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Mental health mobile app use: Considerations for serving underserved patients in integrated primary care settings

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1. Background

1.1. Burden of depression

Depression, the most commonly experienced mental illness, affects more than 264 million people and is one of the leading causes of disability worldwide [1]. Depression, or major depressive disorder, is characterized by depressed mood and often accompanies other symptoms such as lack of interest, fatigue, feelings of worthlessness, impaired thinking, psychomotor agitation or slowing, thoughts of being better off dead and/or of suicide [2]. According to the 2018 National Survey of Drug Use and Health (NSDUH), 17.7 million or 7.7% of U.S. adults met the criteria for having a major depressive episode in the past year [3]. The prevalence of depression is closely related to socioeconomic factors and prevalence increases as family income level decreases. For example, 19.8% of women aged 20 years and older living below the federal poverty level (FPL) experience depression compared to only 4.8% of those living at or above 400% of the FPL [4]. Despite the availability of safe and effective treatments, many adults diagnosed with depressive disorders do not receive treatment [5]. Of the 17.7 million adults (≥ 18 years) meeting criteria for a major depressive disorder in the past year, only 64.8% reported having received treatment for depression [3]. There are disparities in receipt of treatment for mental health care, particularly among racial and ethnic minority groups. Only about 30% of African American and Hispanic adults (≤18 years) with any mental illness receive treatment, compared to 43.3% of the overall U.S. population [3]. Further, for those with lower education, the

odds of receiving treatment declined (women) or remained stable (men) between 2005 and 2014 [6].

1.2. Integrated primary care

One promising setting for providing mental health services is within primary care, defined as “health care provided by a medical professional such as a general practitioner, pediatrician, or nurse with whom a patient has initial contact and by whom the patient may be referred to a specialist” [7]. Providing mental health services within the primary care setting can de-stigmatize treatment for mental health, overcome barriers to accessing care, and offer an opportunity to blend interventions that target both physical and mental health conditions [8]. Integrated Primary Care (IPC) in particular unites medical and behavioral health services to more fully address patients’ total health in a clinically effective and economically efficient manner [9]. IPC has been empirically shown to be an effective strategy in the treatment of a host of medical and psychosocial challenges, including improving global mental health functioning [10] as well as the treatment of depression [11,12].

1.3. Potential roles of e-Health in depression care

Despite the effectiveness of integrated approaches in improving access to behavioral health care and patient outcomes, there are still notable implementation barriers to depression mental health treatment, including low patient appointment attendance, limited insurance coverage, and difficulties in reaching patients via telephone for care management [13]. These barriers may be mitigated through the use of e-health defined by the World Health Organization as “the use of information and communication technologies for health.” E-health may be particularly effective in the context of self-management, which is defined as “the training, skill acquisition, and interventions through which patients who suffer from a disease or chronic condition may take care of themselves and manage their illnesses.” [14] Self-management is “dynamic, interactive process by which individuals seek to meet their everyday social, emotional, psychological and physical needs.” [15] The concept of self-management refers to giving patients more options and control over treatment options and opportunities for their active participation in recovery and maintaining their health [15]. A recent study in integrated care settings indicate promising results regarding the mobile app self-management application to treat patients with depression [16].

E-health, delivered through the use of mobile apps, defined as “a software program you can download and access directly using your phone or another mobile device, like a tablet or music player,” [17] has the potential to 1) increase access to care for patients in the community using mobile technology, defined as “technology that goes where the user goes” which “consist of portable two-way communication devices, computing devices and the networking technology that connects them,” [18] 2) provide reminders for appointments and/or medication regimen recommendations, 3) foster self-reliance and the development of self-management skills for mental health, and 4)

provide a low-resource option to extend clinic-based treatment into the community by promoting patient self-management. For instance, a depressed patient with transportation barriers who struggles utilizing cognitive behavioral therapy (CBT) strategies between clinic appointments could use a no-cost CBT app to promote ongoing skill development at the patient's convenience. E-health also offers a number of solutions to address the depression related barrier of medication adherence including remote medication consultation, automatic ordering of prescriptions through smartphones, and reminders to take medications [19]. Using e-health, patients would have the opportunity to engage in evidence-based mental health self-management without having to overcome common access challenges (e.g., transportation, payment for services, obtaining and paying for childcare), and providers would have a mechanism to more quickly and accurately monitor between-appointment progress. When exploring options to facilitate care outside of the traditional clinic setting, certain factors become crucial, such as determining patients' ability for self-management of depression and what educational tools are needed to reinforce this type of support.

