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EXAMINING THE FEATURES OF MHEALTH APPLICATIONS GEARED TOWARDS CHRONIC MIGRAINES: CONTENT ANALYSIS

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Examining the Features of Mobile Health Applications Geared Towards Chronic Migraines: Content Analysis

Abstract

Background

Over 300,000 mobile health applications are currently available to address a variety of health initiatives including a significant number focused on headache. Due to the volume of headache applications with no established method for content regulation, it remains a challenge to find a user-friendly experience that provides clinically relevant content. Patients utilize results from online queries to identify headache management applications. The purpose of this study is to investigate headache applications identified from popular search queries and analyze their headache management features in hopes to improve existing and future headache management applications.

Method

A systematic review of medical and epidemiologic literature was performed to gather data on treatment nonadherence and existing health-related applications. The first five Google search, Apple App store, and Google Play store results identified popular headache applications, which were then analyzed for customizability, clinical accuracy, design efficiency, and user engagement.

Results

The 27 recommended applications compiled from the query results lacked uniformity in features, with 10/27 (37%) tailored to headache relief while 15/27 (56%) tracked headaches. Of the 11 downloaded applications, Migraine Buddy and N-1 Headache, two of the most popular applications available, were recommended 7 and 6 times, respectively. However, none of the apps were personalizable, clinically accurate, easy-to-navigate, and had features geared toward increasing application engagement.

Conclusion

Current headache applications lack several features tailored to both the user and medical professional. There is a significant need to develop clinically appropriate applications that incorporate customizability, user-centered design, and features to enhance patient-physician interaction. The obtained results may be extrapolated to improve the development of future healthcare management applications for other chronic conditions.

KEYWORDS: migraine; headache; Google; Apple App store; Google Play store; health apps; mobile health; mobile applications; telemedicine; management

Introduction

Almost 50% of the world population has been affected by a headache, making headaches the most common neurological complaint. Despite this high prevalence, headaches are often under-recognized and under-treated due to their episodic nature and low mortality rates [1]. Instead of seeking professional help, headache sufferers often utilize the internet to explore management options [1].

With the significant increase in United States smartphone ownership from 35% in 2011 to 77% in 2018, people began to use the popular search engine, Google, to gain access to healthcare-related treatment options and mobile health (mHealth) applications (apps) [2]. Although there is no established regulation for content management in these mHealth apps, users most commonly turn to two search platforms, Google Play store (Android users) and Apple App store (iPhone users), to find relevant mHealth apps. Apps are highly available in each store, with 3.6 million available apps and 2.2 million apps available to download, respectively [3]. Currently, over 300,000 mHealth apps address a variety of health issues, including a significant number focused on headache [4]. Many of the mHealth apps available are not regulated to ensure that they contain clinically accurate content or user-friendly experiences [5].

The purpose of this study is to investigate headache apps identified from popular search queries and analyze their headache management features. By having a better understanding of currently available mHealth apps for headache, guidelines can be created to improve existing and future headache management apps. The data gathered from this study will serve useful in the development of mHealth apps and serve as a catalyst in offsetting the weaknesses of current mHealth apps.

Methods

Search Methodology

A Google, Apple App store, and Google Play store search was conducted to identify popular migraine apps [6]. The Google search phrases, "Best migraine apps 2019" and "Best headache apps 2019," were entered on a Dell Latitude E7250 computer on April 19, 2019 and resulted in 26,800,000 results. The first 5 search results were identified. The process was repeated for Apple App (iOS) and Google Play (Android) stores on Apple iPhone 6 and Samsung Galaxy S8+ phone on April 20, 2019.

Inclusion and Exclusion Criteria

Duplicate apps, identified by the same developer, and apps that do not feature tracking tools, identified by the apps' descriptions, were removed from the list. When both free and paid version were available, the free version was downloaded to represent a higher purchase likelihood [7].

