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The Functionality, Evidence and Privacy Issues around Smartphone Apps for the Top Neuropsychiatric Conditions

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Abstract

Objective: There are over 325,000 health-related smartphone applications (apps) on the market. To better understand the apps on the market for the five most disabling neuropsychiatric conditions, we conducted a study investigating their intended uses (target population and intervention), data collected, and privacy policies.

Design: This was a cross-sectional study of apps for the five most disabling neuropsychiatric conditions per the World Health Organization: 1.Stroke, 2.Migraine, 3.Depression, 4.Alzheimer's/Dementia, and 5.Anxiety. Up to 15 apps in both the US Google Play and Apple app stores were selected based on pre-specified inclusion criteria: in top 50 search results, offered intervention and/or tracking capabilities, and listed the condition in the app title/description. Exclusion criteria were: \$5+ to purchase, solely motor versus cognitive-based intervention, or designed for use by caregivers/healthcare providers. Data abstracted included function, behavior change rewards, and information about intervention, privacy policy, and payment.

Results: 83 apps were reviewed (Stroke n=8; Migraine n=25; Alzheimer's/Dementia n=8; Depression n=7; Anxiety n=14; apps targeting Depression and Anxiety n=21). 69% of apps had an intervention component; 18% were deemed evidence-based. 77% had a privacy policy. 70% required payment for access to all features. 19% rewarded user behavior changes.

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Author Contributions:

Dr. Mia Minen, Mr. Eric Stieglitz, and Dr. John Torous contributed to the concept design of this study. Ms. Ariana Gopal and Ms. Gabriella Sahyoun collected the data from the Google Play and Apple app stores, respectively. Ms. Gopal and Ms. Sahyoun were also responsible for analyzing the data they collected and interpreting the results, but received oversight from Dr. Minen, Mr. Stieglitz, and Dr. Torous. Dr. Minen, Ms. Gopal, and Ms. Sahyoun were responsible for drafting the initial manuscript, but all authors contributed to revisions. Dr. Minen was responsible for supervising all actions required to complete this cross-sectional study and create this final manuscript.

COMPETING INTERESTS

This study did not receive any funding. Both Dr. Minen and Dr. Torous report National Institutes of Health-funded smartphone app studies. The remaining authors do not have any conflicts of interest to disclose.

DATA SHARING

Beyond information included in the supplementary document, there is no additional data available.

Conclusions: Most apps on the market targeted Migraine, Depression, and Anxiety and contained interventions though most of the interventions did not appear to be evidence based. Further, while most apps had privacy policies, lay people may have difficulty understanding the policies due to their complexities.

Keywords

smartphone applications; self-management tools; stroke; migraine; depression; Alzheimer's/dementia; anxiety

INTRODUCTION

Neuropsychiatric disorders include mental and behavioral disorders as well as neurological disorders, which in total are responsible for 10.4% of total global Disability-Adjusted Life Years (DALYs).^{1} World Health Organization (WHO) research has shown that there are large inequalities in access to neuropsychiatric care across different populations. There is a global shortage of neurologists,^{2} psychiatrists,^{3} and other healthcare professionals who treat these conditions, and there is a need for innovative strategies to help patients with these disabling neuropsychiatric conditions. Many companies and individuals have developed smartphone applications (apps) with claims to help these patients. In 2019, it was estimated that 2.7 billion people would own smartphones and have access to over 325,000 mobile health (mHealth) apps.^{4,5} While there is a negative association between age and the use of smartphone apps,^{6} research suggests that the rise and use of these apps in neuropsychiatric patients is substantial.^{7} With the rapid growth of these monitoring and self-management tools, there is great potential for collecting and sharing personal and health-related information.^{8}

In the United States, there is limited regulation of health or medical apps unless they are considered medical devices under the FDA^{9} or fall under the Health Insurance Portability and Accountability Act (HIPAA), which applies to “covered entities” (such as doctors, hospitals, and insurance providers) and their “business associates.” Third-party app companies need to only abide by HIPAA if there is a direct relationship between the app company and the covered entity.^{10} However, HIPAA is generally focused on patient privacy. Whether apps are of use to patients is not well studied.

