

Perspectives on Enhanced Measurement-Based Care Among Healthcare Providers, Adults, Adolescent Patients with Major Depressive Disorder and Pediatric Family Members: A Multicenter Online Investigation

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Objective: Measurement-based care (MBC) is an emerging, objective, and systematic evidence-based practice for monitoring symptom severity and treatment efficacy to assist clinicians in developing individualized treatment strategies for patients with major depressive disorder (MDD). This study aimed to identify the barriers and facilitators of enhanced MBC (eMBC) in the outpatient setting to clarify the eMBC utilization dilemma.

Methods: Between September 2022 and June 2023, we collected the opinions of healthcare providers, adult and adolescent patients, and family members of adolescent patients via online surveys. Specifically, we surveyed their acceptance and perspectives on MBC and eMBC primarily through custom-designed Likert scales developed for this study.

Results: We received responses from 270 adult patients, 144 adolescent patients, 109 family members, and 355 healthcare providers. The results showed that 85.3% of patients and family members were willing to use the eMBC intervention. However, adolescent patients responded significantly differently from the other two groups, with lower acceptance and confidence. Among healthcare providers, while only 69.9% used MBC in practice, 94% believed standardized scales would be effective in treatment, and 91.8% were willing to try eMBC. Additionally, we received 277 remarks regarding eMBC from patients and families.

Conclusion: In general, both clinicians and patients looked forward to using eMBC and recognized the potential benefits. However, they still had many concerns about privacy, professionalism, and time consumption. Responses from adolescent patients appeared more conservative and lacked confidence in eMBC. Further implementations are required to explore how eMBC can be operationalized in the outpatient setting to help different patients.

Keywords: measurement-based care, enhanced measurement-based care, major depressive disorder, digital health, implementation, treatment

Introduction

Major depressive disorder (MDD) is a chronic and recurrent psychiatric disease that has become a public health challenge worldwide. Non-response to first-line therapy recommended by guidelines referred to treatment-resistant depression (TRD) affects 20–30% of patients.¹ A study from 2001 based on the US Health Survey found that 77.7% of patients with depressive disorder alone had received primary care practitioner visits, but only 15.6% had received appropriate medication treatment.² Statistics from 2012 still reveal that 24% of patients received any treatment, but only 9% received adequate treatment, and 6% achieved remission.³ A recent multi-center national survey in China found that only approximately 7% of patients received adequate and proper treatment.⁴ Medication and dosage can directly affect the remission of depression. Therefore, finding a suitable and personalized treatment regimen for patients has become one of the key issues in current clinical practice. Admittedly, it must be jointly formulated collaboratively and continuously adjusted by both clinicians and patients based on the patient's severity, response, and tolerance to medication.⁵ The Canadian Network for Mood and Anxiety Treatments (CANMAT) guidelines emphasize the need to establish a comprehensive management program while introducing measurement-based care (MBC) and electronic mental health.⁶ Currently, more clinicians have gradually embraced MBC, an evidence-based practice, while current practice still relies on subjective observations and intuition.⁷

MBC was initially employed in a Sequenced Treatment Alternatives to Relieve Depression (STAR*D) study to assess the response and remission rates to citalopram in patients with MDD.⁸ It requires patients to systematically and regularly use measurement tools, such as validated rating scales, to assess their post-treatment outcomes before each clinic follow-up visit.^{8,9} The results of each MBC could serve as an adjunct tool to help clinical decision-making. Due to time constraints, simple and easy-to-use self-rating scales are commonly used for assessment in clinical and research settings.

MBC has been demonstrated to improve outcomes such as symptom remission and adherence,¹⁰ shorten the time to remission, track post-treatment outcomes to enable timely adjustments to medication regimens¹¹ and reduce the emergence of TRD.¹² Compared to usual standard care, MBC does not increase the number of outpatient visits or have any additional side effects;¹³ instead, it enhances patient engagement, allowing patients to understand symptom-driven functional improvements better and provides a clear picture of changes in quality of life from baseline to the current visit.¹⁴ A randomized controlled trial (RCT) comparing MBC with standard care found that patients using MBC experience medication adjustments at twice the frequency of those receiving standard care. Due to more appropriate medication plans, the former group shows a significantly reduced risk of relapse.¹² Furthermore, the implementation and effectiveness of MBC were well documented in a qualitative interview, showing early signs of promise at improving outcomes.¹⁵ Therefore, authoritative guidelines, including CANMAT and the American Psychiatric Association (APA), explicitly recommend clinicians apply MBC to guide treatment decisions.^{6,11,16}

However, paper-based MBC is quite cumbersome and time-consuming for both the clinician and the patient and even leads to a series of data quality issues, including inconveniences in querying and archiving, transcription errors, and data loss. Meanwhile, progressively improved digital technology is being applied to health management. It is universally recognized that digital interventions demonstrate great potential in improving mental health outcomes in a cost-effective manner.¹⁷ For instance, a Primary Care First model through e-health technology was developed to collect patients' self-reported outcomes.¹⁸ Research on this model has confirmed that it can effectively manage MDD and implement mental health navigation and behavioral activation teletherapy in clinics.¹⁹ Simultaneously, a person-centered model of MBC carried by internet-connected devices was initiated in Canada.²⁰ Patients were required to use their computer or smartphone to access a specially developed app or mini program for self-reported assessment before each appointment.²¹ Unlike traditional MBC, which are limited to non-portable data input, this enhanced MBC (eMBC) allows for a wider variety of data types from patients in their everyday environments. It's one of eMBC's quite remarkable advantages and progress. For instance, eMBC delivered via mobile phones may also be used to gather data on patients' movement, sleep performance, heart rate, etc, with the help of wristbands that have been developed and are on the market. This means that digital technology enables the regular collection of multidimensional data from patients and can even be supplemented with information from family members or specific caregivers.

