review of Self-Monitoring and Artificial Intelligence for Bipolar Symptom Monitoring

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Abstract

This scoping review aims to map and analyze the utilization of digital technologies, including self-monitoring applications, wearable devices, and hybrid interventions, for monitoring symptoms of bipolar disorder, as well as to explore their potential implementation in Indonesia. A systematic literature search was conducted across EBSCO Host, ScienceDirect, Oxford Academic, and Emerald Insight, focusing on studies published between 2020 and 2025 that addressed digital monitoring in individuals with bipolar disorder. The review identified ten studies that met the inclusion criteria, consisting of randomized controlled trials, mixed-methods studies, exploratory qualitative studies, pilot studies, and trial protocols. Key findings were categorized into four themes: (1) active self-monitoring via manual input or Ecological Momentary Assessment, which enhances self-awareness, promotes consistent daily routines, and supports symptom management; (2) passive monitoring and digital phenotyping using sensors and wearable devices, providing continuous objective data for early detection of relapse; (3) hybrid approaches integrating monitoring with therapeutic modules such as psychoeducation, mindfulness, and relapse prevention, which improve social functioning and treatment adherence; and (4) psychosocial factors and user engagement, highlighting the importance of personalization, peer support, inclusive language, and interactive features. Overall, digital interventions demonstrate considerable potential as a complement to conventional care by empowering patients, facilitating early detection of mood episodes, and enabling more personalized management. In Indonesia, the adoption of inclusive, evidence-based, and contextually adaptive digital strategies tailored to local digital literacy and infrastructure is expected to strengthen mental health services and sustainably enhance patient empowerment.

Keywords: Bipolar Disorder, Digital Health, Self-Monitoring, Wearable Devices, Hybrid Interventions

1. Introduction

Bipolar disorder is a mental health condition characterized by manic (or hypomanic) and depressive episodes, with a global prevalence of approximately 1–2%, affecting around 37 million people worldwide (0.5% of the global population) (WHO, 2025). According to the 2021 Global Burden of Disease Study, bipolar disorder contributes roughly 8 million disability-adjusted life years (DALYs) worldwide, with an estimated range of 5.2 to 11.5 million cases. Beyond reduced quality of life, bipolar disorder increases the risk of recurrent relapse, suicide, and comorbidities such as anxiety and substance use disorders (WHO, 2025).

Diagnosis is often delayed or inaccurate, resulting in postponed or inappropriate care. Conventional monitoring approaches that rely on patient self-reports are subjective and less sensitive to early mood changes, potentially delaying relapse detection (Murnane et al., 2023). Even when patients adhere to treatment, relapse rates remain high, likely due to the limited sensitivity of self-reports or periodic clinical assessments in detecting early mood fluctuations. An umbrella review indicated that smartphone-based self-monitoring did not significantly reduce manic or depressive symptoms in bipolar patients, highlighting the limitations of conventional monitoring in relapse prevention (Crocamo et al., 2025).

In Indonesia, mental health care faces additional challenges due to limited resources, particularly the low number of psychiatrists and uneven distribution of services. Riskesdas (2018) reported that approximately 9.8% of individuals aged ≥ 15 years experience emotional mental disorders, although the exact prevalence of bipolar disorder remains undocumented. In 2018, Indonesia had 773 psychiatrists, with 70% based on Java, resulting in one psychiatrist serving approximately 323,000 people far below the WHO recommended ratio of 1:30,000

(Ministry of Health of the Republic of Indonesia, 2020). This imbalance restricts access to adequate mental health care, particularly in remote or underserved areas

Globally, digital innovations such as mood tracking apps, wearable devices, digital phenotyping, and AI-based systems have shown promise in enhancing patient engagement, supporting treatment adherence, and enabling early relapse detection (Zhang et al., 2025; Breitinger et al., 2023). However, adoption of digital mental health interventions in Indonesia remains limited due to uneven infrastructure, low digital literacy among patients and providers, and a lack of regulatory policies. Despite these barriers, Indonesia has strong potential for digital mental health interventions, with internet penetration reaching 79.5% of the population (~221 million users) in 2024 (APJII, 2024).

Therefore, this study aims to map existing digital innovations for monitoring bipolar disorder symptoms and to analyze the opportunities and challenges for their implementation in Indonesia.