Currently, there are a wide range of apps on the market for various neurologic and psychiatric conditions. Apps have been developed and used for tracking symptoms and medications for conditions such as migraine,^{11} epilepsy,^{12} Multiple Sclerosis,^{13} concussion,^{14} stroke,^{15} Parkinson's Disease,^{16} dementia,^{17} and depression.^{7} The American Psychiatric Association (APA) recommends a process for informed decision making in picking apps; it does not recommend any particular apps for patient use.^{18} The American Academy of Neurology does not have any such recommendations or guidelines.

Because of the growing attention and interest globally in using smartphone applications for various disabling neurologic conditions,^{19, 20, 7} neurologists and psychiatrists should consider having conversations with patients about how their medical data (and other personal information) might be used by apps they download. In order to better understand

the apps on the market for neurologic and psychiatric conditions, including their intended use (target population and intervention), data collected, privacy policies, and more, we sought to conduct a representative analysis of the apps on the market for the most disabling neuropsychiatric conditions.

METHODS

Table 1 shows the method for determining the top five neuropsychiatric conditions and the method of selection of apps for inclusion/exclusion into the study as determined by the team of experts on the author panel. Using the list of the top five neuropsychiatric conditions, a systematic search of the Google Play Store and Apple App Store was conducted during 7/30/18–9/2/2018. Using these search results, AG and GS selected and evaluated the top 15 apps in each operating systems' stores meeting criteria corresponding to the following search terms: Stroke/Stroke Therapy, Migraine, Depression, Alzheimer's, and Anxiety. GS performed the same search in the Apple App Store. Many of the Stroke apps that appeared in the initial search were ineligible, as they were typically designed for clinicians or family members to determine if another person was having a stroke. For this reason, the search term "Stroke Therapy" was then utilized opposed to "Stroke." If an app appeared in both of these stores, the app was only counted once. These apps were cross referenced between AG and GS to determine if there were any differences in functionality or features offered in different operating systems. Of note, as we were conducting the search, the order of apps appearing in the search results from both app stores varied on a daily basis - related to Apple and Google's proprietary rankings and featuring of apps. AG installed apps on an Android device and abstracted data to review the operation of Google ecosystem apps. Similarly, GS installed apps on an iOS device and abstracted data to review the operation of Apple ecosystem apps.

PATIENT AND PUBLIC INVOLVEMENT

The mobile health apps reviewed on the Google Play and Apple app stores were all publically accessible. Patients were not involved in this study.

DATA COLLECTION

Between 7/30/18 and 9/2/18, AG and GS abstracted data from the apps, information from the app stores and their websites. Data extracted included the following details: app ratings and search logistics, target population, app function, the existence of a privacy policy, intercommunicability, and app/developer endorsements. Details of the search, the data abstracted, and the definitions developed by coders for each of the features can be found in Table S1 and Table S2 in the Supplement. The research team did not attempt to evaluate the technical functioning of the apps, or seek to corroborate the claims of the app developer. As noted in the table, apps were only included in the study if they were free or if their initial payment for app purchase was less than \$5.

For free-purchase apps, the team did not pay for subscriptions, premium versions, or the full versions of Lite apps. Initial purchases were made for the paid versions of one of the Android apps and seven iOS apps. The research team evaluated the app websites for

information pertaining to prior research studies conducted using the app in the form of meeting abstracts and publications to determine if the intervention components of the apps were deemed evidence-based. We did not conduct our own independent review outside of the app websites to determine whether the apps were used in research studies. The research team also abstracted the app websites for information pertaining to endorsements from other organizations. A record was made as to whether there was a privacy policy on the websites, apps themselves, or the Google Play Store and App Store. Even one sentence privacy policies were included in this study. Given the differences between Google and Apple products, some modifications in the searches were required. Specifically, the App Store did not provide information on number of app downloads per app, but the Google Play Store did.