1.4. Self-management mobile apps

Self-management is increasingly becoming the standard of care for chronic medical conditions including depression. Self-management strategies for chronic disorders emphasize promoting patient independence and active patient involvement with the management of their own care [20]. However, self-management outside of the clinic setting can pose a unique dilemma: How can clinical measures be accessed without hindering patient independence, while simultaneously allowing care teams to ensure patients are accessing effective treatments and achieving preferred outcomes for their conditions? Further do under-served populations, defined as those who experience health inequities or difficulties in accessing care as a result of socioeconomic strain; racial or ethnic minorities; lack of insurance; and/or disabilities [21], have the access to the means (smartphone device access and data plans) to utilize mobile technology? Underserved communities have unique needs but they are less likely to participate in health services and have poor health status [22]. A study suggests the importance of the shared-decision making interventions to improve outcomes for these patients from disadvantaged backgrounds [23].

Due to the aforementioned emphasis on self-management for treatment of chronic conditions such as depression, self-management smartphone apps have been introduced to treat certain mental illnesses including post-traumatic stress disorder (PTSD). A recent meta-analysis study found that self-management smartphone app interventions to be effective in reducing PTSD symptoms as well as depressive symptoms among patients with PTSD [24]. Another randomized controlled trial which sought to explore methodology, use, and impact of 3 different depression apps found that apps with cognitive correlates can serve as a means to facilitate treatment, and improve depressed moods [24]. However, app adherence even in patients that downloaded the apps remains poor, suggesting the need to embed these tools into

delivery systems, such as IPC, to provide a means to address adherence and strategically reinforce the use of these tools to promote mental health.

A study conducted by Pew Research Center shows that 81% of Americans own a smartphone [25] and over two-thirds of adults are willing to use their smartphones to help manage their health [26]. Given high rates of ownership of mobile devices among underserved populations [27], mobile apps have the potential to reduce mental healthcare access barriers. Smartphones are among the most rapidly adopted mobile technology and the therapeutic potential of the use of smartphone apps has been examined extensively for physical conditions, such as diabetes and cardiovascular diseases [28]. Less research has been conducted on app use for mental health challenges, especially in underserved communities [29]. Yet, findings from a meta-analysis of randomized controlled trials clearly support the efficacy of smartphone-based mental health interventions [30]. Despite this evidence, there has been limited research on clinical protocols using mobile health apps for patients with depression in IPC settings, particularly those that focus on the self-management of depressive symptoms [31].

Integrating mobile interventions alone does not directly translate into self-initiated symptom recognition and patient utilization of self-management strategies [32]. In fact, it seems that despite perceived benefits of smartphone apps, the extent in which mobile apps are being used for depression self-management are being used irregularly and for periods of less than a month [33]. Importantly though, this study did not look at the use of self-management depression related mobile apps within the IPC. Embedding mobile apps within an IPC environment can leverage the systematic delivery of accountable care, along with the relationship that the patient has with the behavioral health provider to promote health. Further, IPC creates opportunities to actively incorporate mobile app self-management strategies within the patient's treatment plan suggesting a means to ameliorate duration and frequency of app use issues encountered with other studies.

1.5. Tailoring of self-management mobile apps

Another facet to mobile app interventions includes examining the patient population in order to tailor interventions to best support the self-management needs of individuals with depression and supplement the care they receive in IPC. For our purposes, tailoring refers to the customization and relevance of interventions that are unique to the individual which are derived from assessment [34], along with awareness to the content, behavioral techniques, frequency and delivery preferences specific to an individual [35]. A few recent studies on smartphone app use for weight management and hazardous drinking demonstrated the importance of tailoring the interventions to the needs and preference of users [36,37]. Further, another study exploring barriers and facilitators to self-management in individuals with musculoskeletal pain and co-morbid depression, found that self-management practices were not universally applicable highlighting the importance of tailoring interventions to meet an individual's needs [38]. Additionally, having support from care managers, being proactive, and offering multiple

self-management strategies from which individuals could choose from were perceived facilitators of self-management by patients [38].

Another component to the tailoring or personalization of self-management interventions should be to assess patient activation, also an important element in successful patient self-management [40]. While self-management and patient activation are related concepts, these concepts have different meanings. Patient activation is defined as “a multidimensional construct of one’s readiness and ability to manage their own health as well as proactively engaging in making informed decisions about health care.” [39] Patient activation encompasses an individual’s motivation and engagement in the management of their own health needs and can be seen as a moderator for communication among patients and care providers [40]. The relationship between patient activation and self-management is well established in research of diabetes. For example, a recent meta-analysis indicated that improved patient activation levels led to significant improvement in Type 2 diabetes mellitus self-management and clinical outcomes such as HbA1c level. A study of patients with chronic illnesses found that measuring patient activation may be helpful to categorize patients according to their perceived health in order to better support their needs related to their disease management and self-care [41]. Another study of patients in the U.S. Department of Veterans Affairs clinic settings indicate that veterans have varied preferences for self-management of mental health [42]. For instance, preference for special features or specific equipment were different [42]. There is a dearth of research on the potential impact that using mobile technology in patient care may have on patient activation. However, with a few exceptions [43], there have been limited intervention studies focused on smartphone app utilization in IPC settings, which seek to promote the self-management of depression of underserved communities [44].