Data Extraction

Preliminary data (the average customer rating, number of reviews, price, and type of app) was obtained from the app stores' descriptions. The apps were categorized on the basis of the tools provided in the app: relief, tracking, prediction, or diagnosis. Prediction apps were labeled accordingly to words associated with "prediction" in the descriptions, such as "prevention" of a headache or "analysis" of data. The identified headache apps meeting the criteria were downloaded on iPhone 7/iPhone 8 and Samsung S8+. The following information was extracted for each app: customizability, clinical accuracy, design efficiency, and user engagement.

Application Assessment

No standards currently exist for evaluating migraine management mHealth applications. The authors therefore defined baseline criteria for an ideal migraine-tracking app that is intended to gain a better understanding of a user with chronic migraines and provide relevant data to health professionals. Based on the authors' judgement, an ideal migraine app should minimally consider (1) customizability, (2) clinical accuracy, (3) design efficiency, and (4) user engagement.

1. App Criterion #1: Customizability

Customizable tracking systems and reports are necessary to make mHealth apps relevant to each user. To meet this criterion, the apps are required to contain some level of customization in their headache reports (eg. adding a trigger that may not be listed) and have the ability to remove information the user may deem unnecessary. Although it is possible all of the apps may exhibit some form of customizability, the apps were ranked in respects to each other.

2. App Criterion #2: Clinical Accuracy

Clinical accuracy was measured on the basis of medical expertise involvement in the development of the app [8]. The apps determined to have expert involvement were advised or created by MDs, PhDs, or a healthcare institution. Although it is possible that some apps did involve medical expertise but the information was not listed in the app description or affiliated websites, these apps were excluded from the clinical accuracy criterion.

3. App Criterion #3: Design Efficiency

Design efficiency is a qualitative aspect of mHealth apps that measures the organization of user interfaces and its effect on the speed and ease at which users can navigate an interface. Per Nielsen et al.'s "10 Usability Heuristics for User Interface Design," a compiled list of mHealth migraine apps were analyzed for visibility of system status; match between system and the real world; user control and freedom; consistency and standards; error prevention; recognition rather than recall; flexibility and efficiency of use; aesthetic and minimalist design; help users recognize, diagnose, and recover from errors; and help and documentation. [9]. Two trained independent reviewers systematically reviewed each app independently and rated the heuristic factors on a scale of 1 to 5 (1=poor, 5=excellent). Their usability score was the summation of the scores given in each category, with a maximum score of 50, and the average for each app was recorded.

4. App Criterion #4: User Engagement

Adoption rate and long-term usage of mHealth technologies remain an issue in the implementation of mHealth apps as tools for monitoring chronic illnesses [10]. The apps were therefore analyzed for additional unique features, such as an incentivized program or social media sharing. The top and bottom three apps identified from the design efficiency scores were further assessed via the app store reviews to analyze the audience's evaluation of the app.

Results

Search Methodology

The Google search, "Best migraine app 2019" and "Best headache app 2019," resulted in 5 articles pertaining to migraines and headaches. Of the 5 articles for "migraine," 4 provided a list of the "best" apps for migraines or migraine management, while the 5th article did not recommend mobile applications and was therefore excluded from app analysis. Of the 5 articles for "headache," only 1 of the 5 articles differed between the first search query and the second and was included for analysis. A total of 50 application names were compiled from Google search (Fig. 1).

Figure 1. Compiled list of “migraine-” and “headache-” related apps in respects to their listed website or store (n = 50).