DATA ANALYSIS

Data was stored in Excel and descriptive analyses are reported. A priori, we planned to have an attorney who is a Certified Privacy Professional (CIPP) then review the policies for accuracy to ensure that the lay people (AG and GS) could reliably abstract and interpret the privacy data to assess whether typical users would be able to understand the content of the privacy policies.

Of note, given that the 83 apps were initially reviewed from 7/30/18 through 9/2/18, we also sought to determine if they were still available for download in the app store and if they were “active,” or still being used by the general public; apps were considered active if they had a user review dating 9/1/19 and later. Thus, after submission to the journal and prior to publication, we re-reviewed the apps to ensure that the data we presented were still relevant.

The study was exempt from IRB approval, as all data collected was publically accessible and no human subjects were included.

RESULTS

There were five neuropsychiatric conditions and there were a maximum of 15 apps per condition that could be selected from each app store. Some apps were available in both app stores, and after conducting the search we realized that there were some apps that were listed under both anxiety and depression. Thus, there was a total of 83 apps reviewed (Stroke n=8; Migraine n=25; Alzheimer’s/Dementia n=8; Depression n=7; Anxiety n=14; apps targeting both Depression and Anxiety n=21). Details regarding the specifics of the apps evaluated for each condition can be found in Tables S3–S8 in the Supplement. Download data for each category of apps can be found in Table 2. Mean app downloads were highest for anxiety (over 2.12 million) followed by anxiety+depression (135,769) and then migraine (72,440). All of the apps were reported to be self-help apps. The vast majority of all of the apps (with the exception of migraine) included an intervention component (69%). However, less than a quarter of the migraine apps were considered to include interventions (24%), though 76% of the apps for migraine were for tracking data. Apps for anxiety and apps for anxiety+depression were also for tracking, 50% and 57% respectively. Very few of the apps that provided interventions were considered evidence-based (18%). Additionally, only 19% of the apps incorporated rewarding behavioral changes in their design.

For two of the anxiety+depression overlap apps, an interventional component was offered, but was not accessible to the user in any capacity without payment. These apps are included as part of the total percentage values generated above, but are marked with an asterisk in Table 3. App evaluations averaged between 18–28 minutes across all app disease states. This average includes the time we allocated to evaluating the apps themselves, their corresponding websites, and finding and reviewing their privacy policies.

Privacy policy data can be found in Table 3. The vast majority of apps stated that they had privacy policies (77%). We had initially planned to quantitatively define the number of privacy policies stating that they shared data with third parties, sold data to third parties, etc. We had two lay people (AG and GS) abstract the data from the individual apps and then create a table with their results. We then had an attorney who is also a Certified Information Privacy Professional (CIPP) examine the policies and tables created by the two lay individuals. The attorney discovered that there was significant complexity in how the various app companies described if and how the data was shared or sold. Most importantly, the attorney noticed that it was difficult for a lay person to understand from a privacy policy, even ones that appeared to be in plain English how data was shared. For example, some apps stored personal data input e.g. headache days, depression symptoms while others only shared non-personal data such as the operating system on the device. Additionally, some policies specified that personal user data could never be shared or sold however non-personal phone data such as app malfunctions could be shared for app improvement functions.

As seen in Table 4, the app functions varied greatly. The apps most likely to display user-entered data, such as symptoms, emotions, medications taken, were for migraine (76%), anxiety+depression (76%) and anxiety (57%). Accordingly, migraine apps were the most likely to generate a data report (72%) followed by anxiety (57%) and anxiety+depression (48%). These data reports typically compiled previously mentioned user-entered data displayed into a table or graph form. Of the apps that enabled users to generate a data report, one anxiety+depression app required user payment to access this feature. Similarly, to download or export data logged on the app, three of the migraine apps offered this feature, but required user payment to access it. These apps are marked with an asterisk in Table 4. Many of the apps offered an educational component: depression (100%), Alzheimer's disease (63%), and anxiety+depression (62%). Few apps took advantage of online coaching or social networking. As seen in Table 3, online coaching was not part of the large majority of the functionality apps (Median 0, range 0%–29%). As seen in Table 4, only a small minority of apps used social network capability (ranges for the different diseases were 0%–33%).