Another practical factor to consider when seeking to incorporate mobile apps in a clinical setting pertains to patients’ educational needs, especially when working with underserved communities. Identifying what educational tools are needed as well as the health literacy levels of patients is critical to intervention success and should be determined at the onset of a project. Health literacy is defined by the World Health Organization as “the personal characteristics and social resources needed for individuals and communities to access, understand, appraise and use information and services to make decisions about health.” [45] Health literacy, a central factor linked to improving health outcomes, can be strengthened through patient activation [46], suggesting the importance of understanding both activation levels and literacy needs of a given population when planning future interventions. If educational tools are in need of development, it only makes sense to ensure that the materials used to facilitate understanding match the literacy needs of a given population and align with other self-management measures being collected, such as patient activation.

1.6. Study aims

The aim of this study was to explore factors that affect the feasibility of incorporating mobile app self-management tools for depression into two IPCs working with underserved populations defined as those individuals from racial/minority groups and/or lower sociodemographic groups, and individuals with disabilities. Research questions addressed were: 1) Are there significant differences in patient demographic characteristics and mobile self-management app use between two clinics? 2) Do these clinic populations have smartphone resources and self-management skills that could be leveraged to support mobile app use? 3) What descriptive self-management measures and literacy needs should future studies address in these populations? 4) What do the self-management measures tell us about the clinic population and how can this information direct future studies?

2. Methods

2.1. Study design and setting

This was a cross-sectional questionnaire study of depressed patients at two primary care clinics in a Midwest academic medical center. The two clinic locations were specifically chosen because they provide integrated behavioral health care and serve as primary sites for the underserved to access care. The selected clinics are recognized as patient-centered medical homes (PCMH) by the National Committee for Quality Assurance, which is a designation that is received for providing quality comprehensive, patient-centered, coordinated, accessible, and safe care [47]. Specifically, these clinics served 2930 and 4888 unduplicated adult patients (>/=19 years) in the 2018 fiscal year, respectively. The integrated support provided within these clinics is primarily through the use of onsite behavioral health providers (BHPs) who assist in identification of mental health disorders, brief time-limited psychotherapy, screening efforts, and coordination/follow-up for patients with mental health conditions being cared for in the primary care setting. Warm handoffs from medical providers to BHPs occur at point of care. BHPs also proactively identify patients from the medical appointment schedule and discuss these patients with their medical providers during morning and afternoon pre-clinic huddles, in which all multidisciplinary providers are present. When patients are identified who could benefit from behavioral health intervention, BHPs deliver assessments and interventions that are typically between 10 and 15 min in length directly following patients' visits with their PCP. Patients who could benefit from and are interested in follow up care are scheduled to return to clinic to initiate brief therapy with a BHP, who is most often the same provider who delivered the initial brief intervention. Brief therapy typically consists of between 2 and 10 sessions and is focused specifically on patient goals for functional improvement.

Despite both clinics providing integrated care, talking with the staff of the two clinics revealed, that there may be notable age and race/ethnicity differences between the two clinics. Given previous research supports the need to tailor interventions to specific populations [29], we felt it was important to examine the demographics between the two clinics to identify any differences which would alter feasibility of future studies.

The study was approved by the University of Nebraska Medical Center Institutional Review Board (IRB).

2.2. Participants and recruitment procedures

Patients were eligible if they were 19 years of age or older and had an active or previous diagnosis of depression in their medical record. The eligibility of depression diagnosis was intentionally selected because this is a common mental health diagnosis encountered in IPC settings which, in instances where patients agree, are individuals who are typically referred to the behavioral health providers to assist in management of their depression. According, to the electronic health record data, pertaining to these two primary care clinics, the prevalence of patients with depression diagnosis in these primary care clinics is approximately 40.24% at clinic 1 and 34.12% at clinic 2. data from these two clinics. A convenience sampling method was used to recruit patients. Information about the study was distributed to clinic staff and a team of multidisciplinary providers, which included physicians, pharmacists, nurse care coordinators, social workers, and behavioral health providers. For this study, behavioral health providers used the patient schedule to create a list of eligible patients each day during the study period, at both clinics. The patient medical charts were reviewed by the behavioral health providers to confirm the presence of depression among these patients prior to recruitment. The list of eligible patients was provided to one of two graduate assistants (GAs) who were onsite at clinic locations. The GAs informed clinic nursing staff members responsible for rooming the patients which patients were eligible to participate. Rooming staff then read a script to patients which included a short description of the study and asked patients if they were interested in meeting with a study team member to learn more. Interested patients met with a GA following their medical appointment in a private exam room in the clinic. GAs provided patients with information about the study and invited interested patients to complete informed consent documentation.