2. Research Methods

2.1 Design

This study employed a scoping review approach based on the framework of Arksey and O’Malley (2005) and the PRISMA-ScR guidelines (Tricco et al., 2018). The review systematically mapped the literature on digital interventions for monitoring bipolar disorder symptoms, including self-monitoring applications, digital phenotyping, and artificial intelligence (AI)-based systems. This approach facilitates the identification of patterns, opportunities, and challenges associated with the implementation of these interventions, particularly in the Indonesian context. The guiding research question was: “What are the forms of self-monitoring and AI-based digital interventions for monitoring bipolar disorder symptoms, and how can they be applied in Indonesia?

2.2 Search strategy and eligibility criteria

A comprehensive search of secondary sources was carried out, encompassing e-books, peer-reviewed journals, research reports, official publications from relevant institutions, and online articles related to digital monitoring in bipolar disorder. The search was performed on major academic databases, namely EBSCOhost, ScienceDirect, Oxford Academic, and Emerald Insight, using the following keywords in various combinations: “bipolar disorder,” “digital monitoring,” “self-monitoring application,” “wearable device,” and “passive monitoring.” Boolean operators (AND/OR) were applied to optimize search accuracy and relevance.

Studies were included if they met the following criteria:

- Focused on digital monitoring of bipolar disorder symptoms.
- Published between January 2020 and October 2025
- Appeared in reputable scientific journals.
- Available in full-text format.

Studies were excluded if they were abstracts only, gray literature, or did not meet the above criteria.

Table 1. Presentation of Findings

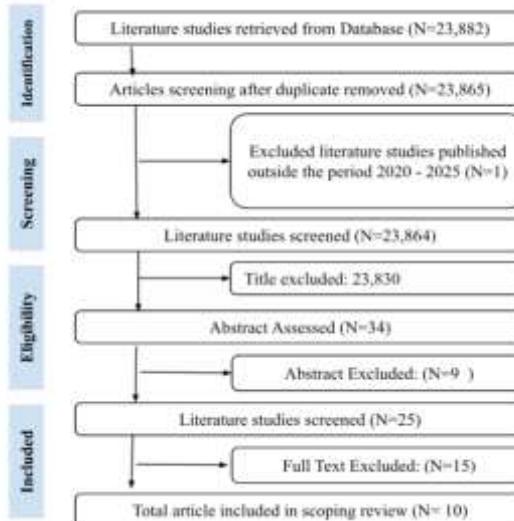
Database	Found Journal	Selected
EBSCOHost	6	6
ScienceDirect	9	2
Oxford Academic	9	2
Emerald Insight	1	-
Total	25	10

2.3 Data Extraction

Data were extracted using a structured table that included information on authors, study objectives, intervention methods, sample size, country, and key findings. This approach facilitated a clear and systematic overview of the included studies. Extraction was performed independently by two researchers with expertise in the field. Any disagreements among the researchers were addressed through discussion until a consensus was achieved.

2.4 Data Analysis and Reporting

Extracted data were analyzed descriptively to map the types of digital interventions, study characteristics, and geographical distribution. Thematic analysis was employed to identify recurring patterns, as well as the challenges and opportunities for implementing digital interventions in Indonesia. The article selection process was visually represented using a PRISMA-ScR flow diagram, showing the number of studies identified, screened, and finally included in the review.



3. Results and Discussions

3.1 Overview of Included Studies

A total of 10 studies published between 2020 and 2025 were included in this scoping review. The study designs varied considerably, comprising three Randomized Controlled Trials (RCTs), two mixed-methods studies, two exploratory qualitative studies, two pilot feasibility/proof-of-concept studies, and one trial protocol. Most studies were conducted in high-income countries, with the majority of participants being adults diagnosed with Bipolar Disorder type I or II. The digital technologies investigated included active self-monitoring applications, wearable devices for passive monitoring, sensor- and GPS-based digital phenotyping, and Digital Health Interventions (DHI) incorporating psychosocial recovery approaches.