MBC has been implemented in RCTs to assess its effectiveness in treating MDD for a while. However, intervention methods based on eMBC are still in program design or initial application stages. Mature software capable of undergoing large-scale, rigorous RCTs to validate its effectiveness and feasibility is not yet available. Therefore, Canadian partners and our team conducted a situational analysis in China to identify the drivers and barriers to eMBC implementation.²² It summarizes the facilitating and hindering factors identified at the organizational, patient, and healthcare provider levels. Efficiency and convenience, age, rural settings, cost, and digital literacy may influence whether patients can benefit from eMBC. However, our previous study only focused on stable patients with MDD and did not assess particular age groups, such as young students. Family members who provide daily care for the patient and are closely engaged in the treatment process were also not considered. Furthermore, Email was the only way to recruit volunteers in the previous survey conducted in Canada.²³ This likely excluded participants unfamiliar with the Internet in the sampling session. Consequently, there is a pressing demand to expand the diversity of the survey population. Notably, in recent years, MDD has become “younger”. About 40% of patients experience their first onset before age 20, mostly in adolescence,¹ a period of rapid social, emotional, and cognitive development and critical life transitions.²⁴ Gaining insight into the acceptance and opinions of adolescent patients regarding eMBC will, therefore, be beneficial for the subsequent program development.

This study aimed to 1) identify facilitators or barriers to implementing eMBC among healthcare providers, adult and adolescent patients with MDD, and pediatric family members; 2) understand clinicians’ knowledge of current MBC, the use of standardized outcome measures (SOM), and the acceptability of eMBC; 3) prepare for developing a novel whole-course management model for MDD treatment applicable to municipal medical institutions in Shanghai.

Method

Participants and Procedure

We conducted a cross-sectional survey involving patients and family members recruited from three hospitals: Shanghai Mental Health Center(SMHC), Children’s Hospital of Fudan University(CHFU), and Shanghai Tongji Hospital(STH). Enrolled participants visited the psychiatric outpatient department from September 2022 to June 2023. Eligible patients were required to be: 1) aged 12–65 years, with the proportion of adolescents aged 12–18 years being at least one-third of the total sample of patients; 2) diagnosed with MDD, as reported in their medical records; 3) middle school educated or higher, with sufficient audiovisual skills to have a good understanding of the research. After successfully enrolling adolescent patients, we would invite the accompanying family members to participate in our study. Before they completed the survey, our research psychiatrists would briefly introduce the concept of MBC and eMBC in clinical practice. Next, they would complete the online study by scanning a QR code in a quiet environment under trained researchers’ guidance.

Another group was focused on in-service healthcare providers, including psychiatrists, nurses, and caretakers. We posted recruitment questionnaires online all over the country. There are no requirements for age, years of experience, or professional title; they only need to be routinely involved in diagnosing and treating MDD.

Our study was approved by the Ethics Committee of Shanghai Mental Health Center, Children’s Hospital Fudan University, and Shanghai Tongji Hospital. All participants were volunteers who signed the informed consent form. For participants under 18, informed consent forms were signed by both them and their legal guardians, such as their parents. Meanwhile, this study complies with the relevant provisions of the Declaration of Helsinki.

Measures

The survey for patients and family members aimed to collect demographic information, familiarity with the Internet, methods of accessing health information online, trust levels, and acceptance of MBC and eMBC. At the end of the survey, each participant was invited to share their viewpoints on eMBC on a voluntary basis. Similarly, the healthcare provider survey focused on demographics, work context, knowledge and confidence in MBC, its application in diagnostics, integration into clinical workflows, and willingness to collaborate with patients on MBC and eMBC.

We provided each group of participants with different scenarios about the clinical application of (e)MBC to help them better understand. [Supplement 1](#) provides detailed descriptions of each scenario. The acceptance survey was presented on a 6-point Likert scale. “Strongly disagree”, “Disagree”, “Slightly disagree”, “Slightly agree”, “Agree”, and “Strongly Agree” were assigned scores of 1, 2, 3, 4, 5, and 6, respectively. A score above 3 indicates agreement with the statement, with higher scores reflecting stronger levels of agreement. Participants were required to express their explicitly favorable or unfavorable opinions for each statement to provide quantitative data on their attitudes and confidence.

Statistical Analysis

All statistical analyses were performed using SPSS 24.0 and R software, version 4.2.3. For data from patients and family groups, we first summarized the frequency distributions or mean ± standard deviation of demographic information and Internet usage. In the analysis of the acceptance survey, the mean and standard deviation for each question were calculated. Because the data for the three groups showed a non-normal distribution, a non-parametric analysis method—the Kruskal—Wallis *H*-test(K-W)—was employed, followed by Bonferroni correction, to detect differences in perspectives among the three groups. Secondly, we calculated the mean of the total scores for each participant’s responses to quantify the overall acceptance of (e)MBC. Through this process, we obtained the total score for each participant’s acceptance and calculated the mean and standard deviation. To study the independent effects of demographic information, Internet usage, and other variables on the acceptance of (e)MBC among different groups of participants, we first constructed multiple linear regression equations for each group separately. Finally, we created an interaction term between age and group and integrated these data from three groups into a unified multiple-stepwise regression model. The results highlighted significant predictor variables and their respective regression coefficients.