As previously mentioned, a majority of the apps evaluated offered some kind of interventional component (69%). Stroke and Alzheimer's apps evaluated provided cognitive tasks, such as mental association or memory games. Of the 24% of migraine apps that offered intervention, a majority of these apps did so in the form of hypnosis or music. The interventions offered through the depression, anxiety, and anxiety+depression apps contrast these methods; while some offered music/hypnosis for relief, these apps were more focused on putting users in control of their symptoms utilizing techniques like

meditation, mindfulness, and deep breathing exercises. Some of these apps incorporated reflection activities for users independently or in conjunction with an artificially intelligent (AI) therapist, which correspond to evidence-based Cognitive Behavioral Therapy (CBT) or Progressive Muscle Relaxation Therapy (PMR) methods deemed effective for treating such conditions in a clinical context.

Finally, as discussed in the methods, we sought to determine whether the apps were still available and current at the time close to publication of the paper. These results are summarized in Table 5. As of 2/27/20, 72 (87%) of the apps were still available on the Google Play and Apple App Stores. Of the 72 apps still available for download, 75% were still considered active by our team.

DISCUSSION

In our critical analysis surveying the landscape of the types of apps for the top five neuropsychiatric conditions, we have several key findings. First, despite all being in the top five neuropsychiatric conditions, there were more apps available for users with Migraine, Depression, and Anxiety than for users with Stroke and Alzheimer's/Dementia. Second, these Stroke and Alzheimer's/Dementia apps generally met few of the recommended features of the APA framework, particularly with respect to functionality and evidence-based components. Lastly, privacy policies could not be easily understood by lay individuals.

It is unsurprising the largest number of apps (and the greatest number of downloads) were for anxiety-depression and migraine given the high disease prevalence in this population as well as the younger age of those affected. Stroke and Alzheimer's had the fewest apps meeting study criteria. A possible explanation for the low number of apps in these categories is that we excluded apps that were intended for caregiver use; perhaps app developers do not focus on apps for use by participants with these conditions because they believe that they would not be able to use such apps. Also, in the case of stroke, we excluded apps related to motor symptoms, and some apps for stroke were focused more on motor improvements. Research into apps for both Alzheimer's and stroke may pose their own issues such as ethical concerns.^{21} On the one hand, the few apps for Alzheimer's included in this study is surprising given that one of the WHO's top ten research priorities to reduce the global burden of dementia by 2025 is delivery of care and services for people with dementia and their caregivers. Included in their thematic analysis of this category is to "understand the role of assistive and technological devices, including e-health and mobile health technology strategies, for people with dementia and/or their carer(s)."^{22} Research has shown that people with dementia want to be included in research using these technologies.^{21} Age itself may not be a barrier but more research in older adults is needed to determine the best ways to scale and implement these technologies.^{23} In particular, we need to consider that everyday technologies oftentimes present a barrier for older people, especially those with dementia.^{24} Thus, as we consider next steps for the adaptation of these wearables and technologies into everyday life, we need to consider whether there might be additional barriers and whether they can be used under nonoptimal or uncontrolled conditions.^{25} A taskforce worked together to discuss and reach consensus regarding the current state of technologies for community-dwelling people with dementia.

Two of the three areas of global need focused on the persons themselves and were thus relevant to the paper: “1. Devices intended to help persons living with dementia to manage their everyday life across the disease journey, such as electronic calendars and reminders for activities, medication reminders, aids to perform activities of daily life, robots, and navigation systems. 2. Technologies to help people engage in meaningful and pleasurable activities such as cognitive stimulation and physical activities, as well as technologies to improve social participation, contact, and support.” They asked, “How can technologies address the heterogeneous needs of persons with dementia? Should technologies be designed specifically for dementia or adapted from mainstream technology? What methods are more efficacious when developing technologies for persons living with dementia?” We refer readers to that article for a more in depth discussion of the consensus recommendations. In summary, though, research into these technologies for people with dementia infrequently deal with home-based, real-life evaluations. Furthermore, most technologies were far removed from everyday life experiences and were not mature enough for use under nonoptimal or uncontrolled conditions.