Table 2. Extraction data

No	Author	Sample	Design	Intervention	Key Findings
1.	Polhemus et al. (2022)	A total of 783 user reviews from 26 depression-tracking applications	Qualitative content analysis	Mood tracking applications and data visualization in mHealth apps	<ul style="list-style-type: none"> 1. Tracking via the apps enhances self-awareness, self-structure, and enables self-management of symptoms. 2. Users prefer flexible and customizable features. 3. The main barriers are technical issues and paywalls, which hinder continued use.
2.	Jagfeld et al. (2023)	4.462 posting dari 1.982 pengguna Reddit dengan self-reported bipolar disorder diagnosis	Mixed-methods: Corpus Linguistic + NLP + Framework Analysis (POETIC)	Analysis of online conversations on Reddit forums related to personal recovery.	<p>Discussions of personal recovery were most frequently related to</p> <ul style="list-style-type: none"> 1. Purpose & Meaning (reproductive decisions, employment), 2. Connectedness (romantic relationships and social

					<p>support), and</p> <p>3. Empowerment (self-management and personal responsibility). This study validated the POETIC Framework and revealed new aspects not captured in interview-based studies.</p>
3.	Pahwa et al. (2023)	122 patients with Bipolar I/II (aged 18 years and older) from three academic centers in the United States.	Open-label randomized controlled trial (RCT) with an active comparator, 52 weeks.	KIOS app (self-monitoring with personalized feedback) vs. eMoods (monitoring without feedback).	<p>1. Higher adherence/persistence was observed with KIOS (84.4%) compared to eMoods (54%) at 52 weeks.</p> <p>2. User satisfaction was higher with KIOS (Cohen's $d = 0.41$).</p> <p>3. No significant differences in clinical symptoms (BISS) were found between the two groups.</p> <p>4. Notification and personalized feedback features were identified as potential engagement factors.</p>
4	Faurholt-Jepsen et al. (2023)	201 adult patients with bipolar disorder receiving outpatient care in Denmark	Randomized Controlled Trial (Protocol), parallel-group (1:1:1)	Smartphone-based monitoring using the Monsenso app with three groups: 1. Monitoring with a clinical feedback loop 2. Monitoring without feedback 3. Mood monitoring only	<p>No final results yet (ongoing trial). Outcomes to be measured:</p> <p>1. Primary: Mood instability (rMSSD from daily data)</p> <p>2. Secondary: Quality of life, depressive and manic symptoms (self-reported), stress, service satisfaction, hospitalization, length of stay</p> <p>3. Tertiary: Daily data: stress, anxiety, irritability, activity, sleep, medication adherence, adherence to self-monitoring</p>
5	Sigurðardóttir et al. (2022)	21 patients (9 with Bipolar Disorder, 12 with Schizophrenia) — 6 weeks of use	Mixed-methods study (quantitative + qualitative)	DataWell platform + Withings Steel HR smartwatch + mobile app with 5 daily questions	<p>1. Patients reported increased self-awareness and motivation by monitoring their own data.</p> <p>2. Empowerment improved “seeing my own data felt rewarding.”</p> <p>3. Sharing data with healthcare providers was viewed positively.</p> <p>4. The smartwatch helped establish routines, particularly for sleep and activity.</p> <p>5. The importance of inclusive and empathetic language within the app was emphasized.</p>

6.	Breitinger et al. (2023)	90 participants (28 with Bipolar Disorder I/II, 49 with Major Depressive Disorder, 32 healthy), aged 18–65 years	Pilot feasibility study (longitudinal, multisite)	MindLAMP app combined with wearables (Apple Watch, Oura Ring, Willful Smartwatch) → collection of passive and active digital phenotyping data (GPS, accelerometer, heart rate, sleep, text/call metadata, Ecological Momentary Assessments [EMAs])	<ol style="list-style-type: none"> 1. Feasible to collect both passive and active digital data over the long term. 2. Data quality was high, particularly among older participants. 3. The majority of participants were willing to share their data, with no significant differences based on race or symptom profile. 4. Recruitment bias: predominantly iOS users and female participants → should be considered when generalizing the findings
7.	Murnane et al. (2016)	552 individuals with self-reported Bipolar Disorder (various types: BD I, BD II, NOS, Cyclothymia)	Cross-sectional survey (mixed-methods: quantitative + qualitative)	Manual tracking (paper, journals, mental notes) + digital tracking (apps: eMoods, Fitbit, banking apps, chat logs)	<ol style="list-style-type: none"> 1. Most participants tracked mood, sleep, finances, social activities, and exercise. 2. Increasing trend in the use of digital tracking apps. 3. Main benefits: enhanced self-awareness, self-control, and improved communication with clinicians. 4. Challenges: manual input burden, complex user interface, difficult data interpretation, and tracking could trigger stress. 5. Design implications: develop systems that are automated, BD-specific, flexible, and non-burdensome during episodes.
8.	Crocamo et al. (2025)	Umbrella Review dari 16 meta-analyses RCT	16 meta-analyses → various RCTs	Schizophrenia, MDD, Anxiety, Bipolar, PTSD, OCD, dll	Digital Health Interventions (DHI) were effective for MDD, anxiety, and PTSD compared to waiting list/TAU. For bipolar disorder, smartphone-based self-monitoring showed no significant effect on mania or depression (SMD -0.05 and -0.19), with very low quality of evidence.
9.	Cormack et al. (2020)	Proof of Concept (Prototype test)	Wearable device + mobile mood & cognition tracking	Not diagnosis-specific (general adult population, with potential applicability to bipolar disorder	The study developed a wearable device that intensively collects mood, cognition, and sensor data, focusing on tolerability, acceptability, compliance, and validation of digital metrics