For survey data from healthcare Providers, we simply counted the frequency distribution or mean ± standard deviation of demographics and work conditions. Similarly, the same Likert scoring system was adopted as above to investigate their knowledge, confidence, and acceptance of MBC. The mean ± standard deviation reflects their attitude towards each issue.

Results

The study enrolled 270 adult patients, 144 adolescent patients, and 109 family members. Demographics and Internet use for the three subgroups are described in [Table 1](#). The average age of adult patients was 36 years, and that of the adolescent group was 14.9 years. Females accounted for a little over 70% of each of the three groups. The proportion of urban residents was 72.6% among adult patients, 39.6% among adolescent patients, and 48.6% among family members. The online survey for healthcare providers received 355 valid surveys from 24 provinces and municipalities nationwide, mainly involving in-service clinicians ([Table 2](#)). Among them, 51.5% were female, and the average age was 40.6 years. Psychiatrists accounted for as much as 87.3%. The proportion of those working exclusively in outpatient settings was 22.8%, those working exclusively in inpatient settings was 31.3%, and those working in both settings was 41.7%.

Table 1 Demographics of the Patients and Family Members

Options	Adult Patients	Adolescent Patients	Family Members
	N=270, n(%) / $\bar{x} \pm s$	N=144, n(%) / $\bar{x} \pm s$	N=109, n(%) / $\bar{x} \pm s$
Age	36.0±13.7	14.90±1.7	43.1±4.9
Gender			
Male	73(27.0)	18(12.5)	25(22.9)
Female	194(71.9)	114(79.2)	83(76.1)
Other	3(1.1)	12(8.3)	1(0.9)
Residents in Shanghai			
Yes	205(75.9)	105(72.9)	78(71.6)
No	65(24.1)	39(27.1)	31(28.4)

(Continued)

Table 1 (Continued).

Options	Adult Patients	Adolescent Patients	Family Members
	N=270, n(%) / $\bar{x} \pm s$	N=144, n(%) / $\bar{x} \pm s$	N=109, n(%) / $\bar{x} \pm s$
Residential area			
Urban	196(72.6)	57(39.6)	53(48.6)
Suburban	66(24.4)	72(50)	48(44)
Rural	8(3.0)	15(10.4)	8(7.3)
Education			
Primary School	5(1.9)	3(2.1)	2(1.8)
Middle School	19(7.0)	77(53.5)	11(10.1)
High School	42(15.6)	38(26.4)	30(27.5)
Vocational School	15(5.6)	6(4.2)	5(4.6)
Bachelor's degree	131(48.5)	6(4.2)	44(40.4)
Master's degree or professional degree	47(17.4)	0(0.0)	7(6.4)
On leave status	0(0.0)	10(6.9)	0(0.0)
Other	11(4.1)	4(2.8)	10(9.2)
Employment			
Full-time job	143(53.0)	5(3.5)	74(67.9)
Part-time	3(1.1)	0(0.0)	2(1.8)
Self-employed	18(6.7)	2(1.4)	17(15.6)
Homemaker	4(1.5)	0(0.0)	11(10.1)
Unemployed	18(6.7)	1(0.7)	2(1.8)
Retired	40(14.8)	1(0.7)	2(1.8)
Student	41(15.2)	135(93.8)	0(0.0)
Other	3(1.1)	0(0.0)	1(0.9)

Table 2 Healthcare Providers' Demographics, Qualifications, and Workload (n = 355)

Option	Response	n(%), $\bar{x} \pm s$
Age		40.6 \pm 9.3
Gender	Female	183(51.5)
	Male	172(48.5)
	Other	0(0.0)
Education	Technical school	6(1.7)
	Associate degree	33(9.3)
	Bachelor's degree	191(53.8)
	Master's degree	80(22.5)
	Doctoral Degree	43(12.1)
	Other	2(0.6)
Employment	Psychiatrist	310(87.3)
	General Practitioner	9(2.5)
	Neurologist	8(2.3)
	Psychotherapist	7(2)
	Social Worker	3(0.8)
	Nurses	7(2)
	Nurse Assistant	0(0.0)
	Other Health Professionals	11(3.1)

(Continued)

Table 2 (Continued).