“Best migraine apps 2019” ^a	“Best headache apps 2019” ^b	Duplicate Applications
Refinery29 <ul style="list-style-type: none"> ▪ N-1 Headache ▪ Migraine Insight ▪ WeatherX Forecast ▪ Migraine Buddy 	PracticalPainManagement <ul style="list-style-type: none"> ▪ N-1 Headache ▪ iHeadache ▪ MigraineBuddy ▪ Migraine eDiary ▪ Ouchie ▪ Symple Symptom Tracker ▪ Headache Log ▪ Manage My Pain Pro ▪ Migraine Diary 	<ul style="list-style-type: none"> ▪ Migraine Buddy (x7) ▪ N-1 Headache (x6) ▪ Migraine Monitor (x3) ▪ Headache Log (x2) ▪ iHeadache (x2) ▪ Migraine Coach (x2) ▪ HeadApp Migraine Diary (x2) ▪ Migraine Insight (x2) ▪ Migraine Relief Hypnosis (x2) ▪ Ouchie (x2) ▪ Symple Symptom Tracker (x2)
MedicalNewsToday <ul style="list-style-type: none"> ▪ Ouchie ▪ Blue Light Filter for Migraine – Eye Shield ▪ Migraine Coach ▪ Migraine Relief Hypnosis ▪ Relax Lite ▪ Symple Symptom Tracker ▪ N-1 Headache ▪ BrainWave Binaural Headache Relief with Ambience ▪ White Noise Free 	<div style="background-color: black; color: white; text-align: center; padding: 2px;">Apple App and Google Play store Applications</div>	
MigraineAgain <ul style="list-style-type: none"> ▪ Headache Diary ▪ N-1 Headache ▪ Migraine Buddy ▪ iHeadache ▪ Acupressure: Heal Yourself ▪ MedZam Headache Migraine Symptom Checker 	<div style="background-color: black; color: white; padding: 2px;">Apple App store: Migraine</div> <ul style="list-style-type: none"> ▪ Migraine Buddy ▪ Migraine Insight ▪ Migraine Monitor ▪ Migraine Coach ▪ Migraine Alert 	<div style="background-color: black; color: white; padding: 2px;">Apple App store: Headache</div> <ul style="list-style-type: none"> ▪ Migraine Buddy ▪ Headspace: Meditation & Sleep ▪ My Pain Diary ▪ Headache ▪ Aura: Calm Anxiety & Sleep
Headaches <ul style="list-style-type: none"> ▪ Migraine Monitor ▪ N-1 Headache 	<div style="background-color: black; color: white; padding: 2px;">Google Play store: Migraine</div> <ul style="list-style-type: none"> ▪ Migraine Buddy ▪ Migraine Monitor ▪ HeadApp Migraine Diary ▪ Migraine Relief Hypnosis ▪ Migraine Headache Relief Music 	<div style="background-color: black; color: white; padding: 2px;">Google Play store: Headache</div> <ul style="list-style-type: none"> ▪ Migraine Buddy ▪ Headache Log ▪ HeadApp Migraine Diary ▪ usSTOP Headache App ▪ N1-Headache

^a No apps were listed on the fifth website, HealthLine, and the website was thus excluded from this list.

^b “Best headache apps 2019” search resulted in 4 of the same websites from “Best migraine apps 2019” search: Refinery29, MedicalNewsToday, MigraineAgain, and Headaches.