			and other psychiatric conditions).	against conventional clinical assessments.	
10.	Sánchez-Gutiérrez et al. (2020)	RCT – Mobile App Intervention (Protocol + Early Findings)	THINK APP (Android & iOS), backend system + 5 modul CBT/Psychoeducation	Adolescents aged 14–19 years with First Episode Psychosis (FEP), Spain	The app consists of five modules (Psychoeducation, Relapse Prevention, Problem-Solving, Mindfulness, Social Wall). It is designed to enhance insight, treatment adherence, early symptom detection, and social functioning. Quantitative outcomes have not yet been fully published, but the design shows promise in improving quality of life and adherence.

From the 10 studies included in this scoping review, four main themes emerged regarding the use of digital technology for monitoring and managing mood disorders, particularly in individuals with bipolar disorder: (1) active self-monitoring through Ecological Momentary Assessment (EMA)-based applications or manual input; (2) passive monitoring and digital phenotyping using sensors and artificial intelligence (AI); (3) hybrid approaches that combine monitoring with therapeutic modules; and (4) psychosocial factors influencing user engagement, personalization, and ethical considerations. The following synthesis summarizes the findings for each theme, highlighting common patterns, supporting evidence, and frequently encountered limitations.

Active self-monitoring. Routine tracking of mood, sleep, and activity generally increased self-awareness and symptom management. Applications that provide notifications and personalized feedback demonstrated higher adherence and continued use compared to passive monitoring apps. Common barriers included technical issues, manual input burden, and interface complexity. Passive monitoring and digital phenotyping. Wearable devices and smartphone sensors enabled continuous collection of behavioral and physiological data, which could be translated into digital indicators of mood and cognitive function. Overall, participant compliance and willingness to share data were high, although some studies noted recruitment biases, such as overrepresentation of iOS users.

Hybrid approaches. Interventions integrating monitoring with digital therapeutic modules such as psychoeducation, mindfulness, relapse prevention, and problem-solving showed promise in improving insight, treatment adherence, and social functioning. Multimodal interventions provided more consistent psychological benefits compared to passive monitoring alone. Psychosocial factors and user engagement. Personalization, empathetic design, and the presence of a digital community significantly influenced user experience and technology acceptance. Features such as social walls, peer support, and flexible interfaces enhanced engagement and a sense of control.

In comparison, active self-monitoring was most effective for self-empowerment, passive monitoring excelled in real-time collection of objective data, and hybrid approaches offered the most comprehensive benefits. Psychosocial factors were key determinants of the successful adoption and sustained use of digital interventions in individuals with bipolar disorder.

3.2 Discussion

The results of this scoping review indicate that digital health innovations hold substantial potential for improving the monitoring and management of symptoms in individuals with bipolar disorder. Across the 10 included studies, four primary themes emerged: (1) active self-monitoring through applications, (2) passive monitoring and digital phenotyping, (3) hybrid approaches that combine monitoring with therapeutic modules, and (4) psychosocial factors influencing user engagement. Collectively, these findings demonstrate that digital interventions can enhance self-awareness, support early detection of relapse, and promote more personalized and continuous care for individuals with bipolar disorder.

