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## ORIGINAL ARTICLE OPEN ACCESS

# Evaluating the Effects of Mental Health e-Learning on the Knowledge, Attitudes and Practices of Primary Healthcare Professionals in Mali. A Pilot Study

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## ABSTRACT

**Background:** Despite their high prevalence and significant burden, mental disorders remain grossly under-diagnosed and under-treated. In low-and-middle-income countries, such as Mali, integrating mental health services into primary care is the most viable way of closing the treatment gap. The aim of this study was to assess the effects of a mental health e-learning program on the knowledge, attitudes and practices of primary healthcare professionals in Mali.

**Methods:** An e-learning platform including 12 interactive modules was used to train 46 healthcare professionals. Changes in knowledge, attitudes and practices, as well as in satisfaction with knowledge and in ability to diagnose and manage patients were evaluated by comparing data collected pre and post e-learning.

**Outcomes:** Knowledge and practices scores increased significantly post e-learning for all modules, except the practices score for anxiety disorders. Similarly, scores regarding satisfaction with knowledge and ability to diagnose and manage patients increased significantly, and more so than the knowledge and practices scores. Changes in attitudes however were not significant.

**Conclusion:** Despite the difficult conditions of implementation in isolated areas of rural Mali, preliminary results suggest a positive effect of the e-learning.

## 1 | Introduction

The World Health Organisation (WHO) estimates that one in four people will suffer from a mental disorder during their lifetime (World Health Organisation 2022). A systematic review and meta-analysis of 174 studies showed a high prevalence of mental disorders with a 29.2% (25.9%–32.6%) lifetime prevalence in 26 high-income countries and 37

low-and-middle-income countries (LMICs) (Steel et al. 2014). In Mali, published data suggest 3.6% as the point prevalence for depression, and 2.6% for anxiety (World Health Organisation 2017a). Despite a high prevalence, mental disorders remain under-diagnosed and under-treated, especially in LMICs; 76%–85% of people with severe mental disorders do not receive any treatment, according to the WHO (World Health Organization 2022). In addition, the number of mental health

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professionals is very low in Mali, as in most LMICs, especially in rural areas. There are only 0.03 psychiatrists per 100 000 inhabitants (World Health Organization 2021a) compared to 10.54 in United States (World Health Organization 2021c), and 20.91 in France (World Health Organization 2021b). Primary healthcare professionals are not sufficiently trained to diagnose and manage people with mental disorders. The integration of mental health services into primary care is recommended by the WHO, especially in LMICs (World Health Organization 2013, 2008; World Health Organization and World Organization of Family Doctors 2008).

Transferring medical knowledge and promoting the adoption of evidence-based practices is challenging and requires strategies that account for the complexity of healthcare systems and cultures, individual practitioners, leadership, to name but a few (Titler 2008). There are several conceptual frameworks for maximising and accelerating the transfer of medical knowledge, among which, the framework from the Agency for Healthcare Research and Quality (AHRQ) (Nieva et al. 2005). The AHRQ framework is a synthesis of concepts from scientific information on knowledge transfer, social marketing, social and organisational innovation, and behaviour change.

Knowledge transfer in the AHRQ model (Nieva et al. 2005) includes three major stages: (1) knowledge creation and distillation, (2) diffusion and dissemination, and (3) organisational adoption and implementation. *Knowledge creation and distillation* involves translating relevant research findings into actionable products, such as practice guidelines, to improve the chances that research will be applied in real-world settings. *Diffusion and dissemination* focuses on collaborating with key opinion leaders and healthcare organisations to spread knowledge that can inform practice. These partnerships give credibility to new information and help identify influential individuals or communities that can drive the demand for applying the evidence. A combination of broad communication and targeted dissemination strategies is key to reach various audiences, with the expectation that early adopters will influence those who adopt later. The final stage, *end user adoption, implementation, and institutionalisation*, ensures that organisations, teams, and individuals consistently integrate evidence-based research and innovations into their routine practice.

Following a successful mental health capacity building initiative in Mali combining face-to-face training of rural GPs with awareness activities among communities (Poudiougou et al. 2021), the NGO “Santé Sud” joined forces in Bamako with the Department of Psychiatry of the Point G University Hospital, the Center of Expertise and Research in Telemedicine and e-Health (CERTES), the Faculty of Medicine and Odontostomatology (FMOS) to pilot a mental health e-learning platform developed by Sanofi Global Health, the World Association of Social Psychiatry (WASP) and the World Francophone Digital University (UNFM).

Although e-learning is not the “be-all and end-all” of educational training, it nevertheless is a very useful addition to the learning and development armamentarium. It has several benefits: it is

flexible allowing participants to learn at anytime, anywhere and at their own pace; in most cases, it is a much cheaper option than face-to-face training and much easier to organise; often, it allows to easily track each participant’s learning activities and it is easy to update. However, e-learning is not without its limitations, especially in LMICs. Difficulty in connectivity, electricity issues, low information technology literacy of participants, issues with the structure of online courses, lack of interaction with colleagues and teachers, have been reported as some of the downsides of e-learning in LMICs (Abbas et al. 2024). For this program, the cost-effectiveness (Bandla et al. 2012; Maloney et al. 2015) and flexibility of e-learning made it a very attractive option to provide mental health training to primary healthcare professionals, the intention being to scale-up and to implement in other LMICs. The mobile network allowing already more than 73% of the population in Mali to get access to the internet, e-learning represents a particularly good option for healthcare professionals practicing in rural areas who do not get many learning opportunities.

This pilot study aimed primarily to evaluate the effects of this e-learning program on the mental health knowledge, attitudes, and practices (KAP) of primary care health workers in Mali; and secondarily, to assess the effect of the training on learners’ satisfaction with their mental health knowledge, and on their self-assessment of their ability to diagnose and manage patients with mental disorders.