As stated above, we used the APA framework as a guide for the categories we sought to incorporate into our app evaluation model. To start, a majority of the apps in this study required subscription or cost to either purchase the app or access all of its features. Of the eight apps that required initial purchase, seven were from the Apple App Store. This means it is difficult for people using the iOS platform to pick an app without investing in it before being able to fully evaluate if it is suitable to their health needs.

The functionality of many of the apps was limited. With the exception of Alzheimer’s and anxiety+depression apps having the lowest likelihood of being able to share information or achievements with other applications, 57–75% of apps for all of the other conditions had intercommunicability features. This is surprising given that anxiety+depression apps were the second most downloaded. Scarcity in intercommunicability features along with the limited capacity to export/download data reports generated reduces the user’s ability to communicate directly from the app with others, for example, his or her physician or family and friends – and risks fragmenting care by decreasing the feasibility of sharing user entered data (symptoms, feelings, etc). Additionally, very few apps provided guidance based on user entered data, which could be beneficial to users in instances where they are experiencing a mental health crisis or at risk of suicide.

Further, while the need for evidence-based interventions and apps, as reflected in the APA framework, makes clinical sense, few apps we examined offered such evidence. Migraine apps were the least likely to include any evidence-based intervention, while anxiety and depression apps were the most likely, although even that evidence was often minimal and of a pilot nature. Migraine was also the condition least likely to include any interventional component at all, focusing more on tracking capabilities. The lack of evidence surrounding such interventional components in this study is consistent with findings reported by Byambasuren et al., who also found limited quality evidence amongst predominantly obesity, mental health, and diabetes geared mhealth apps. {26}

The evidence-based intervention most commonly purported to be adapted as an intervention in the app was cognitive behavioral therapy. Though several apps in our study stated that they used CBT or CBT-based techniques, (Pacifica, Youper, Wisa, What's up?, Depression CBT Self Help, Curable) only the Betterhelp app appeared to deliver therapist-supported internet based CBT (ICBT), an established CBT intervention in which an identified therapist who provides direct support to a user/patient in need.^{27} Even so, although ICBT appears to be an efficacious treatment for anxiety in adults, the evidence comparing therapist-supported ICBT to waiting list, attention, information, or online discussion group only control was low to moderate quality, the evidence comparing therapist-supported ICBT to unguided ICBT was very low quality, and comparisons of therapist-supported ICBT to face-to-face CBT were low quality.^{28} Further research is needed to better define and measure any potential harms resulting from these types of treatment.

An emerging intervention in some apps was chatbot technology; four apps utilized this tool, including Wisa, Youper, and 7 Cups for mental health, and Curable for migraine/general pain. Chatbot technology tries to offer treatment in the form of an ongoing text message conversation. The interest in these bots is due to their often intuitive interface and efforts to establish a therapeutic alliance with the user, compared to often difficult to navigate health apps that do not seek to form a bond with the user. However, one limitation to bots is that they do not always have the correct answers and few have been clinically evaluated for safety or efficacy.

Additionally, of significant concern was the fact that many of the apps did not have an easy to understand privacy policy. The actual privacy rights provided to the user arise from a combination of applicable data laws and regulations, contractual promises made in apps' terms of services and privacy policies, and the technical mechanics of how an app records and stores information. With regards to the contractual promises, our experience in asking lay people to attempt to interpret and quantitatively assess how a policy either allows or limits the use of personal data showcase the difficulty that a lay person using the app may have understanding how a privacy policy affects their rights and use of the data.

With regard to the technical mechanics, if the app does not record personally identifiable information (e.g. the app merely plays music and sends no usage data to a data provider), privacy concerns are low. Similarly, if the app records personal information but only stores it on the user's own device instead of a remote server, and never transmits this information elsewhere, privacy concerns are low. However, if personal data, especially personal health information and app usage data, are stored remotely on the app provider's servers, there is increased risk that the user's data may be used or sold for purposes not known or desired by the user.