Option	Response	n(%), $\bar{x} \pm \text{sd}$
Primary work setting	Outpatient Department	81(22.8)
	Inpatient Department	111(31.3)
	Inpatient and Outpatient Departments	148(41.7)
	Community Clinics	0(0.0)
	Chronic Disease Center (CDC)	2(0.6)
	Other	13(3.7)
Years of experience in psychiatric work	<1 year	27(7.6)
	1–5 years	67(18.9)
	6–10 years	59(16.6)
	11–15 years	68(19.2)
	16–20 years	42(11.8)
	>20 years	92(25.9)
Hours spent directly treating patients per week	<8	61(17.2)
	8–20	81(22.8)
	20–30	58(16.3)
	30–40	70(19.7)
	>40	85(23.9)
Number of patients to treat per week	20–50 hours	180(50.7)
	50–80 hours	64(18)
	80–110 hours	41(11.5)
	110–140 hours	30(8.5)
	140–160 hours	14(3.9)
	160–200 hours	10(2.8)
Main specialization/key areas	>200 hours	16(4.5)
	Mood disorders	55(15.5)
	Clinical Psychology	37(10.4)
	Geriatric Psychiatry	32(9)
	Child and Adolescent Psychiatry	44(12.4)
	General Adult Psychiatry	182(51.3)
	Substance Use Disorders	5(1.4)

Patient and Family Member Group

As seen from [Table 3](#), the percentage of people surfing the Internet daily surpassed 90% in all three subgroups. Familiarity with the mobile apps was, in descending order: adult patients (78.1%), adolescent patients (81.1%), and family members (61.5%). The proportion of adult patients who agreed or strongly agreed that they could find the physical and mental health information they desired via the Internet and to distinguish the quality of that information were both 56.3%, but only 34.8% said they had used online resources to manage their health. This compares with 42.3%, 54.2%, and 27.8% in the adolescent subgroup and 46.8%, 43.1%, and 29.4% in the family subgroup. According to the results of the K-W analysis, they only reported no significant discrepancies in their answers regarding the frequency of Internet use, familiarity with WeChat, Source to health information, and Confidence in making decisions using health information online.

The average acceptance and confidence in standard MBC ranged from highest to lowest, as follows: the adult patients (5.04), the family members (5.02), and the adolescent patients (4.46), with an overall mean of 4.88. The order in which the average acceptance and confidence in eMBC were ranked from highest to lowest was the adult patients (4.86), the family members (4.74), and the adolescent patients (4.40), with an overall mean of 4.70. ([Table 4](#)) It is worth noting that there were statistically significant differences between adult and adolescent patients regarding their acceptance of (e) MBC for each issue in the questionnaire; however, there was no significant difference among family members and adult patients. [Supplement 2](#) summarizes the response proportions for each question in the (e)MBC acceptance survey across the three groups and the proportion of positive attitudes for each question. The results indicate that all acceptance-related

Table 3 Internet Use in the Patients and Family Members

Options	Adult Patients	Adolescent Patients	Family Members	Total Difference	Adult vs Adolescent	Adult vs Family Members	Adolescent vs Family Members
Internet use				0.051			
Multiple times a day	251(93.0)	123(85.4)	99(90.8)				
Once a day	9(3.3)	12(8.3)	3(2.8)				
Every few days	5(1.9)	5(3.5)	3(2.8)				
Once a week	2(0.7)	1(0.7)	0(0.0)				
A few times a month	2(0.7)	0(0.0)	1(0.9)				
Rarely or not at all	1(0.4)	3(2.1)	3(2.8)				
Smartphone use				0.003	0.004	1.000	0.021
I have my smartphone	267(98.9)	135(93.8)	108(99.1)				
I use the same smartphone with family or friends	2(0.7)	2(1.4)	0(0.0)				
I do not use a smartphone	1(0.4)	3(2.1)	0(0.0)				
Other	0(0.0)	4(2.8)	1(0.9)				
Time of using smartphones.				0.000	0.000	1.000	0.000
0 years	1(0.4)	7(4.9)	1(0.9)				
Less than one year	2(0.7)	15(10.4)	0(0.0)				
2–3 years	6(2.2)	46(31.9)	5(4.6)				
3–5 years	13(4.8)	28(19.4)	7(6.4)				
More than five years	248(91.9)	48(33.3)	96(88.1)				
Internet access				0.000	0.000	0.209	0.038
Only smartphone	66(24.4)	60(41.7)	29(26.6)				
Smartphone and computer	199(73.7)	77(53.5)	74(67.9)				
Only computer	3(1.1)	2(1.4)	1(0.9)				
Rarely go online	2(0.7)	5(3.5)	3(2.8)				
Never go online	0(0.0)	0(0.0)	2(1.8)				
Mobile app familiarity				0.000	1.000	0.002	0.001
Very familiar	211(78.1)	117(81.3)	67(61.5)				
A little	55(20.4)	26(18.1)	39(35.8)				
Not at all familiar	2(0.7)	0(0.0)	3(2.8)				
Not applicable	2(0.7)	1(0.7)	0(0.0)				
Wechat mini-program familiarity				0.059			
Very familiar	230(85.2)	111(77.1)	85(78)				
Slightly familiar	39(14.4)	27(18.8)	23(21.1)				
Not familiar at all	0(0.0)	1(0.7)	1(0.9)				
Not applicable	1(0.4)	5(3.5)	0(0.0)				
WeChat usage interval				0.000	0.000	1.000	0.000
Never	1(0.4)	6(4.2)	1(0.9)				
Several times a day	261(96.7)	104(72.2)	107(98.2)				
Once a day	3(1.1)	16(11.1)	1(0.9)				
Once every few days	5(1.9)	9(6.3)	0(0.0)				

(Continued)

Table 3 (Continued).

