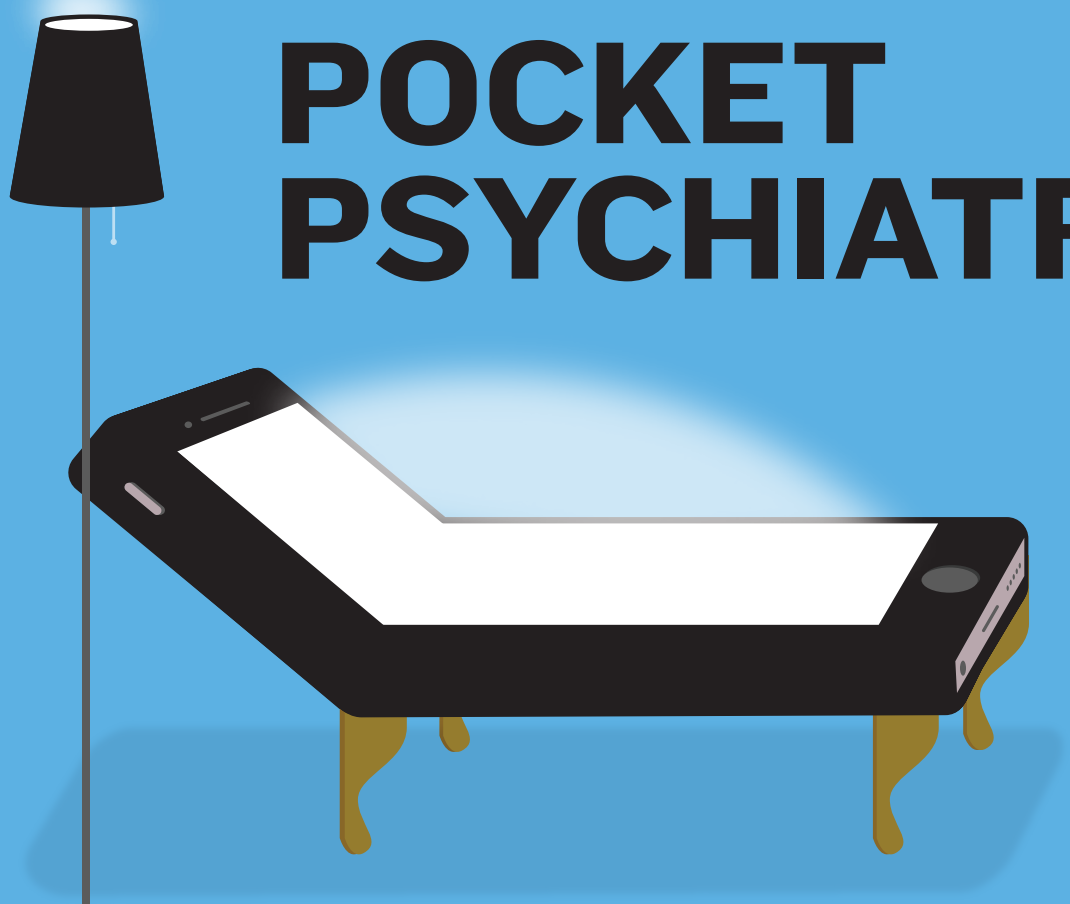


POCKET PSYCHIATRY

MOBILE MENTAL-HEALTH APPS HAVE EXPLODED ONTO THE MARKET, BUT FEW HAVE BEEN THOROUGHLY TESTED.

BY EMILY ANTHES

Type 'depression' into the Apple App Store and a list of at least a hundred programs will pop up on the screen. There are apps that diagnose depression (Depression Test), track moods (Optimism) and help people to "think more positive" (Affirmations!). There's Depression Cure Hypnosis ("The #1 Depression Cure Hypnosis App in the App Store"), Gratitude Journal ("the easiest and most effective way to rewire your brain in just five minutes a day"), and dozens more. And that's just for depression. There are apps pitched at people struggling with anxiety, schizophrenia, post-traumatic stress

ILLUSTRATION BY OLIVER MUNDAY

disorder (PTSD), eating disorders and addiction.