## 2 | Methods

### 2.1 | Type and Period of Study

This was a quasi-experimental “before/after” study comparing data on learner’s mental health KAP collected through online questionnaires completed before and after the different e-learning modules. The program was implemented between March 2021 and October 2021.

### 2.2 | Population Study

All healthcare professionals registering for the mental health e-learning program were systematically invited to take part in the study. Fifty-two physicians from the Association of Rural Physicians (Association des Médecins de Campagne—AMC), an association regrouping physicians who practice at primary care centers in rural Mali (Centres de Santé Communautaire—CSCoM) were offered the opportunity to register for the e-learning. Out of these, 46 registered and six indicated they were too busy at the time to commit to the e-learning program.

### 2.3 | E-Learning Program

The e-learning platform included 12 modules (an introduction and 11 modules focusing on various mental disorders and psychosocial support) (Table 1) which learners could access at any

**TABLE 1** | List of e-learning platform modules and learning objectives.

| Module                                            | Learning objectives                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Introduction                                      | Appreciate the burden of mental disorders and the key role that primary healthcare providers can play in their identification & management                                                                                                                                                                                                                                                                                                                       |
| Schizophrenia                                     | Learn how to diagnose schizophrenia, understand the therapeutic options available and know how to follow-up the patient at all stages of the disease.                                                                                                                                                                                                                                                                                                            |
| Depression                                        | Learn how to diagnose a depressive disorder and how to manage and follow-up patients through the different stages of the disease.                                                                                                                                                                                                                                                                                                                                |
| Bipolar disorders                                 | Learn how to diagnose bipolar disorder, understand the different therapeutic options available and know how to manage a patient at all stages of the disease.                                                                                                                                                                                                                                                                                                    |
| Anxiety disorders                                 | Learn about: <ol style="list-style-type: none"> <li>1. Generalised anxiety disorders (GAD)</li> <li>2. Obsessive Compulsive Disorder (OCD),</li> <li>3. Panic disorder with or without agoraphobia</li> <li>4. And Post Traumatic Stress Disorder (PTSD)</li> </ol> Learn how to diagnose an anxiety disorder, learn about the various therapeutic options available and know how to manage a patient at different stages of the disease (and at different ages) |
| Psychiatric disorders in children and adolescents | Learn how to identify psychiatric issues in children and adolescents and to make an appropriate diagnosis. Learn about the therapeutic options available and understand how to manage a young patient for disorders such as autism spectrum disorder, attention deficit hyperactivity disorder, depression, obsessive-compulsive disorder and enuresis                                                                                                           |
| Agitation in psychiatry                           | Learn how to make an etiological diagnosis of agitation, to identify its emergency characteristics and how to care for agitated patients.                                                                                                                                                                                                                                                                                                                        |
| Addictive disorders – The fundamentals            | Learn about the risk factors, the different methods of identifying addictions and how to care for people with addictions in general.                                                                                                                                                                                                                                                                                                                             |
| Addictive disorders - Cannabis                    | Learn how to identify and diagnose cannabis addiction and how to implement management strategies such as withdrawal and preventing relapses.                                                                                                                                                                                                                                                                                                                     |
| Addictive disorders—Tobacco                       | Learn how to identify, diagnose and assess the impact of a tobacco addiction and know how to initiate and support smoking cessation.                                                                                                                                                                                                                                                                                                                             |
| Addictive disorders—Alcohol                       | Learn how to identify and diagnose alcohol use disorders, identify possible co-morbidities, and initiate and monitor alcohol detoxification or reduction of alcohol consumption.                                                                                                                                                                                                                                                                                 |
| Psychosocial support                              | <ul style="list-style-type: none"> <li>– Understand the main components and issues of psychosocial support</li> <li>– Deliver psycho-educational support to patients and families via face-to-face meetings</li> <li>– Know how to set up and lead a psycho-educational group intended for patients and/or families</li> <li>– Know how to raise awareness of psychosocial support among health workers and the community</li> </ul>                             |

time, and complete at their own pace. Each module included animated text and graphics with a voice-over recording, so that both visual and auditory memories could be leveraged. The modules also included frequent quizzes to make the experience more interactive and engaging. The total curriculum would take a maximum of 15 h to complete. The modules could be accessed online, or downloaded and completed offline, whilst registration and all the questionnaires could only be completed online.

The content of the e-learning platform was complemented by interactive webinars organised at set times by a local psychiatrist. Validation of specific modules was a prerequisite to attend the webinar regarding these specific modules. These webinars aimed to provide learners with an opportunity to ask the questions they might have had while doing the online

modules, to go more in depth regarding some topics and to discuss clinical cases.

Participants who completed the e-learning program, received a certificate which was signed by the Dean of FMOS, as well as WASP & UNFM.

## 2.4 | Evaluation Criteria

A primary endpoint was a change in the knowledge and practice score for each of the mental disorders (each module), and in the attitudes score for all mental disorders.

The secondary endpoints were the change in participants' level of satisfaction with their knowledge, and the change in

participants' self-assessment of their ability to diagnose and manage patients.

## 2.5 | Data Collection

Knowledge and practices were evaluated for each module, by a pre- and post- online questionnaire that was systematically asked at the beginning and at the end of each e-learning module. There were 11 questionnaires with single or multiple-choice questions, directly related to the points covered in each module. The scores were expressed in percentage of correct answers.

In addition, before and after each module, two questions were asked to assess learners' level of satisfaction with their knowledge of the topic, as well as their self-assessment of their ability to diagnose and manage people with the disorder covered in each module. Scores ranged from 1 (extremely dissatisfied/not at all able) to 10 (extremely satisfied/extremely able).

Attitudes were assessed by a general questionnaire completed at the beginning and end of the entire curriculum. This questionnaire included 10 statements (positive and negative) for which learners were asked to indicate their level of agreement by scoring from 1 (strongly disagree) to 10 (strongly agree).