Options	Adult Patients	Adolescent Patients	Family Members	Total Difference	Adult vs Adolescent	Adult vs Family Members	Adolescent vs Family Members
Once a week	0(0.0)	3(2.1)	0(0.0)				
A few times a month	0(0.0)	1(0.7)	0(0.0)				
Rarely or not at all	0(0.0)	5(3.5)	0(0.0)				
Gain general health information online				0.000	0.000	1.000	0.001
Always	131(48.5)	40(27.8)	49(45)				
Sometimes	123(45.6)	80(55.6)	57(52.3)				
Never	16(5.9)	24(16.7)	3(2.8)				
Gain mental health information online				0.001	0.001	1.000	0.014
Always	106(39.3)	39(27.1)	41(37.6)				
Sometimes	141(52.2)	75(52.1)	61(56)				
Never	23(8.5)	30(20.8)	7(6.4)				
Source to health information				0.101			
Never to get information	29(5.4)	22(15.3)	2(1.8)				
Official websites (eg, government, state agencies, research institutions, etc.)	121(22.5)	63(43.8)	60(55)				
Online discussion forums	82(15.3)	41(28.5)	25(22.9)				
Online or mobile apps	136(25.3)	64(44.4)	53(48.6)				
Social media (eg, WeChat forum)	162(30.2)	66(45.8)	46(42.2)				
Other	7(1.3)	3(2.1)	10(9.2)				
Type of information				0.000	0.000	1.000	0.007
Never get information	10(1.5)	21(14.6)	2(1.8)				
Medication information (eg, side effects)	137(21.1)	62(43.1)	57(52.3)				
How to manage symptoms	154(23.7)	54(37.5)	56(51.4)				
Health and mental health problems	211(32.5)	97(67.4)	83(76.1)				
General health and mental health services	134(20.6)	41(28.5)	50(45.9)				
Other	4(0.6)	8(5.6)	8(7.3)				
Confidence in accessing (mental) health information online.				0.026	0.071	0.105	1.000
Strongly disagree	4(1.5)	4(2.8)	3(2.8)				
Disagree	15(5.6)	8(5.6)	5(4.6)				
Uncertain	99(36.7)	71(49.3)	50(45.9)				
Agree	129(47.8)	48(33.3)	51(46.8)				
Strongly agree	23(8.5)	13(9)	0(0.0)				
Confidence in discerning the quality of information online.				0.029	1.000	0.104	0.029
Strongly disagree	7(2.6)	1(0.7)	3(2.8)				
Disagree	12(4.4)	8(5.6)	3(2.8)				
Uncertain	99(36.7)	57(39.6)	56(51.4)				
Agree	136(50.4)	53(36.8)	45(41.3)				
Strongly agree	16(5.9)	25(17.4)	2(1.8)				

Confidence in making decisions using health information online.				0.182			
Strongly disagree	14(5.2)	5(3.5)	4(3.7)				
Disagree	27(10.0)	16(11.1)	11(10.1)				
Uncertain	115(42.6)	64(44.4)	61(56)				
Agree	102(37.8)	45(31.3)	32(29.4)				
Strongly Agree	12(4.4)	14(9.7)	1(0.9)				
Previously used online resources to help manage health.				0.028	0.029	0.449	1.000
Yes	94(34.8)	40(27.8)	32(29.4)				
No	149(55.2)	73(50.7)	60(55)				
Uncertain	27(10.0)	31(21.5)	17(15.6)				

Notes: The fifth column of the table shows the p-values after the K-W test for the three groups, and the sixth, seventh, and eighth columns show the Bonferroni-corrected p-values after pairwise comparisons.

Table 4 Patient Acceptability of Standard MBC and eMBC

Options	Adult Patients	Adolescent Patients	Pediatric Family Members	ALL	Total Difference	Adult vs Patients	Adult vs Family Members	Adolescent vs Family Members
Acceptability of standard MBC								
I would like to (have my child) spend 5 minutes completing a questionnaire before each follow-up appointment with my doctor.	5.00±0.93	4.63±1.16	4.93±0.94	4.89±1.01	0.002	0.001	1.000	0.101
I (and my child) want to be more actively involved in my own treatment decisions for my depression.	5.25±0.83	4.52±1.17	5.36±0.71	5.07±0.98	0.000	0.000	1.000	0.000
I believe documenting changes in my (child's) depressive symptoms with a short questionnaire would help me with my (child's) depression.	4.94±1.02	4.27±1.27	4.83±1.00	4.73±1.13	0.000	0.000	0.709	0.001
I believe documenting changes in my (child's) depressive symptoms with a short questionnaire would help me (my child and me) and my doctor discuss my treatment for depression.	5.02±0.95	4.45±1.23	4.97±0.88	4.85±1.05	0.000	0.000	1.000	0.001
I believe that using the questionnaire described in the scenario will help understand my (child's) depression condition.	5.00±0.93	4.42±1.20	5.03±0.87	4.85±1.03	0.000	0.000	1.000	0.000
Acceptability of eMBC								
I would be willing to use resources on the Internet, such as those described in the above scenario, to help manage my (child's) depression.	4.77±1.07	4.28±1.25	4.81±1.00	4.64±1.13	0.000	0.000	1.000	0.001
I am willing to (have my child) use a phone app to track my symptoms if my doctor recommends it.	4.94±1.02	4.46±1.13	4.73±1.02	4.76±1.07	0.000	0.000	0.147	0.086
I believe my child could use a cell phone app to complete a short depressive symptom questionnaire regularly (eg, every two weeks)	4.87±0.99	4.45±1.15	4.68±0.95	4.71±1.04	0.000	0.000	0.146	0.373

Notes: Columns 2 to 5 of the table are the mean and standard deviation of the Likert scores, column 6 is the p-value of the three groups after the K-W test, and columns 7, 8 and 9 are the Bonferroni-corrected p-values after pairwise comparison.

questions received over 80% agreement. Among adult patients, all questions had an agreement rate of over 90%, except for “I would be willing to use resources on the Internet, such as those described in the above scenario about eMBC, to help me manage my depression”, which had an agreement rate of 87.04%. In contrast, the adolescent group showed a 79.17% agreement rate for this question.