This burgeoning industry may meet an important need. Estimates suggest that about 29% of people will experience a mental disorder in their lifetime[1]. Data from the World Health Organization (WHO) show that many of those people — up to 55% in developed countries and 85% in developing ones — are not getting the treatment they need. Mobile health apps could help to fill the gap (see 'Mobilizing mental health'). Given the ubiquity of smartphones, apps might serve as a digital lifeline — particularly in rural and low-income regions — putting a portable therapist in every pocket. "We can now reach people that up until recently were completely unreachable to us," says Dror Ben-Zeev, who directs the mHealth for Mental Health Program at the Dartmouth Psychiatric Research Center in Lebanon, New Hampshire.

Public-health organizations have been buying into the concept. In its Mental Health Action Plan 2013–2020, the WHO recommended "the promotion of self-care, for instance, through the use of electronic and mobile health technologies." And the UK National Health Service (NHS) website NHS Choices carries a short list of online mental-health resources, including a few apps, that it has formally endorsed.

But the technology is moving a lot faster than the science. Although there is some evidence that empirically based, well-designed mental-health apps can improve outcomes for patients, the vast majority remain unstudied. They may or may not be effective, and some may even be harmful. Scientists and health officials are now beginning to investigate their potential benefits and pitfalls more thoroughly, but there is still a lot left to learn and little guidance for consumers.

"If you type in 'depression', its hard to know if the apps that you get back are high quality, if they work, if they're even safe to use," says John Torous, a psychiatrist at Harvard Medical School in Boston, Massachusetts, who chairs the American Psychiatric Association's Smartphone App Evaluation Task Force. "Right now it almost feels like the Wild West of health care."

APP HAPPY

Electronic interventions are not new to psychology; there is robust literature showing that Internet-based cognitive behavioural therapy (CBT), a therapeutic approach that aims to change problematic thoughts and behaviours, can be effective for treating conditions such as depression, anxiety and eating disorders. But many of these online therapeutic programmes are designed to be completed in lengthy sessions in front of a conventional computer screen.

Smartphone apps, on the other hand, can be used on the go. "It's a way of people getting access to treatment that's flexible and fits in with their lifestyle and also deals with the issues around stigma — if people are not quite ready to maybe go and see their doctor, then it might be a first step to seeking help," says Jen Martin, the programme manager at MindTech, a national centre funded by the United Kingdom's National Institute for Health Research and devoted to developing and testing new mental-health technologies.

One of the best-known publicly available apps was devised to meet that desire for flexibility. In 2010, US government psychologists conducting focus groups with military veterans who had PTSD learned that they wanted a tool they could use whenever their symptoms flared up. "They wanted something that they could use in the moment when the distress was rising — so when they were in line at the supermarket," says Eric Kuhn, a clinical psychologist and the mobile apps lead at the US Department of Veterans Affairs' National Center for PTSD.

The department joined up with the US Department of Defense to create PTSD Coach, a free smartphone app released in early 2011. Anyone who has experienced trauma can use the app to learn more about PTSD, track symptoms and set up a support network of friends and family members. The app also provides strategies for coping with overwhelming emotions; it might suggest that users distract themselves by finding a funny video on YouTube or lead users through visualization exercises.

In its first three years in app stores, PTSD Coach was downloaded more than 150,000 times in 86 different countries. It has shown promise in several small studies; in a 2014 study of 45 veterans, more than 80% reported that the app helped them to track and manage their symptoms and provided practical solutions to their problems[2]. More results are expected soon. Kuhn and his colleagues recently completed a 120-person randomized trial of the app, and a Dutch team is currently analysing data from a 1,300-patient trial on a similar app called SUPPORT Coach.

"IF YOU TYPE IN 'DEPRESSION', ITS HARD TO KNOW IF THE APPS THAT YOU GET BACK ARE HIGH QUALITY, IF THEY WORK, IF THEY'RE EVEN SAFE TO USE."

Smartphone apps can also interact with users proactively, pinging them to ask about their moods, thoughts and overall well-being. Ben-Zeev created one called FOCUS, which is geared towards patients with schizophrenia. Several times a day, the app prompts users to answer questions such as "How well did you sleep last night?" or "How has your mood been today?" If users report that they slept poorly, or have been feeling anxious, the app will suggest strategies for tackling that problem, such as limiting caffeine intake or doing some deep-breathing exercises.

Some apps help people to stay connected to health-care professionals, too. ClinTouch, a psychiatric-symptom-assessment app designed by researchers at the University of Manchester, UK, analyses users' responses for signs that they may be experiencing a relapse; it can even notify a clinical-care team.