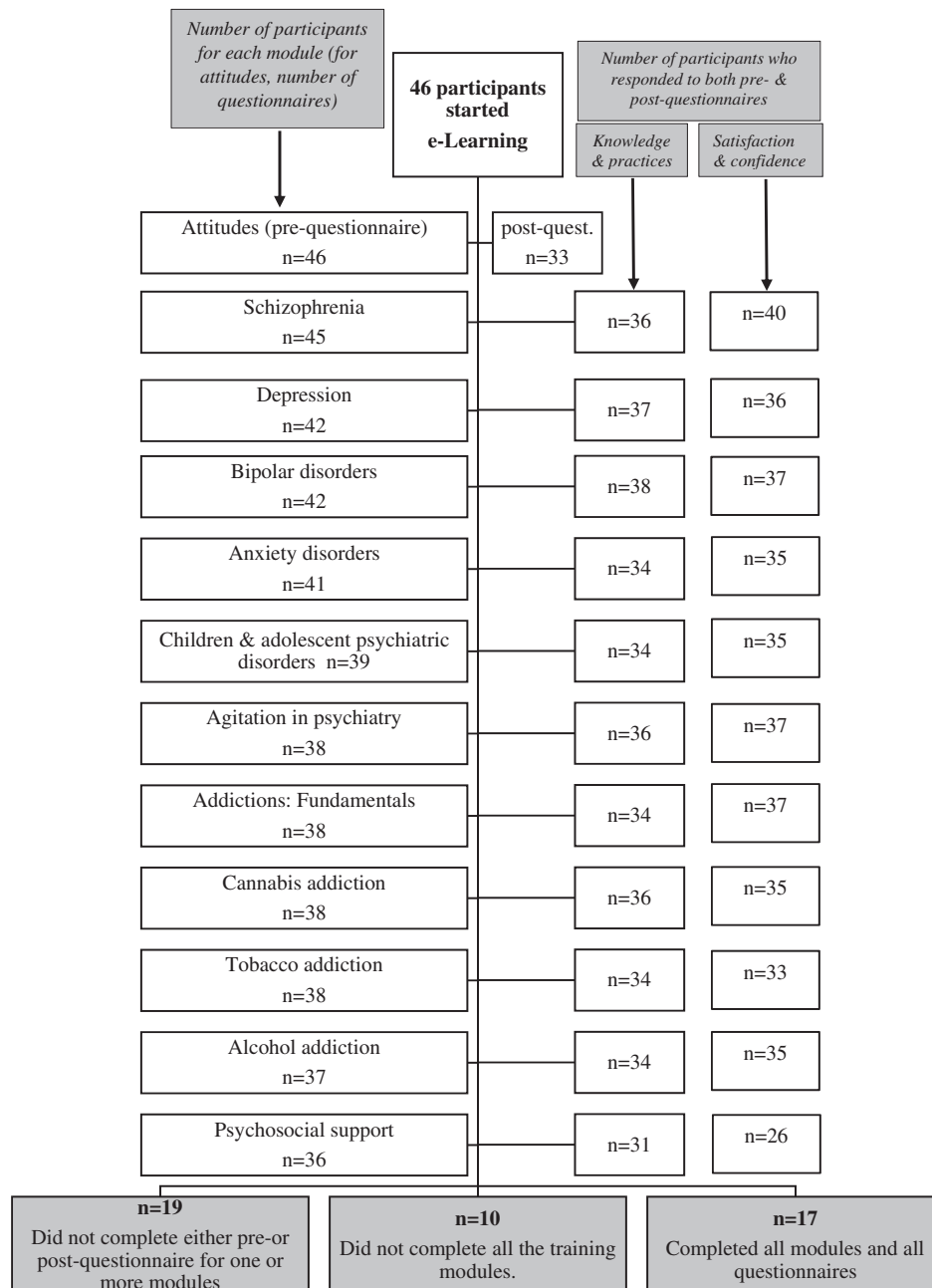


FIGURE 1 | Description of participation in the e-Learning.

Knowledge questionnaires included questions on disease definition, aetiology, diagnosis, epidemiology, and management. Practices questions included interviewing techniques, procedures, and management. Attitudes towards mental disorders and towards people with mental disorders, covered topics including feelings, impressions, stigma and patients interactions with family, work, and community. Questions for the pre and post-tests were identical.

In addition to these questionnaires, socio-demographic data concerning the profile of the learners (age, gender, profession, type of institution, etc.) were also collected.

## 2.6 | Statistical Analysis

A statistical analysis was conducted using SPSS 26. For descriptive analysis, qualitative variables were described by using numbers and percentages, and quantitative variables by using means and standard deviation.

A comparison between sub-scores, and overall scores for knowledge and practices, before and after e-learning, was done using Wilcoxon test. Mann-Whitney test was used to compare between overall satisfaction scores.

Mann-Whitney test was used to compare means between two independent groups, Kruskal-Wallis to compare means between more than two independent groups, and Pearson correlation to evaluate association between two quantitative variables.

A *p*-value <0.05 was considered significant throughout the study.

## 3 | Results

### 3.1 | Description of Participants' Characteristics

Among the 46 participants who registered and completed the attitude questionnaire at the beginning of the e-learning curriculum, only 33 completed it at the end of it. There was a continuous drop-out of participants as they progressed through the curriculum, with 45 accessing the first module on schizophrenia and 36 accessing all modules. Numbers of pre and post-questionnaires both completed for each of the modules, and available for paired analysis, varied from 40 (schizophrenia) to 26 (psychosocial support).

Overall, 19 participants did not complete either pre- or post-questionnaire for one or more modules, 10 did not complete all the training modules, and 17 completed all modules and all questionnaires (Figure 1).

Among the 46 participants, all but one were men, and 95.7% were GPs. More than half of them worked solely in the public sector, and a quarter only in the private sector, with 85.8% practicing in rural areas. This is representative of the population of the Association of Rural Physicians included in this program. Almost two-thirds had not taken part in "Santé Sud" mental health project (Table 2).