Regression analysis revealed that the only predictor determining adolescents’ acceptance of both MBC and eMBC was their confidence in accessing (mental) health information online, which could positively affect acceptance. The only shared influencing factor among adults was the frequency of gaining general health information online. The number of sources to health information was the only statistically significant positive predictor of MBC acceptance in the adult group. The detailed impact coefficients and significance levels are presented in Table 5. In the multiple stepwise regression model, MBC and eMBC were separately used as dependent variables to compare the similarities and differences in predictive models significantly affecting each outcome. As shown in Table 6, the final predictors included-“Gaining general health information online”, “Source of health information, Confidence in accessing (mental)

Table 5 Predictors of Acceptance of MBC (Adult and Adolescent Patient Groups)

Options	MBC		eMBC	
	Adults	Adolescents	Adults	Adolescents
(Constant)	5.49**	1.86	5.97**	1.97
Age	0.00	0.08	0.00	0.06
Gender	-0.06	-0.26	-0.17	-0.21
Residents in Shanghai	-0.02	-0.21	0.16	-0.11
Residential area	-0.08	0.01	0.08	-0.08
Education	0.01	-0.07	0.02	0.05
Employment	0.01	0.03	0.03	0.05
Internet use	-0.11	0.21	-0.08	0.13
Smartphone use	0.49	0.28	0.13	-0.17
Time of using smartphone.	-0.05	0.12	-0.05	-0.07
Internet access	0.07	-0.11	0.04	0.01
Mobile app familiarity	-0.03	-0.05	-0.45**	-0.04
Wechat mini-program familiarity	-0.06	-0.04	0.22	-0.03
WeChat usage interval	-0.37*	-0.06	-0.23	-0.01
Gain general health information online	-0.41**	0.01	-0.55**	-0.01
Gain mental health information online	0.14	0.06	-0.02	0.03
Source to health information	0.13**	0.09	0.10	0.04
Type of information	0.01	0.17	0.00	0.19
Confidence in accessing (mental) health information online.	0.02	0.34**	0.09	0.47**
Confidence in discerning the quality of information online.	0.04	0.05	-0.06	-0.09
Confidence in making decisions using health information online.	0.01	-0.13	0.04	0.07
Previously used online resources to help manage health.	-0.13	0.09	-0.16	0.00

Notes: In the table, “*” represents the p-value of the coefficient ≤ 0.05 , and “**” represents the p-value of the coefficient ≤ 0.01 .

Table 6 Results of the Multiple Stepwise Regression of (e)MBC Acceptance

Options	MBC	eMBC
Age	0.008	\
Time of using smartphone.	0.087	\
Gain general health information online	-0.251	-0.305
Source to health information	0.118	0.130
Confidence in accessing (mental) health information online.	0.147	0.226
Previously used online resources to help manage health.	\	-0.158

health information online”, “Age”, “Time spent using a smartphone, and Previous use of online resources to help manage health”. The first three were common predictors for both outcomes (all p -values < 0.01).

Healthcare Provider Group

In Table 7, only the Likert scores for the feasibility survey of MBC did not exceed 4 points, the remaining questions were all four and above. They generally expressed a positive inclination toward descriptive statements highlighting the benefits of MBC, with a mean Likert score of 4.80, and overall confidence in applying MBC to assist clinical diagnosis was 4.35. However, response scores were only 3.72 for “integrating MBC into daily workflows”, while acceptance of “using eMBC in collaboration with patients” was relatively high at 4.66.

94.08% of participants believed standardized surveys and scales are valid for assessing the severity of symptoms. 95% of them acknowledged it’s highly important and valuable in aiding clinical decision-making. However, only 80.85% would discuss MBC scores with patients, 75.21% reported receiving related training, and 69.86% would use MBC to monitor the patient’s therapeutic progress at each visit. Additionally, 46.76% felt too busy to integrate MBC into their current workflow (Supplement 3).

Table 7 Healthcare Providers’ Knowledge, Confidence, and Acceptance of MBC (n = 355)