2.3. Materials and procedures

Variables examined in this study included demographics, smartphone ownership, data plan type, smartphone application usage, mobile app self-management use, health literacy, and patient activation. Information was collected through self-administered paper-and-pencil survey among patients.

2.3.1. Demographics

Demographic information was collected for each participant, including sex, age (19–39, 40–59, 60+ years), race/ethnicity, marital status (widowed, divorced, not married, married), education attainment (<12th grade, high school/General Educational Development [GED], some college, technical/associate degree, bachelor’s and above), English proficiency, and primary language used at home. GED certifies that individuals have the knowledge and skills equivalent to that of a high school graduate.

2.3.2. Smartphone ownership, data, and usage

Participants were asked about the smartphone ownership (yes, no), type of smartphone (Apple/iOS, Android, others), type of phone plan (prepaid, monthly plan, monthly capped plan), unlimited data plan (yes, no), and smartphone use for health conditions or health-related issues (yes, no).

2.3.3. Mobile app self-management use

Participants were asked if they had used an app for health improvement in the past 12-months (yes, no), if they are currently using an app for health improvement (yes, no), reasons for downloading a health-related app (concerned about health, family member recommendation, friend/coworker/acquaintance recommendation), when deciding to use an app, whether it is important that learning the app is easy (yes, no), whether they are willing to use their data on an app that would help them self-manage their depression (yes, no), and if they believe an app can help them in self-managing depressive symptoms (yes, no).

2.3.4. Patient activation measure

The Patient Activation Measure® Short Form (PAM- 13®) is a self-management measure that assesses an individual's knowledge, skills, and confidence in self-management [48]. The 13-item questionnaire is predictive of preventive behaviors, health behaviors, and self-management behaviors [49]. Its validity and reliability have been tested in a variety of clinical settings and with population groups [50–52]. The PAM-13® acknowledges four activation levels from low (1) to high (4) which are linked to health-related behavior. Level 1 indicates low activation, suggesting that the person does not yet understand their role in health care; Level 2 means that the person has some knowledge but they largely believe health is largely out of their control; Level 3 means that the person has key facts and is beginning to engage in positive health behaviors; and Level 4 means that the person is proactive and adopted many of the positive health behaviors [32,48]. This instrument demonstrates adequate reliability with an internal consistency score of Cronbach $\alpha = 0.81$ and has been moderately correlated with each of Patient-Reported Outcomes Measurement Information System Global Health components [53]. We elected PAM because the measure has been validated across a wide array of demographic/socioeconomic characteristics in dozens of countries [48] and has acceptable psycho-metrics. The Cronbach's alpha for this study sample was 0.88.

2.3.5. Health literacy

The Single Item Literacy Screener (SILS) [54] was used as a brief instrument to explore the reading ability of participants. The SILS is a single-item question which asks participants "How often do you have someone help you read written materials from your doctor or pharmacist?" (always, often, sometimes, rarely, never). The sensitivity of the SILS in detecting limited reading ability is 54%, and specificity is 83% making it a

reliable measure for use with primary care clinic populations [55]. We selected SILS because of it is brief, has been used in many medical settings and has acceptable psychometrics.

2.3.6. English proficiency

The English proficiency was asked with a question “How well do you speak English?” The response options included: Very well, well, not well, and not at all.

2.4. Data collection and minimizing bias

Survey data were collected between October 2019 and March 2020. Following informed consent, participants were asked to complete a group of assessments. Participants noting impairments were given the opportunity to have the survey read aloud by the administering GA. Following completion of the questionnaires, patients were provided with a $15 Visa gift card. In order to minimize bias, the data collection protocol was standardized.

2.5. Analysis

Chi-square analysis was conducted to compare the patient demographic characteristics (Appendix Table), the smartphone ownership, phone plan, smartphone use for health information, and willingness to use app for depression self-management (Table 1) between two clinics. Multinominal logistic regression analysis was conducted to examine the association between the self-management scores and patient characteristics. We used Level 4 of PAM as a reference group in the multi-nominal logistic regression. All analysis was conducted with SAS 9.4 (Carey, NC). The alpha level of 0.05 was used to test for significance.

3. Results

3.1. Demographic characteristics

A total of 164 patients were recruited from the two clinics (Clinic 1 = 98; Clinic 2 = 66). A table in the Appendix summarizes the demographic characteristics of patients at two clinics. Differences in demographic characteristics between the two clinics were present. Clinic 1 had a larger proportion of male patients than Clinic 2 (39.8% vs. 22.7%) ($p = 0.02$). Clinic 2 had a larger proportion of African American patients than Clinic 1 (47.0% vs. 29.6%) ($p = 0.02$) while Clinic 1 had a larger proportion of Hispanic patients than Clinic 2 (12.4% vs. 1.5%) ($p = 0.01$). For both clinics, a high percentage of people reported being disabled (41.8% at Clinic 1 and 34.9% at Clinic 2). Overall, 38.4% of the sample had high school or lower educational levels. Additionally, 26.9% of the sample reported that they sometimes, often or always need someone help with written materials from the doctor or the pharmacist.