### 3.2 | Description of e-Learning Parameters

Among the 17 participants who completed all modules and all questionnaires, the number of days between first and last connection varied from 16 to 207 days (nearly 6 months). The majority of connections took place on weekdays from Monday to Friday, and especially after noon. Some participants accessed the e-learning platform for less than 10 days in total, with less than 10 connections, while one participant connected nearly 60 times over a 50 day-period (Figure 2).

**TABLE 2** | Characteristics of the participants in the e-learning.

| Variables (N=46)                          | n (%)      |
|-------------------------------------------|------------|
| Profession                                |            |
| General practitioner                      | 44 (95.7)  |
| Specialist                                | 2 (4.3)    |
| Practice type                             |            |
| Public                                    | 25 (55.6)  |
| Private                                   | 12 (26.7)  |
| Both                                      | 8 (17.7)   |
| Missing                                   | 1          |
| Work environment                          |            |
| City                                      | 3 (7.1)    |
| Peri-urban                                | 3 (7.1)    |
| Rural                                     | 36 (85.8)  |
| Missing                                   | 4          |
| Type of institution                       |            |
| Community Health Center                   | 13 (81.2)  |
| Clinic                                    | 1 (6.3)    |
| Health post or dispensary                 | 2 (12.5)   |
| Missing                                   | 30         |
| Part of "Santé Sud" mental health project |            |
| Yes                                       | 15 (32.6)  |
| No                                        | 31 (67.4)  |
| Additional mental health training         |            |
| Yes                                       | 21 (45.7)  |
| No                                        | 25 (54.3)  |
| Gender                                    |            |
| Male                                      | 45 (97.8)  |
| Female                                    | 1 (2.2)    |
| How did you find about it                 |            |
| Friend/colleague                          | 1 (2.2)    |
| Professional association                  | 10 (21.7)  |
| "Santé Sud"                               | 35 (76.1)  |
| Age (mean ± SD)                           | 42.6 ± 6.7 |
| Years of practice (mean ± SD)             | 11.8 ± 7.0 |



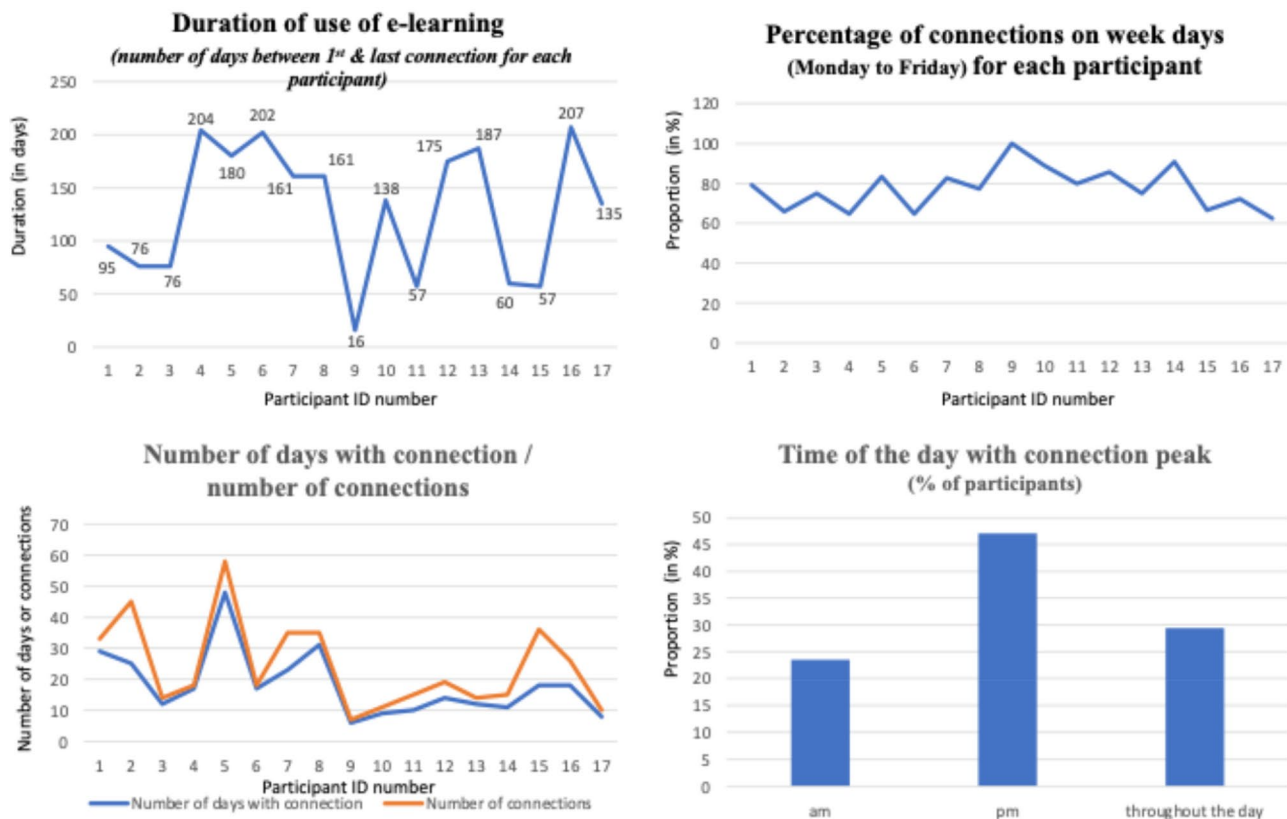


FIGURE 2 | Description of the parameters of e-learning use for the 17 participants who completed all modules.

### 3.3 | Comparison of Scores for Each Module and Overall Scores Before and After e-Learning

The overall attitudes score did not change significantly after the e-learning. The knowledge, and practices scores increased significantly after the e-learning for all modules, except the practices score for anxiety disorders. Similarly, scores regarding satisfaction with knowledge and ability to diagnose and manage diseases increased significantly, and in a greater way than the knowledge and practices scores (Table 3).