The laws and regulations applicable to any app are specific to the location of the user and the location of the app company and its computer servers. Users may not realize that they have downloaded and used an app that transmits their data to a country with limited data protection laws. If the app company lacks a physical or legal presence in the user's own country, the user may have little recourse to misuse of their personal data. In this study, many of the apps came from providers outside the United States. The protection

granted by local laws varies widely. For example, the California Consumer Privacy Act and the European Union's General Data Protection Regulation both allow users to demand deletion of their personal data from providers under certain conditions. However, many other jurisdictions do not provide users with the right of deletion, and the only rights available to the user are those contractual rights that the user can enforce locally. Thus, though marketed as tools to help alleviate the conditions in question and help users keep track of their symptoms, there needs to be clearer regulation and transparency regarding how user information is being collected, used, stored, and potentially sold.

Strengths

We believe that this is the first study to examine the landscape of apps targeting the most disabling neuropsychiatric conditions, and who such apps may be intended for. The data obtained was data that a lay person or patient might view when searching for an app to address their health needs. This study also sheds light on the types of interventions offered by such apps, whether the apps themselves are evidence-based, and what features are prevalent amongst apps to facilitate communication between patient and physician.

Limitations

This was a study to better understand the types of apps on the market for various neuropsychiatric conditions. We did not deconstruct any of the apps to better understand the way in which they work nor did we do an in-depth critique of the privacy policies. Additionally, beyond the data shown in Table 5, it is possible that the top 15 apps available on the market for these five specific neuropsychiatric conditions may have changed since the initial data collection period from 7/30/18–9/2/18,{29} as well as specific app features/evidence supporting interventional components.

Future Directions

Future work may examine whether more apps over time utilize evidence-based interventions, whether companies make it easier to comprehend privacy policies, and whether there are efforts to promote funding from the government, foundations and private sector to prioritize mHealth research.

Conclusion

The issues raised in this article are relevant today and will be for the near foreseeable future. Because neither major federal regulation or reimbursement for the use of these apps has greatly advanced since 2018 - in many ways the core forces shaping the app marketplaces remain the same today in 2020. For example, the issues around engagement with diverse health apps featured in 2018 and earlier are now coming to light and publication{30} and work on technical security issues from early 2018 were only published in mid 2019.{31} Even current reviews of the entire app space in 2020 continue to rely heavily on results from prior years.{32}

In conclusion, we found few apps on the market for select neuropsychiatric conditions. Moreover, few of the interventions these apps offered were evidence-based. While the

majority of the apps had privacy policies, lay people had difficulty understanding their implications. Patients and providers may still find benefit with currently available apps, but should carefully evaluate them to ensure they are informed of the risks and benefits.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1:

Methods for Apps Selected for this Study and Pre-specified Criteria

Determining Top Five Neuropsychiatric Conditions	
1	The APA app evaluation framework served as an initial starting point for determining the key features in the app evaluation process, such as privacy, security, and efficacy. ³³
2	GS generated a list of the top five most disabling neuropsychiatric conditions worldwide according to the 2016 Global Burden of Disease Study by the WHO. We used the WHO’s global results tool ³⁴ to generate the list by selecting disability adjusted life years (DALYs) as the measure of disability.
3	Stroke, and neurological disorders, mental disorders, drug use disorders, depressive disorders, eating disorders, and autistic spectrum disorders were selected as the causes of DALYs for all ages and both sexes. This generated a list of 28 conditions, from which we picked the top five that caused the most DALYs. This list encompassed the following conditions ordered from most DALYs caused to least: 1. Stroke; 2. Migraine; 3. Major Depressive Disorder; 4. Alzheimer’s and other Dementias; 5. Anxiety Disorders.
Inclusion Criteria	
1	Listed under the medical, health or educational categories in the app stores.
2	Appear in the first 50 search results in the Google Play Store and the first 50 search results in the Apple App Store.
3	Offer an intervention/treatment or tracking mechanism for the user.
4	Included the name of the condition in the app title or description.
Exclusion Criteria	
1	If the interventions offered were solely motor opposed to cognitive-based therapy, since motor apps are a more heterogeneous category.
2	If the apps were designed for use by a family member or a healthcare provider.
3	If their initial payment for app purchase was greater than \$5.