3.2. Smartphone ownership, data, and usage

Table 1 shows the results of the phone ownership data and usage. Over 90% of Clinic 2 patients and 78.6% of Clinic 1 patients owned a smart phone. The majority of the patients owned an Android phone (63.3% at Clinic 1 and 62.1% at Clinic 2). The percentage of patients with a monthly plan was 68.4% at Clinic 1 and 75.8% at Clinic 2. The percentage of patients with an unlimited data plan was 63.3% at Clinic 1 and 74.2% at Clinic 2. A higher proportion of patients at Clinic 2 reported having used a smartphone to check for health information compared to patients at Clinic 1 (77.3% vs. 59.2%).

3.3. Patient activation and health literacy

Table 2 shows results of multivariable multinomial logistic regression analysis. The “reference” group indicates the comparison group. Gender (male/female), age group (19–49 vs. 50 years and older), education (high school or lower vs. some college and higher), race (white vs. other race) and English literacy (speak very well vs. speak well / not well) were not significantly associated with PAM outcomes. However, health literacy had a significant association with PAM outcomes (Wald Chi-Square 8.5453, p = 0.00360). A higher health literacy level was correlated with a higher patient activation level. This means that individuals who answered ““never” or “rarely” to a question “How often do you have someone help you read written materials from your doctor or pharmacist” compared to those who answered “sometimes” or “always” had a higher patient activation level.

4. Discussion

4.1. Summary

This study sought to explore feasibility factors of incorporating mobile app self-management tools for depression into two IPC clinics working with underserved populations. Specifically, we examined differences between demographics and mobile-app self-management use between clinics; mobile app resources and self-management skills to support mobile app use; and self-management and health literacy levels of the population in order to inform the existing mobile app interventions already used in IPC settings and the development of new mobile app interventions in IPC settings. As findings from studies conducted in primary care settings suggest, there are many possible uses of mobile apps in IPC settings. For example, a 1-year longitudinal study of patients and providers from 12 primary care clinic discovered that clinicians found self-management mobile apps to be useful to augment clinical care and patients reported the usefulness of mobile aps for managing stress and anxiety [56]. Another example in an underserved primary care clinic found parents reported the usefulness of mobile apps for obtaining their child’s health information [57]. Finally, a study among health care providers in rural primary care settings suggested that smartphones can potentially promote better communication among providers and patients [58].

Table 1
Phone ownership and mobile app use.

Variable	Clinic1 (n = 98)		Clinic2 (n = 66)		p-Value	Total (N = 164)	
	Number	Percent	Number	Percent		Number	Percent
Own a smart phone							
Yes	77	78.6%	60	90.9%	0.07	137	83.5%
No	21	21.4%	6	9.1%		27	16.5%
Type of smartphone							
Apple/ios	15	15.3%	17	25.8%	0.09	32	19.5%
Android	62	63.3%	41	62.1%		103	62.8%
Other	7	7.1%	1	1.5%		8	4.9%
Missing	14	14.3%	7	10.6%		21	12.8%
Type of phone plan							
Prepaid	16	16.3%	8	12.1%	0.65	24	14.6%
Monthly plan	67	68.4%	50	75.8%		117	71.3%
Monthly capped plan	2	2.0%	2	3.0%		4	2.4%
Missing	13	13.3%	6	9.1%		19	11.6%
Unlimited plan							
Yes	62	63.3%	49	74.2%	0.45	111	67.7%
No	28	28.6%	12	18.2%		40	24.4%
Missing	8	8.2%	6	7.6%		13	7.9%
Smartphone use for health information/issues							
Yes	58	59.2%	51	77.3%	0.006	109	66.5%
No	36	36.7%	11	16.7%		47	28.7%
Missing	4	4.1%	4	6.1%		8	4.9%
Past 12 month app use for health improvement							
Yes	36	36.7%	33	50.0%	0.09	69	42.1%
No	62	63.3%	33	50.0%		95	57.9%
Current app use for health improvement							
Yes	25	25.5%	23	34.8%	0.21	48	29.3%
No	72	73.5%	43	65.2%		115	70.1%
Missing	1	1.0%	0	0.0%		0	0.6%
Reasons for downloading an app							
Concerned about health	19	19.4%	15	22.7%	0.54	34	20.7%
Family member recommendation	6	6.1%	1	1.5%		7	4.3%
Friend/coworker/acquaintance recommendation	4	4.1%	1	1.5%		5	3.0%
Missing	44	8.2%	39	9.1%		71	8.5%
A health care provider recommendation	8	7.1%	6	6.1%		14	6.7%
Other	7	44.9%	4	59.1%		11	43.3%
Easy app learning							
Yes	80	81.6%	53	80.3%	0.38	133	81.1%
No	18	18.4%	8	12.1%		26	15.9%
Missing	0	0.0%	5	7.6%		5	3.0%
Willingness to use data for depression management							
Yes	75	76.5%	57	86.4%	0.005	132	80.5%
No	23	23.5%	4	6.1%		27	16.5%
Missing	0	0.0%	5	7.6%		5	3.0%
Believe an app can help in symptoms management							
Yes	65	66.3%	48	72.7%	0.31	113	68.9%
No	33	33.7%	17	25.8%		50	30.5%
Missing	0	0.0%	1	1.0%		1	0.6%