The overall knowledge, practices, satisfaction and confidence scores for the 17 participants who completed all modules showed a significant increase for all scores (Table 4).

Furthermore, the relative changes between before/after e-learning were greater in terms of satisfaction and confidence of participants (satisfaction with knowledge: +73.7%; ability to diagnose and manage: +60.1%) than their acquired skills scores (knowledge: +16.4%; practices: +10.7%) (Figure 3).

### 3.4 | Absolute Changes in Scores According to Characteristics of Participants and e-Learning Parameters

The absolute changes in scores did not differ significantly according to participants' characteristics and e-learning parameters. Indeed, the participants who had not taken part in "Santé Sud" mental health project had a greater evolution in their practices ( $10.5 \pm 5.5$  vs.  $4.8 \pm 1.7$ ). Healthcare professionals working

in the public sector had a greater improvement in their satisfaction with knowledge than those in the private sector ( $35.6 \pm 11.7$  vs.  $22.5 \pm 4.7$ ) (Table 5).

## 4 | Discussion

Our study demonstrated the positive effects of the e-learning program on the knowledge, attitudes, and practice of healthcare professionals in Mali. The e-learning program also increased their confidence as shown by the improvement in their satisfaction with knowledge score, and the self-assessment of their ability to identify and manage people with mental disorders.

Several studies and reviews (Colaceci et al. 2017; George et al. 2014; Konstantinidis, Apostolakis, and Karaiskos 2022; McCaughan et al. 2021; Schulz-Quach, Wenzel-Meyburg, and Fetz 2018; Scott and Barrett 2015; Sinclair et al. 2016; World Health Organization 2015; Williams 2014) have assessed the effectiveness of e-learning for healthcare professionals and students, covering very diverse topics such as prostate cancer care, medical imaging, radiation therapy, hand trauma management, and breastfeeding attitudes and practices. Current evidence suggests that online e-learning can be as effective, if not more so, than traditional learning methods, providing a strong incentive to promote its use. (George et al. 2014).

In the field of mental health, the benefits of e-learning have been demonstrated in various contexts. For example, in Australia, e-learning was shown to improve public servants' knowledge, reduce stigmatising attitudes, and increase confidence and

**TABLE 3** | Comparison of scores for the various types of questionnaires before and after each module.

| Modules                                     | N  | Type of questionnaire                | Before           | After            | p <sup>a</sup> |
|---------------------------------------------|----|--------------------------------------|------------------|------------------|----------------|
|                                             |    |                                      | Median (IQR)     |                  |                |
| Overall attitudes                           | 33 |                                      | 75.0 (67.0–80.5) | 79.0 (69.5–85.0) | 0.3            |
| Schizophrenia                               | 36 | Knowledge                            | 79.0 (64.5–87.1) | 93.5 (83.9–96.7) | <0.001         |
|                                             | 36 | Practices                            | 94.1 (89.7–100)  | 100 (94.1–100)   | 0.008          |
|                                             | 40 | Satisfaction with knowledge          | 45.0 (30.0–60.0) | 90.0 (80.0–100)  | <0.001         |
|                                             | 40 | Confidence with diagnosis/management | 50.0 (20.0–70.0) | 90.0 (80.0–90.0) | <0.001         |
| Depression                                  | 37 | Knowledge                            | 73.1 (69.2–80.8) | 92.3 (88.5–96.2) | <0.001         |
|                                             | 37 | Practices                            | 81.8 (72.7–90.9) | 90.9 (81.8–100)  | <0.001         |
|                                             | 36 | Satisfaction with knowledge          | 50.0 (30.0–70.0) | 90.0 (62.5–100)  | <0.001         |
|                                             | 36 | Confidence with diagnosis/management | 50 (42.5–77.5)   | 90.0 (72.5–90.0) | <0.001         |
| Bipolar disorders                           | 38 | Knowledge                            | 83.9 (77.4–90.3) | 96.8 (86.3–100)  | <0.001         |
|                                             | 38 | Practices                            | 90.9 (79.5–93.2) | 100 (81.8–100)   | 0.02           |
|                                             | 37 | Satisfaction with knowledge          | 40.0 (25.0–65.0) | 90.0 (80.0–90.0) | <0.001         |
|                                             | 37 | Confidence with diagnosis/management | 50.0 (20.0–65.0) | 90.0 (80.0–90.0) | <0.001         |
| Anxiety disorders                           | 34 | Knowledge                            | 77.3 (70.5–84.1) | 90.9 (86.4–100)  | <0.001         |
|                                             | 34 | Practices                            | 78.6 (57.1–89.3) | 85.7 (71.4–85.7) | 0.4            |
|                                             | 35 | Satisfaction with knowledge          | 50.0 (40.0–50.0) | 80.0 (80.0–90.0) | <0.001         |
|                                             | 35 | Confidence with diagnosis/management | 50.0 (40.0–70.0) | 90.0 (80.0–90.0) | <0.001         |
| Children & adolescent psychiatric disorders | 34 | Knowledge                            | 79.1 (73.3–83.7) | 93.0 (90.7–95.9) | <0.001         |
|                                             | 34 | Practices                            | 87.5 (75.0–93.8) | 100 (93.8–100)   | <0.001         |
|                                             | 35 | Satisfaction with knowledge          | 50.0 (30.0–60.0) | 90.0 (80.0–90.0) | <0.001         |
|                                             | 35 | Confidence with diagnosis/management | 50.0 (30.0–50.0) | 90.0 (80.0–90.0) | <0.001         |
| Agitation in psychiatry                     | 36 | Knowledge                            | 92.3 (76.9–92.3) | 100 (94.2–100)   | <0.001         |
|                                             | 36 | Practices                            | 80.0 (73.3–86.7) | 96.7 (93.3–100)  | <0.001         |
|                                             | 37 | Satisfaction with knowledge          | 50.0 (30.0–60.0) | 90.0 (80.0–90.0) | <0.001         |
|                                             | 37 | Confidence with diagnosis/management | 50.0 (30.0–70.0) | 90.0 (80.0–100)  | <0.001         |
| Addictions fundamentals                     | 34 | Knowledge                            | 75.0 (71.4–89.3) | 96.4 (89.3–100)  | <0.001         |
|                                             | 34 | Practices                            | 80.8 (69.2–88.5) | 96.2 (88.5–100)  | <0.001         |
|                                             | 37 | Satisfaction with knowledge          | 50.0 (30.0–55.0) | 90.0 (75.0–90.0) | <0.001         |
|                                             | 37 | Confidence with diagnosis/management | 50.0 (40.0–60.0) | 90.0 (80.0–90.0) | <0.001         |
| Cannabis addiction                          | 36 | Knowledge                            | 79.2 (75.0–91.7) | 100 (100–100)    | <0.001         |
|                                             | 36 | Practices                            | 88.9 (77.8–88.9) | 100 (100–100)    | <0.001         |
|                                             | 35 | Satisfaction with knowledge          | 40.0 (30.0–60.0) | 90.0 (80.0–100)  | <0.001         |
|                                             | 35 | Confidence with diagnosis/management | 50.0 (30.0–60.0) | 90.0 (90.0–100)  | <0.001         |
| Tobacco addiction                           | 34 | Knowledge                            | 77.8 (72.2–84.7) | 100 (94.4–100)   | <0.001         |
|                                             | 34 | Practices                            | 90.0 (80.0–90.0) | 100 (100–100)    | <0.001         |
|                                             | 33 | Satisfaction with knowledge          | 50.0 (35.0–70.0) | 90.0 (80.0–100)  | <0.001         |
|                                             | 33 | Confidence with diagnosis/management | 60.0 (40.0–70.0) | 90.0 (80.0–100)  | <0.001         |