Small feasibility studies — which are generally designed to determine whether an intervention is practical, but do not necessarily evaluate its efficacy — have shown that patients use and like both apps, and a 2014 study found that those who used FOCUS for a month experienced a reduction in psychotic symptoms and depression[3]. FOCUS and ClinTouch are both now being evaluated in randomized, controlled trials.

Some researchers see opportunities in the data that smartphones collect about their users' movement patterns or communication activity, which could provide a potential window into mental health. "Your smartphone is really this interesting diary of your life," says Anmol Madan, the co-founder and chief executive of Ginger.io, a digital mental-health company based in San Francisco, California. Studies have now shown that certain patterns of smartphone use can predict changes in mental-health symptoms[4]; a drop in the frequency of outgoing text messages, for instance, may suggest that a user's depression is worsening.

The Ginger.io app, which is still in beta, monitors these sorts of patterns and alerts each user's assigned mental-health coach if it detects a worrying change.

ABSENT EVIDENCE

The evidence supporting the use of such apps is building[5–7]. But this is a science in its infancy. Much of the research has been limited to pilot studies, and randomized trials tend to be small and unreplicated. Many studies have been conducted by the apps' own developers, rather than by independent researchers. Placebo-controlled

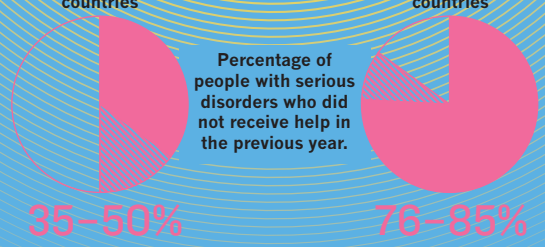
MOBILIZING MENTAL HEALTH

SMARTPHONE APPS FOR MENTAL HEALTH HAVE THE POTENTIAL TO REACH PEOPLE WITHOUT ACCESS TO CARE.

Global prevalence of mental disorders

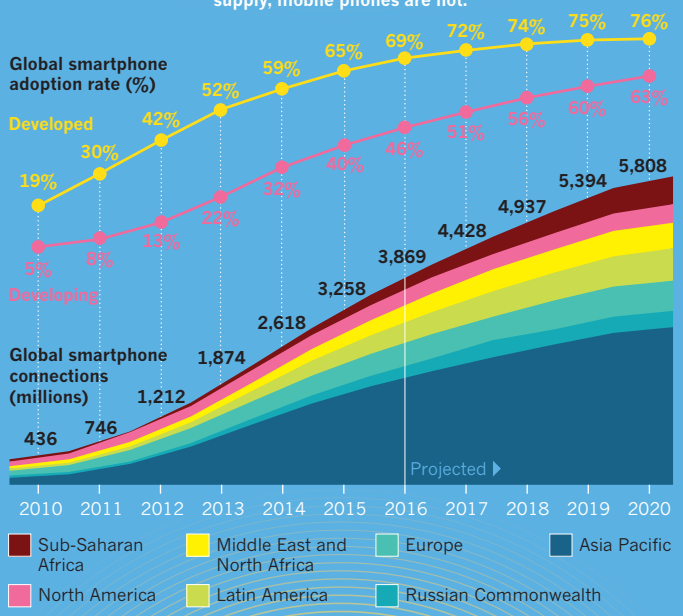
29%

Many people with mental illnesses don't get the help they need.



Although many factors might explain this treatment gap, a shortage of trained mental-health professionals plays a part, particularly in low-income countries.

But although psychiatrists may be in short supply, mobile phones are not.



Of about 15,000 disease-specific mobile health apps identified in a 2015 survey, nearly one-third dealt with mental-health issues.

29%

Disease-specific health apps that focus on mental health

SOURCES: WHO; REF. 1; GSMA; IMS INST.

trials are rare, raising the possibility that a 'digital placebo effect' may explain some of the positive outcomes that researchers have documented, says Torous. "We know that people have very strong relationships with their smartphones," and receiving messages and advice through a familiar, personal device may be enough to make some people feel better, he explains.

But the bare fact is that most apps haven't been tested at all. A 2013 review[8] identified more than 1,500 depression-related apps in commercial app stores but just 32 published research papers on the subject. In another study published that year[9], Australian researchers applied even more stringent criteria, searching the scientific literature for papers that assessed how commercially available apps affected mental-health symptoms or disorders. They found eight papers on five different apps.