Our study provided several critical pieces of information useful for researchers and clinicians designing mobile-app based self-management of depression symptoms interventions within IPC settings. First, results indicated that in line with other research [25], the majority of patients had cellular phones and data plans to support their use of eHealth technology-based interventions despite financial and/or social challenges. Determining interest in the use of e-health technology as well as interest in self-management is critical when planning technology based interventions. A majority of

those who use their smartphones for obtaining health information were willing to use data for depression self-management and believed an app could help in their self-management of their depression symptoms. These results suggest that planning interventions that use mobile apps within this patient population is likely feasible and underserved patients with depression at these clinics have an interest in using depression-related apps which is similar to findings in other studies exploring app interest [59]. Second, the distribution of types of smartphone varied primarily between Android smartphones and iPhones. This finding suggests that when planning interventions, it would be necessary to identify apps which can be used on both Android and iPhone platforms to be more broadly applicable to the intended population.

Table 2
Multinomial logistic regression examining factors related to PAM levels.[a]

Variable	Level 1	Level 2	Level 3	Wald Ch-Square
Gender				
Male	Reference	Reference	Reference	5.23998
Female	0.45 (0.12–1.60)	2.35 (0.61–9.15)	1.09 (0.43–2.79)	p = 0.1551
Age group				
19–49 years	Reference	Reference	Reference	1.5990
50 years+	0.45 (0.13–1.59)	0.76 (0.24–2.40)	0.71 (0.30–1.68)	p = 0.6596
Education				
High School or Lower	0.50 (0.12–2.02)	0.95 (0.28–3.27)	0.74 (0.29–1.86)	1.1945
Some college and Higher	Reference	Reference	Reference	p = 0.7543
Race				
White	Reference	Reference	Reference	0.98002
Other Race	1.69 (0.50–5.75)	1.27 (0.41–3.91)	1.01 (0.43–2.41)	p = 0.8060
How well do you speak English?				
Very well	Reference	Reference	Reference	5.8287
Well /Not Well	3.65 (0.58–22.85)	5.00 (0.80–31.33)	1.18 (0.21–6.69)	p = 0.1202
Health Literacy[b]				
Never – Rarely	Reference	Reference	Reference	**8.5453**
Sometimes – Always	**8.14 (1.84–36.01)**	3.35 (0.80–14.20)	2.00 (0.59–6.76)	**p = 0.0360**

The bold one is statistically significant result at alpha=0.05 level.

[a] Level 4 of PAM was used as a reference group.

[b] Question: How often do you have someone help you read written materials from your doctor or pharmacist?

4.2. The need for tailoring of self-management mobile apps

Understanding patient activation levels within a given population can help to shape corresponding needs. The use of tailored depression-related self-management mobile apps will likely require the development of personalized patient educational materials which are matched to health literacy needs in order to facilitate app use and patient engagement. Patient educational materials may include paper- or online-based products that explains the purpose and uses of the depression self-management mobile apps as well as a “how to” guide to walk the patient through the steps she/he can take to learn about the use of the mobile app. It is likely that at minimum a flyer or informational handout may be needed to provide an overview of how to download apps and use specific app features that integrate with their behavioral health care. To our knowledge, this is one of the understudied areas in mobile app research. While there are many mobile app interventions exist, there are no published studies that explore the need for patient and provider education to facilitate mobile app use and patient engagement. One advantage of embedding an e-health intervention within an IPC is that the BHP will have frequent, planned interactions with the patients enabling the opportunity to provide clarity and address any literacy or educational needs that impede patient use of such an intervention.

While a handout may be an important first step, our results indicate that there may be difficulties in understanding provider distributed materials. Specifically, anywhere from 12.8–38.5% of participants at all patient activation levels noted sometimes to always needing help with reading written materials provided by their doctor or pharmacist. Since patient activation can serve as a moderator for communication among patients and care providers [60], ensuring educational materials are easily understandable regardless of patient activation level is critical. A recent meta-analysis found a significant positive effect of patient activation intervention on depression symptoms [61].