(Continues)



TABLE 3 | (Continued)

| Modules              | N  | Type of questionnaire                | Before           | After            | p <sup>a</sup> |
|----------------------|----|--------------------------------------|------------------|------------------|----------------|
|                      |    |                                      | Median (IQR)     |                  |                |
| Alcohol addiction    | 34 | Knowledge                            | 80.6 (72.2–88.9) | 100 (94.4–100)   | < 0.001        |
|                      | 34 | Practices                            | 83.3 (75.0–91.7) | 100 (97.9–100)   | < 0.001        |
|                      | 35 | Satisfaction with knowledge          | 50.0 (30.0–60.0) | 90.0 (80.0–90.0) | < 0.001        |
|                      | 35 | Confidence with diagnosis/management | 50.0 (40.0–60.0) | 90.0 (80.0–100)  | < 0.001        |
| Psychosocial support | 31 | Knowledge                            | 93.3 (80.0–100)  | 100 (93.3–100)   | < 0.001        |
|                      | 31 | Practices                            | 89.3 (82.1–92.9) | 96.4 (92.9–100)  | < 0.001        |
|                      | 26 | Satisfaction with knowledge          | 50.0 (37.5–60.0) | 80.0 (70.0–90.0) | < 0.001        |
|                      | 26 | Capacity to develop and motivate     | 50.0 (40.0–70.0) | 90.0 (80.0–90.0) | < 0.001        |

Note: p values in bold indicate statistical significance at the p < 0.05 level.

<sup>a</sup>Wilcoxon test.

TABLE 4 | Comparison of overall scores before and after the e-learning for the 17 participants who completed all modules and questionnaires.

| Mean ± SD                  |  | Knowledge overall score                   | p <sup>a</sup> | Practices overall score                          | p <sup>a</sup> |
|----------------------------|--|-------------------------------------------|----------------|--------------------------------------------------|----------------|
|                            |  | Before e-learning<br>N = 17               | 81.1 ± 6.0     | <b>0.001</b>                                     | 84.7 ± 5.6     |
| After e-learning<br>N = 17 |  | 94.4 ± 3.1                                |                | 93.8 ± 1.9                                       |                |
| Mean ± SD                  |  | Satisfaction with knowledge overall score | p <sup>b</sup> | Confidence in diagnosing/ managing overall score | p <sup>b</sup> |
|                            |  | Before e-learning<br>N = 17               | 47.2 ± 15.8    | < 0.001                                          | 53.6 ± 18.3    |
| After e-learning<br>N = 12 |  | 82.0 ± 13.0                               |                | 85.8 ± 10.5                                      |                |

Note: p values in bold indicate statistical significance at the p < 0.05 level.

<sup>a</sup>Wilcoxon test.

<sup>b</sup>Mann–Whitney test.

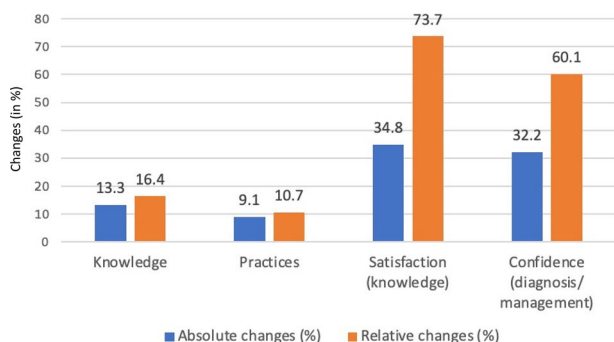


FIGURE 3 | Absolute and relative changes of overall scores.

intentions to support individuals with depression or post-traumatic stress disorder, with effects observed immediately post-training (Reavley et al. 2018) and maintained at one- and two-year follow-ups (Reavley et al. 2021). In Japan, a one-day e-learning program on perinatal mental health positively impacted midwives' and healthcare workers' psychological support skills (Shinohara et al. 2022). A randomised controlled

trial conducted in Australia showed that e-learning improved mental health knowledge, reduced stigma and increased self-confidence in participants (Jorm et al. 2010). In this study, e-learning was also shown to be superior to the printed manual in reducing stigma and disability due to mental ill health (Jorm et al. 2010).