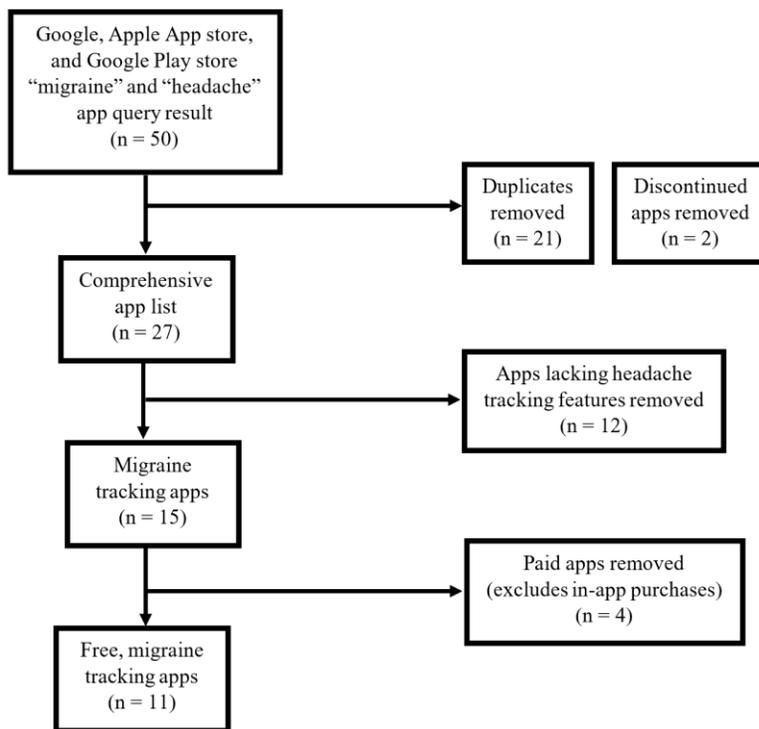
Comprehensive Search Query App Results

After duplicates and discontinued apps were removed, the 27 migraine-related apps comprised of 1 of 27 (3.7%) providing diagnostics, 1 of 27 (3.7%) attempting to predict headache onset patterns, 4 of 27 (14.8%) tracking headache frequency, 10 of 27 (37.0%) providing headache relief plans, and 11 of 27 (40.7%) both attempting to predict headache onset patterns and tracking headache frequency. In addition, the apps were generally distributed amongst both stores, with 40.7% available in both stores, 33.3% available in only the Apple App store, and 25.9% available in only the Google Play store. In terms of payment, 70.3% were either free or offered in-app purchases while 29.6% of the apps required a form of payment to download.

Selection Algorithm

The initial query resulted in 50 app names. Once duplicates (n = 21) and discontinued apps (n = 2) were removed, the apps that did not involve headache-tracking features in their descriptions were removed (n = 12). Of the remaining 15 applications, 4 required payment and were thus excluded from the final list. The final list consisted of 11 mHealth applications (Fig. 2), all of which were advised or created by MDs, PhDs, or a healthcare institution.

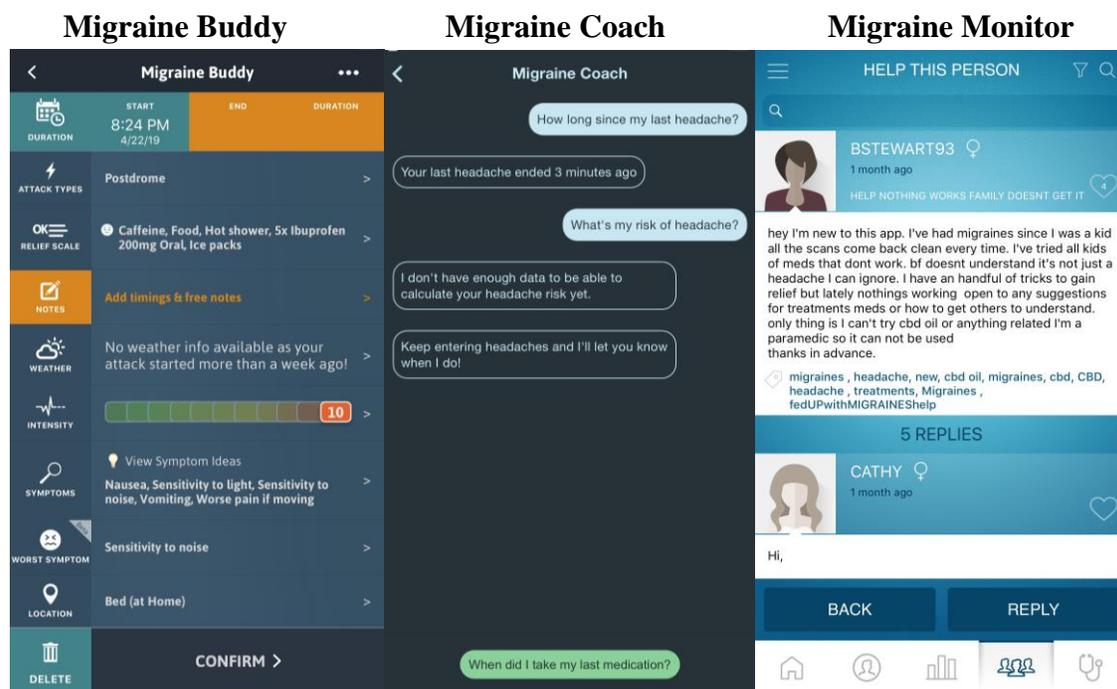
Figure 2. Selection algorithm for the most popular free migraine self-management apps.