Options	Likert Scores
Knowledge and beliefs of MBC	
Standardized questionnaires and scales are valid for assessing the severity of symptoms.	4.82±0.78
MBC can improve patient prognosis.	4.63±0.90
MBC helps make treatment decisions.	4.84±0.78
The use of MBC at each visit helps to monitor treatment effects	4.88±0.78
MBC contributes to the reinforcement of patients’ treatment.	4.79±0.75
Patients find MBC helpful.	4.65±0.85
MBC contributes to educating patients about their mental symptoms and illness.	4.83±0.74
MBC enables patients to have better engagement in medical decision-making.	4.84±0.77
MBC facilitates collaborative treatment with other healthcare professionals for the same patient.	4.89±0.72
Average	4.80±0.65
Clinical Application of MBC	
MBC is highly important and valuable in aiding clinical decision-making.	4.78±0.83
I have received training on using MBC and applying its results to guide clinical decision-making.	4.15±1.25
I have enough knowledge to explain the MBC ratings.	4.43±1.05
I use MBC to monitor the patient’s therapeutic progress at each visit.	4.06±1.18
I will discuss the MBC score with the patient.	4.34±1.09
Average	4.35±0.89
Feasibility of using MBC	
MBC is easy to integrate into my daily workflow.	3.70±0.67
If my hospital provides training and resources, I will use MBC.	3.92±0.67
I will use the data collected from MBC to evaluate my clinical practice.	3.83±0.68
My patients are willing to complete MBC at each follow-up visit.	3.53±0.77
I will be more likely to use MBC if it’s automated, electronic, and easy to explain.	4.00±0.66
I am too busy to know how to integrate MBC into my current workflow.	3.32±0.88
Average	3.72±0.53
Acceptability of use of eMBC	
The mobile app will make MBC easier to use.	4.86±0.82
I would like to use MBC with my patients via a mobile app.	4.76±0.88
My patients would find the above mobile app easy to use.	4.52±0.94
My patients are willing to use the app to track their prognosis.	4.51±0.93
Average	4.66±0.79

Comments on eMBC

A total of 170 adults, 40 adolescents with depression, and 67 family members completed valid comments. Of these, 213 expressed explicit favorable or supportive attitudes toward implementing eMBC. 43 patients mentioned “convenience”, and “Real-time tracking of conditions” making them the most frequently mentioned advantage. 48 participants expressed clear opposition or negative concerns, such as “unreliable and unsafe”, “prone to make children addicted to the Internet and dependent on mobile phones”, “dislike forms and questionnaires”, and “cannot fully reflect the objective truth”.

In addition, there were many suggestive opinions in the comments. 14 participants emphasized the importance of privacy. 22 participants wished to have an official team to manage, review, or provide professional assistance. Other suggestions for the development and design of eMBC include:

- 1) Setting up a communication website;
- 2) Connecting to the official hospital system;
- 3) Documenting changes during the healing process;
- 4) Including medical knowledge for learning;
- 5) Providing font enlargement capabilities for the elderly;
- 6) Offering a psychological helpline;
- 7) Designing simple interfaces;
- 8) Adding reminders for taking medication.

Discussion

To our knowledge, this is the first mixed methods study to investigate the acceptance of standard MBC and eMBC use among adolescent patients and families. We compared attitudes towards eMBC among adult patients, adolescent patients, and pediatric families and also analyzed knowledge, confidence, concerns, and acceptance from healthcare providers. A large sample of 878 participants, aged 12–65 years, was collected in the study. And there is no extreme bias in the distribution of patients and their families regarding residential status (urban and rural), years of education, and employment, making results broadly representative. The included healthcare providers were primarily undergraduate and master’s degree holders. Gender, years of experience in psychiatric work, primary work setting (inpatient or outpatient), and hours spent directly treating patients per week were all approximately evenly distributed. These results enhance our research’s credibility and make the sample more broadly representative.

Many of our findings are similar to those previously surveyed by Canadian partners with our team.^{22,23} Participants were optimistic about eMBC and expressed a strong willingness to use it. The results revealed that adolescent and adult patients’ rates of mobile phone ownership exceeded 90%. The frequency and time spent accessing the internet and mobile phones were considerable. Such widespread use of smartphones has laid a solid foundation for the future development of eMBC services. The general acceptance of eMBC was high, similar to findings in previous studies on attitudes toward using mobile phones to monitor and manage depression, anxiety, and stress.²⁵ Patients’ and families’ acceptance of eMBC was affected by several factors: Those who gained general health information online more frequently, had more sources of information, were more confident in accessing (mental) health information online, and previously used online resources to help manage health demonstrated higher acceptance. Additionally, the first three factors just mentioned similarly affected MBC’s acceptance.

We added a novel aspect that included observations from adolescent patients and families and found a surprising conclusion. Adolescent patients used their mobile phones significantly less than adults due to school regulations (most Chinese students are banned from carrying digital devices in school), but their familiarity with mobile phones and confidence in accessing high-quality health information on the Internet was no different from those of the other two groups. It’s surprising that adolescent patients were more conservative in smartphone use and using the Internet to manage their health. They also had the least acceptance and confidence in eMBC. According to regression analysis, the only factor influencing adolescents’ acceptance of (e)MBC is confidence in accessing (mental) health information online. Moreover, since they have been exposed to the Internet since childhood, their conservative attitudes are worth further insight through qualitative analysis such as semi-structured interviews. Based on the current evidence, we hypothesize

that it may be related to adolescents' restricted time on their smartphones, lack of sufficient knowledge of the Internet to distinguish between high and low quality, increased concern for privacy and fear of being known by parents or peers, and lack of awareness of the long-term benefits of symptom tracking. It's encouraging to note that previous studies found that high-intensity digital technology enabled adolescents to be more proactive in their mental health care.²⁶ This indicated that Internet technology applied to clinical practice does not have intractable obstacles to overcome despite the relatively conservative attitudes of adolescent patients we surveyed. And worth pointing out, to date, although versions of the classic scales suitable for assessing depressive symptoms in adolescents have been pioneered,²⁷ adolescents still lack well-grounded measures to gauge disease, symptoms, and functions compared to well-established assessments for adults.²⁸ This could be a key factor hindering adolescent patients' full benefit from eMBC in the future. For instance, the classic Sheehan Disability Scale (SDS) is widely used to assess functional impairment in adults across work, social, and family domains. However, a scale comparable to the SDS to evaluate adolescents' academic functioning, social interactions, and family life has not yet been broadly implemented.