There are however limitations to our study. Participants were not randomly chosen but self-selected from an existing network of rural GPs, introducing a selection bias which would limit the applicability of the results to the overall GP population. Participants were not required to complete all modules and all questionnaires, which resulted in a limited number of questionnaires completed for each of the modules and therefore available for paired analysis, thus limiting comparison across modules. In addition, baseline levels of education and mental health literacy might have varied among participants.

Another limitation of our work is that it evaluated only the effects of the e-learning modules available on the platform, and not those of the webinars. As webinars were conducted after the corresponding e-learning modules had been completed, it

**TABLE 5** | Absolute changes in scores according to the characteristics of participants and correlation with the e-learning use.

| Variables                                 | Absolute change of knowledge score |  | p                | Absolute change of practice score |  | p                       | Absolute change of satisfaction (knowledge) score |  | p                        | Absolute change of confidence (diagnosis/management) score |  | p                 |
|-------------------------------------------|------------------------------------|--|------------------|-----------------------------------|--|-------------------------|---------------------------------------------------|--|--------------------------|------------------------------------------------------------|--|-------------------|
|                                           | Mean ±SD                           |  |                  | Mean ±SD                          |  |                         | Mean ±SD                                          |  |                          | Mean ±SD                                                   |  |                   |
| Profession                                |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| General practitioner                      | 13.5 ± 5.5                         |  | 0.5 <sup>a</sup> | 9.4 ± 5.5                         |  | 0.2 <sup>a</sup>        | 35.2 ± 14.3                                       |  | 0.5 <sup>a</sup>         | 30.7 ± 17.4                                                |  | 0.7 <sup>a</sup>  |
| Specialist                                | 9.6                                |  |                  | 4.6                               |  |                         | 24.5                                              |  |                          | 24.5                                                       |  |                   |
| Practice type                             |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| Public                                    | 15.1 ± 6.9                         |  | 0.4 <sup>b</sup> | 10.1 ± 7.5                        |  | 0.3 <sup>b</sup>        | 35.6 ± 11.7                                       |  | <b>0.049<sup>b</sup></b> | 32.0 ± 16.8                                                |  | 0.06 <sup>b</sup> |
| Private                                   | 10.5 ± 3.5                         |  |                  | 6.7 ± 3.6                         |  |                         | 22.5 ± 4.7                                        |  |                          | 17.3 ± 7.1                                                 |  |                   |
| Both                                      | 15.3 ± 3.9                         |  |                  | 11.8 ± 0.1                        |  |                         | 54.1 ± 5.8                                        |  |                          | 50.5 ± 1.9                                                 |  |                   |
| Work environment                          |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| In city                                   | 8.2                                |  | 0.7 <sup>b</sup> | 5.3                               |  | 0.5 <sup>b</sup>        | 18.2                                              |  | 0.1 <sup>b</sup>         | 21.0                                                       |  | 0.5 <sup>b</sup>  |
| Suburban                                  | 11.9                               |  |                  | 11.9                              |  |                         | —                                                 |  |                          | —                                                          |  |                   |
| Rural                                     | 13.5 ± 5.8                         |  |                  | 9.2 ± 6.1                         |  |                         | 34.7 ± 13.9                                       |  |                          | 29.8 ± 17.7                                                |  |                   |
| Part of “Santé Sud” mental health project |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| Yes                                       | 9.8 ± 2.9                          |  | 0.2 <sup>a</sup> | 4.8 ± 1.7                         |  | <b>0.02<sup>a</sup></b> | 23.6 ± 5.1                                        |  | 0.2 <sup>a</sup>         | 17.9 ± 8.6                                                 |  | 0.1 <sup>a</sup>  |
| No                                        | 14.3 ± 5.6                         |  |                  | 10.5 ± 5.5                        |  |                         | 37.9 ± 14.3                                       |  |                          | 34.2 ± 17.0                                                |  |                   |
| Additional mental health training         |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| Yes                                       | 13.4 ± 5.3                         |  | 0.8 <sup>a</sup> | 9.5 ± 6.9                         |  | 0.8 <sup>a</sup>        | 32.5 ± 14.0                                       |  | 0.6 <sup>a</sup>         | 28.3 ± 14.1                                                |  | 0.4 <sup>a</sup>  |
| No                                        | 13.1 ± 5.9                         |  |                  | 8.7 ± 3.5                         |  |                         | 38.0 ± 15.1                                       |  |                          | 33.9 ± 23.0                                                |  |                   |
| How did you find about it                 |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |
| Friend/colleague                          | —                                  |  | 0.5 <sup>b</sup> | —                                 |  | 0.3 <sup>b</sup>        | —                                                 |  | 0.053 <sup>b</sup>       | —                                                          |  | 0.07 <sup>b</sup> |
| Professional association                  | 14.6 ± 4.6                         |  |                  | 10.7 ± 1.9                        |  |                         | 54.1 ± 5.8                                        |  |                          | 50.5 ± 1.9                                                 |  |                   |
| “Santé Sud”                               | 13.0 ± 5.6                         |  |                  | 8.8 ± 5.9                         |  |                         | 30.4 ± 14.0                                       |  |                          | 26.1 ± 15.2                                                |  |                   |
| Connection peak in the day                |                                    |  |                  |                                   |  |                         |                                                   |  |                          |                                                            |  |                   |

(Continues)