3.3 Active Self-Monitoring

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Active self-monitoring via manual input or Ecological Momentary Assessment (EMA) consistently improves self-awareness, the regularity of daily routines, and perceived control over symptoms. Studies by Polhemus, Murnane, and Sigurðardóttir indicate that routine logging of mood and activity serves not only as a reporting tool but also as a method for self-reflection and psychological empowerment. Applications incorporating notifications and personalized feedback—such as the KIOS app in the Pahwa study—demonstrated higher adherence and user satisfaction compared to apps offering only passive recording. These findings underscore the importance of interactivity and personalized feedback as key drivers of effective digital self-monitoring.

3.4 Passive Monitoring and Digital Phenotyping

Passive monitoring using wearable devices and smartphone sensors enables real-time collection of behavioral and physiological data, including sleep patterns, mobility, physical activity, and digital social interactions, with high quality. Studies by Breitinger and Cormack confirm the feasibility of long-term passive data collection, as well as participants' high willingness to share data. The Monsenso protocol (Faurholt-Jepsen et al., 2021) introduces the concept of mood instability based on daily variability, which appears more sensitive than conventional clinical scales and offers opportunities for real-time episode prediction. These findings highlight the potential of digital phenotyping as an early relapse indicator and as a foundation for personalized therapeutic strategies.

3.5 Hybrid Approaches

Hybrid approaches, which integrate monitoring with digital therapeutic interventions—such as psychoeducation, mindfulness, relapse prevention, and problem-solving modules—demonstrate promising clinical and psychosocial outcomes (Sánchez-Gutiérrez et al., 2022). The THINK APP study indicates that combining weekly symptom reporting with interactive psychoeducation modules improves insight, treatment adherence, and social functioning in adolescents with first-episode psychosis. Furthermore, a meta-analysis by Crocamo et al. (2023) suggests that multimodal digital interventions provide more consistent psychological benefits than passive monitoring alone, supporting the notion that hybrid approaches offer a more comprehensive framework for patient recovery.

3.6 Psychosocial Factors and User Engagement

Psychosocial factors are critical determinants of digital intervention effectiveness (Jagfeld et al., 2022). Recovery extends beyond symptom reduction to include connectedness, empowerment, and purpose in life. Sigurðardóttir et al. (2021) found that personal data visualization enhances motivation and a sense of control, while sharing data with clinicians supports treatment processes. Features such as social walls, peer support, and the use of inclusive and empathetic language further increase technology acceptance. Consequently, user-centered, flexible, and socially sensitive application design is essential for achieving meaningful engagement and clinical benefit.

3.7 Comparative Synthesis

Active self-monitoring excels at promoting self-reflection and empowerment, whereas passive monitoring provides continuous, objective data for detecting relapse. Hybrid approaches combine the strengths of both strategies and offer the most comprehensive benefits. Successful adoption is strongly influenced by personalization, usability, and the integration of social and clinical support.

3.8 Implications for Practice

Digital self-monitoring applications can complement conventional care by enabling patients to actively manage their condition while providing clinicians with longitudinal data. In Indonesia, these interventions hold particular promise due to the limited number of psychiatrists and the high rate of smartphone penetration. Implementing such technology could facilitate early detection, reduce relapse rates, and improve quality of life for individuals with bipolar disorder.

3.9 Limitations and Directions for Future Research

Despite these promising results, several limitations must be considered. Variations in study design, sample characteristics, and measurement instruments constrain direct comparisons between interventions. Evidence regarding long-term effectiveness remains limited, as most studies are still in pilot or protocol phases (Crocamo et al., 2023). Additionally, the majority of studies were conducted in high-income countries, limiting generalizability to developing contexts, including Indonesia. Future research should focus on large-scale trials, the integration of monitoring with multimodal interventions, and the cultural adaptation and feasibility of implementing digital interventions in local settings.

4. Conclusion

This scoping review demonstrates that digital technologies such as self-monitoring applications, wearable devices, and hybrid systems integrating monitoring with therapeutic modules offer significant potential to improve symptom tracking among individuals with bipolar disorder. Active self-monitoring enhances self-awareness and personal responsibility in managing symptoms, while passive monitoring supports early detection through continuous data collection. Hybrid approaches provide more comprehensive benefits, particularly in improving treatment adherence and social functioning. Psychosocial and personalization factors, including peer support and interactive design, are essential for maintaining engagement. In the Indonesian context, developing inclusive, adaptive, and evidence-based digital interventions that align with local digital literacy and infrastructure may strengthen mental health services and promote sustainable empowerment. Future research is recommended to evaluate the long-term effectiveness and feasibility of these interventions in real-world clinical settings.

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