Furthermore, given the wide distribution of patient activation levels within this clinic population, it seems necessary to tailor mobile app interventions to fit a patient’s activation level. Tailoring interventions to a person’s activation level can help to build the necessary skills and confidence in self-management [52]. For instance, individuals in level 1 could be provided more support and confidence building strategies surrounding the use of mobile apps. In comparison, a patient who is at level 4, could be provided a mobile app directed at providing support to facilitate stress management and adjustment to change outside of the clinic setting which may be when their self-management behaviors may decline. When tailoring interventions to a patient activation level, it is also essential to keep in perspective that most changes for patient activation occurs at levels 1 and 2, and interventions tailored to meet the needs of level 1 and level 2 will likely result in a greater overall impact on activation when compared to levels 3 and 4. Participants in levels 3 and 4 may experience less change in activation level so

it is important to also evaluate change in individual scores within each level to evaluate the response to an intervention [62], otherwise, important findings might be missed.

4.3. Roles of health literacy

Importantly, when also considering the development of interventions for patients with lower activation levels, additional health literacy supports may be needed to ensure they understand and are able to effectively use e-health intervention supports. Patient-centered interventions seeking to improve health outcomes and promote health, should address both patient activation and health literacy, in order to reduce health disparities [63]. According to a review study by Yadav, et al. health literacy and patient activation are weakly related but independently correlated with health outcomes [64]. Also, according to Yadav, et al., health literacy provides “judgmental skills and underlying knowledge about the disease conditions and their management“ whereas patient activation results in “situational and psychological empowerment of patients essential for behavioral changes.” Relatedly, a study of cancer patients found that mobile-based patient-provider communication (MBPPC) alone does not directly result in better emotional health outcome; however, they found that MBPPC was associated with health literacy, which led to better emotional health [46]. Further, they found that patient activation moderated the relationship between health literacy and emotional health among patients [46]. Another study of a diabetic self-management intervention indicated that neither health literacy nor patient activation was directly related to glycemic control but the interaction between the two was significantly associated with glycemic control [65]. These findings together point out a complex relationship between health literacy, patient activation and self-management in influencing both physical and mental health.

4.4. Study limitations

This study had some limitations. First, questions used to evaluate mobile app self-management interest factors were developed for the purpose of this study to provide a better understanding of mobile app use for our target population; however, they have not been validated. Second, the global outbreak of SARS-CoV-2 placed restrictions on participant recruitment, which resulted in a smaller sample size. Third, data were collected at two primary care clinics, both in the Midwest, likely limits the generalizability of our findings. The clinics chosen for this study were both considered integrated primary care clinics. However, clinic 1 had a higher level of behavioral health integration than clinic 2. At clinic 2, behavioral health providers (BHP) were present 1–3 days per week in comparison to 5 days per week in clinic 1. Since participants were identified with the assistance of the behavioral health providers, their daily presence at clinic 1 likely accounted for the higher recruitment rates at this clinic. When planning interventions within IPC settings, it may be beneficial to seek clinics with higher levels of behavioral health integration that have consistent interactions among clinic staff and BHPs as this may facilitate patient recruitment. This may also help with the needs required for patients at different levels of patient activation, since those with lower

activation levels may need more direct interactions with integrated providers using mobile app interventions to establish and maintain motivation for use [55].

4.5. Future directions

Future research should examine patient activation and its relationship with health literacy and other patient characteristics that may contribute toward successful integration of mobile apps into clinical settings. For instance, engagement strategies within the e-health intervention could be tailored to a patient's activation level. When working with the patients the BHP could help to direct the patients to the appropriate e-health features which align with an individual's activation level. These activities could promote sustained engagement and promote self-management by individualizing e-health features to one's needs recognizing that they may change over time. Increasing our understanding how e-health interventions can be tailored to a patient's activation level and promote self-management will be useful for app development in the future. We know that sustained engagement with e- health interventions such as apps remains a challenge. Therefore, if we can use patient activation levels to direct what features of apps would align most closely with an individual's needs then perhaps we can overcome this challenge. For example, for a patient who is a level 3 patient activation level, the BHP would guide the patients to identify e-health features which align with their self-management goals, such as tracking regular behavioral activation, in addition to using built in CBT techniques within the app in between visits. In comparison with a patient who is at a patient activation level 1, the BHP would seek out e-health app features which can build confidence and promote self-management work that seeks to improve adherence to treatment such as appointment reminders and listening to relevant education in between appointments.