Additionally, our study encouraged participants to think creatively about eMBC, which would facilitate the future development of the eMBC program better to address the needs of patients and their families. Patients and their families expected eMBC to be like a reliable "housekeeper", which could save clinicians' workload while ensuring effective treatment. We noted that they repeatedly mentioned certain perceptions about the desired functions of eMBC. Privacy protection, records and reminders of medication regimens, professionalism and reliability, and tailored care for particular populations, such as font enlargement for the elderly and preventing smartphone dependence in children, should be prioritized in the subsequent eMBC program development. A qualitative study was conducted to determine the needs of patients and healthcare providers before establishing the Pathway Platform, a digital MBC platform for patients with MDD. Keywords such as simplicity, interaction, health tracker, easy to use, and reliable were frequently mentioned.²⁹ Combined with our results, developing an intervention model for eMBC requires great attention to the system's user-friendly design, interactivity, and reliability to ensure that it meets the actual expectations of patients. Furthermore, approximately 20–30% of patients have encountered inadequate response or resistance to treatment and then repeatedly adjusted their medication.^{1,30} This is one of the key challenges in MDD treatment. Patients hoped eMBC could function as a medication reminder, record patient adherence, detect failure to respond to treatment promptly and assist clinicians in changing the treatment program to improve outcomes.³¹

The healthcare providers surveyed, for the most part, were in favor of having MBC and eMBC as assistants for treatment and were proficient in applying them in practice. However, MBC has not been extensively utilized in treating patients with MDD, although theoretically, grounded evidence has demonstrated the benefits of MBC.^{9,32–34} Our study supported that less than 50% of them would incorporate it into their practice, while in previous studies, this number was fewer than 20%.^{35,36} According to our survey results, we assume that this might be associated with the fact that paper-based assessments are not user-friendly and add to the burden of outpatient care because they are more optimistic about using MBC if it is automated and electronic and outcomes are easy to interpret. This is similar to the findings of a previous Canadian study that demonstrated a dramatic increase in adherence when patients had access to an online-based MBC instead of a paper-based MBC for follow-up.³⁷ After all, eMBC has greater flexibility and continuity in data collection to amplify the strengths of traditional assessments.⁷ However, clinicians were also concerned about time constraints and the issue of confidentiality imposed on them and their patients.³⁸

Consequently, We need to be aware that the key to successful implementation of eMBC interventions is not only to adequately address the burdens and needs of clinicians, patients, and even their families but also to consider the broader healthcare environment. Shanghai was chosen as the setting for recruiting patients primarily because its psychiatric healthcare system is relatively advanced, with ongoing efforts to improve tiered diagnosis and referral systems. Healthcare reforms are moving towards a "patient-friendly" and "patient-centered" model, as demonstrated by initiatives like the establishment of a "Patient Experience Department" to accommodate diverse patient populations. Additionally, the city's inclusivity and support for digital mental health initiatives are favorable factors promoting the implementation of eMBC.

The primary reason for initially implementing eMBC first in tertiary hospitals is that, in the current healthcare environment, the public clearly tends to rely more on higher-level, advanced tertiary public hospitals.³⁹ We hope to develop an implementation of eMBC to be applicable to the full-course management model for MDD treatment in

Shanghai's municipal healthcare institutions. This would ideally meet the needs of both municipal psychiatric hospitals and tertiary general hospitals' psychiatry departments, as well as psychology departments in general children's hospitals, thereby covering a range of MDD patients from children and adolescents to adults.

We note four limitations to this study. First, there may be a sample selection bias. Our patients were all recruited from large tertiary hospitals without primary hospitals and district mental health centers. The results may not be generalizable to patients with mild symptoms or those with financial difficulties who prefer seeking clinic visits locally to minimize travel time and medical expenses. Second, all enrolled subjects were willing to participate in the surveys after their clinician's recommendation, excluding some patients who were sick of completing the questionnaires. This may lead to the inclusion of fewer patients who are reluctant to use eMBC for follow-up management. Third, although we strongly recommended enrolling adolescent patients and their families together, not all the parents of enrolled adolescents were willing to participate, and therefore, we could not identify a family's acceptance of eMBC by pairwise matching. Fourth, the Likert scale transforms actual attitudes into discrete categorical variables and may be infused with the researchers' subjective perceptual bias, which may introduce some loss of information and bias.

Conclusion

Overall, participants had positive attitudes toward the intervention of using eMBC to manage MDD. Among them, adolescent patients were more conservative. The use of eMBC in clinical settings could potentially be significantly enhanced if the concerns of different patients and healthcare providers are addressed and eMBC is seamlessly integrated into the treatment process without additional time costs. In the future, standardized structured interviews and focus group symposia could be implemented to better understand the attitudes, concerns, and design perspectives of different types of patients, families, and healthcare providers and intervene on key factors affecting acceptability.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

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Disclosure

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