TABLE 5 | (Continued)

| Variables                                       | Absolute change of knowledge score |                  | Absolute change of practice score |                  | Absolute change of satisfaction (knowledge) score |                  | Absolute change of confidence (diagnosis/management) score |                  | p |
|-------------------------------------------------|------------------------------------|------------------|-----------------------------------|------------------|---------------------------------------------------|------------------|------------------------------------------------------------|------------------|---|
|                                                 | Mean ±SD                           | p                | Mean ±SD                          | p                | Mean ±SD                                          | p                | Mean ±SD                                                   | p                |   |
| Am                                              | 10.9 ± 5.2                         | 0.2 <sup>b</sup> | 8.1 ± 1.5                         | 0.7 <sup>b</sup> | 49.1 ± 3.9                                        | 0.3 <sup>b</sup> | 47.3 ± 6.4                                                 | 0.3 <sup>b</sup> |   |
| Pm                                              | 14.9 ± 4.8                         |                  | 10.5 ± 6.9                        |                  | 31.5 ± 12.6                                       |                  | 27.3 ± 19.0                                                |                  |   |
| Throughout the day                              | 12.4 ± 6.6                         |                  | 7.7 ± 4.9                         |                  | 31.3 ± 15.5                                       |                  | 26.2 ± 14.9                                                |                  |   |
| Period between first and last day of connection | —                                  | 0.9 <sup>c</sup> | —                                 | 0.9 <sup>c</sup> | —                                                 | 0.5 <sup>c</sup> | —                                                          | 0.9 <sup>c</sup> |   |
| Number of connections                           | —                                  | 0.2 <sup>c</sup> | —                                 | 0.2 <sup>c</sup> | —                                                 | 0.6 <sup>c</sup> | —                                                          | 0.1 <sup>c</sup> |   |
| Percentage of connection during weekdays        | —                                  | 0.6 <sup>c</sup> | —                                 | 0.7 <sup>c</sup> | —                                                 | 0.8 <sup>c</sup> | —                                                          | 0.7 <sup>c</sup> |   |

Note: p values in bold indicate statistical significance at the p < 0.05 level.

<sup>a</sup>Mann-Whitney test.

<sup>b</sup>Kruskal-Wallis test.

<sup>c</sup>Pearson.

made it difficult to set-up pre-post questionnaires. We however surveyed participants after the first three webinars to gather insights regarding their level of satisfaction and potentially adjust the time/day as well as duration for the next webinars. Overall, their level of satisfaction was high, 8.4/10 on average, and they were highly likely to recommend the webinars to their colleagues (9.5/10). The duration was adequate for 77% of the responders.

Although the primary endpoint was a change in knowledge, attitudes and practice scores leaving little place for self-reported outcomes, the issue of social desirability and its potential bias, shouldn't be overlooked. Socially desirable responding is the tendency for participants to present a favourable image of themselves (Johnson and Fendrich 2002). It could have had some influence on the self-reported "satisfaction with own knowledge" and "confidence in diagnosing and managing".

An additional limitation of our study is the fact that practice was only assessed through multiple choice questions about appropriate practices (mental health-related assessment scales, screening tools, interviewing techniques, procedures, management...). It was not assessed through observation of participants' behaviours, in real-life settings, while interacting with people with mental health issues or their relatives. Several studies have shown though that health professional learners' self-assessment of their knowledge and skills is a significant predictor of their future performance in clinical activities (Mavis 2001; Mohamadirizi et al. 2015).

Our study focused on effectiveness outcomes and it didn't evaluate implementation outcomes. Implementation outcomes regarding the roll-out of this e-learning program such as acceptability, appropriateness, feasibility and fidelity would be very important to evaluate in order to enhance the implementation process and help plan for future scaling-ups, and extension to other countries.

Computer literacy among healthcare providers as well as internet access and bandwidth availability are important barriers to take into account when implementing an e-learning program in LMICs (Abbas et al. 2024), especially in rural areas. Our e-learning platform allows learners to download modules and to complete them off-line. Although registration and questionnaires have to be completed online, offline access to the modules, once downloaded, allows people to study at any time and at their own pace, without having to rely on internet connectivity. In Mali, this e-learning program was the first e-learning experience for the vast majority of participants, with many having low computer skills. Moreover, this pilot was implemented in difficult conditions in fairly isolated areas of Mali. However, the design of the platform combined with local support via phone for some learners, especially at the beginning of the program, allowed to overcome these barriers. A helpdesk to assist learners overcome the technical issues they might encounter is key to a smooth implementation of an e-learning program.

This e-learning program, which was derived from materials used for face-to-face training in other LMICs, could be an effective step to integrate mental health care into primary care,

and to help GPs, especially those in rural areas, to acquire knowledge and skills in order to identify, diagnose, and manage people with mental disorders, at primary health care level. It offers the flexibility to be used either as an initial training course, or as refresher classes for healthcare workers already in the field.

The findings of our study, and lessons learned through this pilot program in Mali have guided the implementation of this e-learning in Senegal to train a group of 322 allied and healthcare professionals, under the auspices of the Ministry of Health (Bruand et al. 2024). As a result, the Ministry of Health of Senegal has planned to integrate mental health in its national e-learning program for the continuing education of health workers, and mental health supervisors have been appointed in each medical region, to act as mentors for first line health workers willing to upskill in mental health.

## 5 | Conclusion

This study is the first in Mali to evaluate the effects of a mental health e-learning platform for healthcare workers. Although positive, the results are considered as preliminary and a basis for further investigation. Developing e-learning may make it possible to train a greater number of healthcare workers and help them to better manage their time, resources, and efforts. By improving their mental health knowledge, skills and confidence, e-learning could contribute to closing the very large treatment gap for mental disorders in LMICs.

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### Ethics Statement

Informed consent was obtained from all individual participants included in the study.

### Consent

Individuals involved in the study were aware of the planned publication of the results and gave their consent.

### Conflicts of Interest

PEB and AFN were Sanofi employees at the time of the study and own Sanofi shares. LM, OP, FB, PMP and LK report grants or personal fees received either directly or indirectly from Sanofi Global Health in the context of the submitted work. FB, PMP and LK report grants from Sanofi Global Health outside the submitted work. DM and COB report no competing interests.

### Data Availability Statement

De-identified data are stored on the secure server of the EpiMaCT team, so all authors from this team (LM, PMP and FB) can access them. De-identified data may be shared on a case-by-case basis upon requests to the corresponding author.

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