Highest and Lowest Scoring Applications

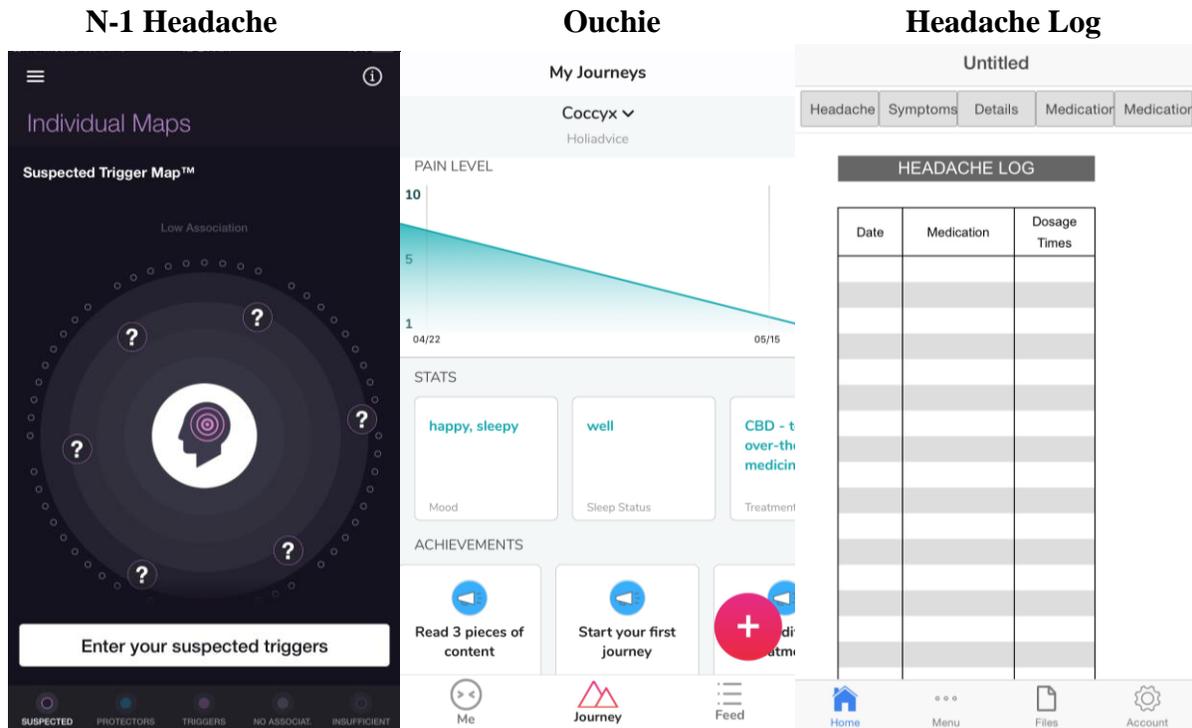
The top 3 apps, defined by the heuristics score, were Migraine Buddy (ranked 1), Migraine Coach, and Migraine Monitor (Fig. 3). Created on a dark blue background, Migraine Buddy (customizability = rank #1, usability score = 47.0/50) heavily caters to the user, having an information button on most screens, providing "Doctor Matching Services," offering a subscription to food and lifestyle tips, and displaying a report summary of headache-related factors on one editable page. However, one major weakness of Migraine Buddy is the excessive amount of information that may not be relevant to some patients. Migraine Coach's (customizability = rank #3, usability score = 45.5/50) minimalist, dark color scheme considers photosensitivity and the user's pain, allowing users to input the headache logging details at a later time. One unique feature of Migraine Coach is the text messaging feature that uses AI to respond to commonly asked questions. Unlike Migraine Buddy, Migraine Coach does not use graphs and figures to help visualize the data obtained from logging headaches, thus making the app less user-friendly. Although Migraine Monitor (customizability = rank #6, usability score = 45.0/50) has a bright blue color scheme and lacks clear delineators between information, Migraine Monitor displays graphical outputs and emphasizes a platform in which people experiencing pain can consult with others. One major flaw of Migraine Monitor occurs when a user is recording an attack. If a user were to accidentally change tabs while recording an attack, the current headache log is erased, and the user must re-enter the information pertaining to the headache, which can be cumbersome and unnecessary.