The same year, the NHS launched a library of "safe and trusted" health apps that included 14 devoted to treating depression or anxiety. But when two researchers took a close look at these apps last year, they found that only 4 of the 14 provided any evidence to support their claims[10]. Simon Leigh, a health economist at Lifecode Solutions in Liverpool, UK, who conducted the analysis, says he wasn't shocked by the finding because efficacy research is costly and may mean that app developers have less to spend on marketing their products.

A separate analysis[11] found that 35 of the mobile health apps originally listed by the NHS transmitted identifying information — such as e-mail addresses, names and birthdates — about users over the Internet, and two-thirds of these did not encrypt the data.

Last year, the NHS took this apps library offline and posted a smaller collection of recommended online mental-health services. The NHS did not respond to e-mailed questions or make an official available for interview, but it did provide this statement: "We are working to upgrade the Health Apps Library, which was launched as a pilot site in 2013 to review and recommend apps against a defined set of criteria which included data protection."

The regulation of mental-health apps is opaque. Some apps designed to be used in a medical context can be considered medical devices and therefore may be regulated by the UK Medicines and Healthcare Products Regulatory Agency, the US Food and Drug Administration (FDA) or equivalent bodies elsewhere. But the lines are fuzzy. In general, an app that claims to prevent, diagnose or treat a specific disease is likely to be considered a medical device and to attract regulatory scrutiny, whereas one that promises to 'boost mood' or provide 'coaching' might not. The FDA has said that it will regulate only those health apps that present the highest risks to patients if they work improperly; even mental-health apps that qualify as medical devices might not be regulated if the agency deems them to be relatively low risk.

But the potential risks are not well understood. "At the low end, people might waste their money or waste their time," says Martin, "and at the higher end, especially with mental health, they might be actively harmful or giving dangerous advice or preventing people from going and getting proper treatment."

When a team of Australian researchers reviewed 82 commercially available smartphone apps for people with bipolar disorder[12], they found that some presented information that was "critically wrong". One, called iBipolar, advised people in the middle of a manic episode to drink hard liquor to help them to sleep, and another, called What is Biopolar Disorder, suggested that bipolar disorder could be contagious. Neither app seems to be available any more.

Martin says that in Europe, at least, apps tend to come in two varieties, those that are commercially developed and come with little supporting evidence or plans for evaluation, and those with academic or government backing that take a more rigorous

approach. The problem is that the former are generally more engaging for users and the latter take so long to make it to the market — if they even do — that they look out of date. "This is a generalization," Martin says, "but it's broadly true."

UNINTENDED CONSEQUENCES

Even well-intentioned apps can produce unpredictable outcomes. Take Promillekoll, a smartphone app created by Sweden's government-owned liquor retailer, designed to help curb risky drinking. While out at a pub or a party, users enter each drink they consume and the app spits out an approximate blood-alcohol concentration.

When Swedish researchers tested the app on college students, they found that men who were randomly assigned to use the app ended up drinking more frequently than before, although their total alcohol consumption did not increase. "We can only speculate that app users may have felt more confident that they could rely on the app to reduce negative effects of drinking and therefore felt able to drink more often," the researchers wrote in their 2014 paper[13].

It's also possible, the scientists say, that the app spurred male students to turn drinking into a game. "I think that these apps are kind of playthings," says Anne Berman, a clinical psychologist at the Karolinska Institute in Stockholm and one of the study's authors. There are other risks too. In early trials of ClinTouch, researchers found that the symptom-monitoring app actually exacerbated symptoms for a small number of patients with psychotic disorders, says John Ainsworth at the University of Manchester, who helped to develop the app. "We need to very carefully manage the initial phases of somebody using this kind of technology and make sure they're well monitored," he says.

In a pilot trial published earlier this year, ten US veterans with PTSD were randomly assigned to use PTSD Coach on their own for eight weeks, while another ten used the app with the support and guidance of primary-care providers. At the end of the trial, seven of the ten patients using the app with support showed a reduction in PTSD symptoms, compared with just three of the patients who used the app on their own[14].

But if apps require medical supervision, that undermines the idea that they will serve as an easy and low-cost way to provide care to the masses. "People think there's an app for everything," says Helen Christensen, the director of the Black Dog Institute at the University of New South Wales in Sydney, Australia, who has developed and studied mental-health apps. "It's actually about how we build systems around apps, so that people have health care."