Additional future directions for e-health technology interventions such as apps should focus on ensuring the apps are developed with health literacy needs in mind. Exploration should include 1) how apps communicate recommended minimum required literacy requirements for use and 2) the development of a standard e-health literacy rating for all health related apps to ensure suitability for target populations; similar to how materials used for patient education are created to be congruent with particular grades levels (IE third grade reading level). Lastly, when BHP's are seeking out apps which would be suitable to for varying degrees of literacy needs, training pertaining to app features that are applicable to a broad range of literacy needs, such as simple interface design, visual information, animations, dictionaries [66], should be provided.

Overall, patients have expressed an interest in using mobile apps as part of their care, but an important component of the use of apps involves how the utilization of the data they enter into the app will be incorporated into the care they are receiving. If mobile technology interventions are designed in collaboration with patients and care providers, access, engagement and continuity of care can improve [67]. Mobile technology should be embedded within a model of care that has demonstrated treatment effectiveness while simultaneously tailoring the mobile technology to support

patient engagement for the behaviors identified in need of improvement [43]. Obtaining patient activation scores prior to implementing mobile technology interventions may provide an opportunity to better understand an individual's potential success or lack thereof in self-management behaviors. Follow-up measurements of patient activation and health literacy may be able to determine relationships between the technological intervention and self-management behaviors. Furthermore, utilizing consumer technologies can empower patients, extend benefits of traditional clinical services, and enhance patient's decision-making in the management of their own health [26].

Compliance with ethical standards

On behalf of all the authors, the corresponding author states that the work completed within this submission was congruent with our affiliated compliance and ethical standards. We obtained IRB approval for the purposes of our funded grant proposal, however the findings provided in this manuscript do not contain the human subject data collected with informed consent therefor it is our assumption that the IRB and consent forms are not applicable to the content submitted.

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Author statement

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Declaration of Competing Interest

"On behalf of all authors, the corresponding author states that there are no conflicts of interest".

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Appendix A. Demographic characteristics of the sample

Variable	Clinic1 (n = 98)		Clinic2 (n = 66)		p-Value	Total (N = 164)	
	Number	Percent	Number	Percent		Number	Percent
Gender							
Male	39	39.8%	15	22.7%	0.02	54	32.9%
Female	59	60.2%	51	77.2%		110	67.1%
Age (years)							
19–39	20	20.4%	25	37.9%	0.06	45	27.4%
40–59	47	48.0%	25	37.9%		72	43.9%
60+	29	29.6%	16	24.2%		45	27.4%
Missing	2	2.0%	0	0.0%		2	1.2%
Current occupation							
Disabled	41	41.8%	23	34.9%	0.6	64	39.0%
Employed	28	28.6%	29	43.9%		57	34.8%
Retired	13	13.3%	6	10.0%		19	11.6%
Unemployed	9	9.2%	4	6.1%		13	8.0%
Other	7	7.1%	4	6.1%		11	6.7%
Marital status							
Widowed	12	12.2%	4	6.1%	0.5	16	9.76%
Divorced	27	27.6%	16	24.2%		43	26.2%
Not married	35	35.7%	28	42.4%		63	38.4%
Married	24	24.5%	18	27.2%		42	25.6%
Education							
<12th grade	13	13.3%	6	9.1%	0.96	19	11.6%
High school/GED	27	27.6%	17	25.8%		44	26.8%
Some college – No degree	21	21.4%	18	27.3%		39	23.8%
Technical/Associate degree	25	25.5%	18	27.3%		43	26.2%
Bachelor's degree or above	12	12.2%	7	10.6%		19	11.6%
Race							
White	59	60.2%	28	42.4%	0.02	87	53.1%
Black/African American	29	29.6%	31	47.0%		60	36.6%
American Indian/Alaska Native	5	5.1%	0	0.0%		5	3.1%
Asian/Pacific Islanders	1	1.0%	1	1.5%		2	1.2%
More than one race	4	4.1%	6	9.1%		10	6.1%
Hispanic, Latino/Latina or Spanish origin							
Yes	12	12.2%	1	1.5%	0.01	13	7.9%
No	85	86.7%	65	98.5%		150	91.5%
Missing	1	1.0%	0	0.0%		1	0.6%
How well you speak English							
Very well	84	85.7%	60	90.9%	0.25	144	87.8%
Well	13	13.3%	5	7.6%		18	11.0%
Not well	0	0.0%	1	1.5%		1	0.6%
Missing	1	1.0%	0	0.0%		1	0.6%
Primary language used at home							
English	94	96.9%	63	96.9%	0.25	157	96.9%
Other	3	3.1%	2	3.1%		5	3.1%
How often do you have someone help you read written materials from your doctor or pharmacist?							
Never	46	46.9%	40	60.6%	0.51	86	52.4%
Rarely	23	23.5%	11	16.7%		34	20.7%
Sometime	18	18.4%	10	15.2%		28	17.1%
Often	3	3.1%	2	3.0%		5	3.1%
Always	8	8.2%	3	4.6%		11	6.7%