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Table 2:

Download Data

Condition	Download Data		
	Mean	SD	Range
Stroke	4,420	4,010	100 – 10,000
Migraine	72,440	256,628	100 – 1,000,000
Depression	59,167	36,113	5,000 – 100,000
Alzheimer's	1,550	2,338	100 – 5,000
Anxiety	2,167,286	3,918,605	1,000 – 10,000,000
Anxiety + Depression	135,769	165,326	5,000 – 500,000
			Median
			5,000
			5,000
			50,000
			550
			50,000
			100,000

Table 3:

Composite Data Collected

Condition	Clinically Customizable		Self Help/ Public		Part of Care with Clinician		Online Coaching		Tracking		Intervention		Is Intervention Evidence Based?		Rewards Behavior Change		Username/ Password		Privacy Policy	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Stroke	8	100	8	100	1	13	0	0	2	25	8	100	2	25	0	0	1	13	7	88
Migraine	19	76	25	100	7	28	1	4	19	76	6	24	0	0	0	0	8	32	17	68
Depression	3	43	7	100	0	0	0	0	3	43	6	86	1	17	1	14	3*	43	4	57
Alzheimer's	3	38	8	100	0	0	0	0	3	38	8	100	1	13	4	50	4	50	7	88
Anxiety	7	50	14	100	0	0	0	0	7	50	14	100	1	7	6	43	11	79	12	86
Anxiety + Depression	16	76	21	100	4	19	6	29	12	57	15*	71	5	33	5	24	15	71	17	81

* Some apps required additional payment or a subscription to access certain features. Of the 3 Depression apps that enabled users to include a username/password, 1/3 = 33% of them required payment to access this feature. Of the 15 Anxiety + Depression apps that offered an interventional component, 2/15 = 13% of these apps required payment to access this feature.

App Features/Function Data

Table 4:

Condition	Displays Data		Generates Data Report		Data Export/Download		Education		Provides Guidance		Inter-communicability		Social Network		Ads		Organization Support/Endorsement	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Stroke	0	0	2	25	2	25	0	0	3	38	6	75	0	0	0	0	1	13
Migraine	19	76	18	72	15*	60	4	16	8	32	17	68	2	8	11	44	6	24
Depression	3	43	2	29	1	14	7	100	2	29	5	72	0	0	3	43	0**	0
Alzheimer's	2	25	3	38	2	25	5	63	2	25	2	25	1	13	0	0	3	38
Anxiety	8	57	8	57	3	21	8	57	3	21	8	57	4	29	1	7	9	64
Anxiety + Depression	16	76	10*	48	4**	20	13	62	7	33	8	38	7	33	3	14	9	43

* Some apps required additional payment or a subscription to access certain features. Of the 15 Migraine apps that enabled users to export data, 3/15= 20% required payment to access this feature. Of the 10 Anxiety + Depression apps that generated data reports, 1 required additional payment to access this feature.

** Uncertainties were excluded from final analyses for if an individual feature's presence lacked clarity. 1 Depression app was unclear if it had any organization support/endorsement, and 1 Anxiety + Depression app lacked clarity with respect to its data export/download capacity.

Table 5: Apps that continued to be available throughout the study period (7/30/18–2/28/20)

Condition	Available for Download		Removed from Stores		Active*	
	N	%	N	%	N	%**
Stroke	5	63	3	38	3	60
Migraine	22	88	3	12	9	41
Depression	7	100	0	0	6	86
Alzheimer's	7	88	1	13	6	86
Anxiety	13	93	1	7	12	92
Anxiety + Depression	18	86	3	14	18	100

Table 5 showcases the number of apps we evaluated that are currently available for download, how many have been removed from stores, and the quantity that are actively being used by the general public.

* Apps are considered active if they had a reviewer comment posted from 9/1/19 to present.

** The percentage of active apps shown in this table was derived by dividing the total number of active apps by the total number of apps that were still available for download.