Distributing mental-health apps in the developing world presents further challenges. Although mobile technology is spreading rapidly, there are many people who do not have — or cannot afford — smartphones or mobile Internet access. And the content of apps needs to be delivered in local languages and reflect local cultures. "The notion that you can take an intervention and just plop it down in a region where people might not even use the same terms for mental health as you're using is a little unrealistic," says Ben-Zeev. "What we might call 'hearing voices' in the United States might be something like 'communicating with your elders' in a different region, depending on what label people attach to that experience."

At this point, the notion that apps can deliver quality health care in low-income regions remains largely theoretical. "This is generally where the mHealth field is," says Natalie Leon, a scientist at the South African Medical Research Council in Cape Town. "It's a promise of potential effectiveness."

GOOD PRACTICE

To make good on that promise, apps will have to be tested. Between 2013 and 2015, the number of mobile-health trials registered on ClinicalTrials.gov more than doubled, from 135 to 300. And the number of trials specifically focused on mental and behavioural health increased by 32%, according to a report by the IMS Institute for Health Informatics in Parsippany, New Jersey.

One digital health company that has earned praise from experts is Big Health, co-founded by Colin Espie, a sleep scientist at the University of Oxford, UK, and entrepreneur Peter Hames. The London-based company's first product is Sleepio, a digital treatment for insomnia that can be accessed online or as a smartphone app. The app teaches users a variety of evidence-based strategies for tackling insomnia, including techniques for managing anxious and intrusive thoughts, boosting relaxation, and establishing a sleep-friendly environment and routine.

> "WE NEED TO VERY CAREFULLY MANAGE THE INITIAL PHASES OF SOMEBODY USING THIS TECHNOLOGY AND MAKE SURE THEY'RE WELL MONITORED."

Before putting Sleepio to the test, Espie insisted on creating a placebo version of the app, which had the same look and feel as the real app, but led users through a set of sham visualization exercises with no known clinical benefits. In a randomized trial, published in 2012, Espie and his colleagues found that insomniacs using Sleepio reported greater gains in sleep efficiency — the percentage of time someone is asleep, out of the total time he or she spends in bed — and slightly larger improvements in daytime functioning than those using the placebo app[15]. In a follow-up 2014 paper[16], they reported that Sleepio also reduced the racing, intrusive thoughts that can often interfere with sleep.

The Sleepio team is currently recruiting participants for a large, international trial and has provided vouchers for the app to several groups of independent researchers so that patients who enrol in their studies can access Sleepio for free.

"We think this is the way forward for digital health," says Espie. Mobile-phone-based treatments, he says, "should be tested and judged like any other intervention. We shouldn't treat people's health with any less respect because the treatment is coming through an app." ■ SEE COMMENT P. 25

Emily Anthes *is a freelance journalist in New York City.*

1. Steel, Z. *et al. Int. J. Epidemiol.* **43,** 476–493 (2014).
2. Kuhn, E. *et al. Mil. Med.* **179,** 12–18 (2014).
3. Ben-Zeev, D. *et al. Schizophr. Bull.* **40,** 1244–1253 (2014).
4. Beiwinkel, T. *et al. J. Med. Internet Res.* **3,** e23 (2016).
5. Dagöö, J. *et al. J. Anxiety Disord.* **28,** 410–417 (2014).
6. Watts, S. *et al. BMC Psychiatry* **13,** 49 (2013).
7. Birney, A. J., Gunn, R., Russell, J. K. & Ary, D. V. *J. Med. Internet Res.* **4,** e8 (2016).
8. Martínez-Pérez, B., de la Torre-Díez, I. & López-Coronado, M. *J. Med. Internet Res.* **15,** e120 (2013).
9. Donker, T. *et al. J. Med. Internet Res.* **15,** e247 (2013).
10. Leigh, S. & Flatt, S. *Evid. Based Ment. Health* **18,** 97–99 (2015).
11. Huckvale, K., Prieto, J. T., Tilney, M., Benghozi, P.-J. & Car, J. *BMC Med.* **13,** 214 (2015).
12. Nicholas, J., Larsen, M. E., Proudfoot, J. & Christensen, H. *J. Med. Internet Res.* **17,** e198 (2015).
13. Gajecki, M., Berman, A. H., Sinadinovic, K., Rosendahl, I. & Andersson, C. *Addict. Sci. Clin. Pract.* **9,** 11 (2014).
14. Possemato, K. *et al. Gen. Hosp. Pyschiatry* **38,** 94–98 (2016).
15. Espie, C. A. *et al. Sleep* **35,** 769–781 (2012).
16. Espie, C. A. *et al. Sleep Med.* **15,** 913–917 (2014).