Figure 3. Top 3 ranked apps (Migraine Buddy, Migraine Coach, and Migraine Monitor) scored by Jakob Nielsen's ten usability heuristics.



The bottom 3 apps were N-1 Headache (ranked 9), Ouchie, and Headache Log (Fig. 4). Although the black and purple color scheme of N-1 Headache (customizability = rank #2, usability score = 41.5/50) is photosensitive, the app does not consistently allow the user to enter information at a later time or end a process by exiting out of a feature. For example, in the Suspected Trigger Map Page, users are forced to answer > 30 questions before accessing the app's other content. Ouchie (customizability = rank #4, usability score = 39.5/50) provides both a headache tracker and a social media platform. Using gamification and having the ability to share one's headache journey, Ouchie falls short in providing adequate support and information in the case the user is unable to navigate the app. Headache Log (customizability = rank #9, usability score = 37.0/50) has users manually type in and organize headache-related factors in minimalistic charts resembling a Microsoft Excel spreadsheet. Lacking information to analyze data, the app also does not offer a FAQ section or does not easily allow users to know more about what features the app has to offer.

Figure 4. Bottom 3 ranked apps (N-1 Headache, Ouchie, and Headache Log) scored by Jakob Nielsen’s ten usability heuristics.



Discussion

Identified Applications

In contrast to 2014’s review in which only 18% of the reviewed commercially available mHealth headache apps involved medical expertise, all top 11 recommended, free apps consulted with medical professionals or healthcare institutes, indicating the possible strength of current search queries recommendations or the improvement of mHealth apps since half a decade ago [11]. Although some of the more popular apps indicated by search queries, such as N-1 Headache, received a high number of recommendations (times recommended = 7), the app was not user-friendly and did not permit logging the headache after the pain has resolved. In general, there appears to be a preference towards multifaceted apps that contain features that are geared toward users’ treatment and headache tracking capability. As a result, Migraine Buddy scored the highest in all four criteria, allowing for moderate levels of customizability, incorporating medical expertise involvement, being user-friendly in design, and having additional features. However, the one major weakness of Migraine Buddy, like most of the popular mHealth apps, is the overabundance of information provided to the user.

The lack of high levels of customization in many mHealth migraines apps provide an overload of information that is time-consuming and could be confusing[12]. Customization is necessary to prevent an overload of information and provide a simplified avenue for users to understand and monitor their chronic illnesses. In addition, technological innovations, such as iPhone X, Samsung Galaxy S9, and FitBit, have additionally provided passive-tracking features

that can further enhance mHealth apps and subsequent data analysis, such as sleep-tracking capabilities, weather prediction tools, screen time usage, optical heart rate sensors, and blood pressure sensors. When tailored to the user, these tools can be used to further understand possible triggers without overloading the user and physician with excessive information [13].

Recommendations and Future Direction

In the advent of the Internet and new technologies, physicians are challenged to adopt new treatments to tailor to each patient's needs. To follow a participatory medicine model in which patients and physicians actively participate in the treatment plan, physicians require 6 key characteristics to empower physicians in the participatory medicine model: “electronic“ (ie, use digital technologies in their practice with ease), ”equipped“ (ie, have digital health technologies at their disposal), ”enabled“ (ie, by regulations and guidelines), ”empowered“ (ie, by technologies that support their jobs and their e-patients), “engaged” (ie, need compassion and empathy to understand the feelings and points of view of patients, give relevant feedback, and involve them throughout the whole healing process), and ”expert“ (ie, in using technologies in their practice or know the best, most reliable, and trustworthy digital health sources and technologies)” [14]. By experiencing each trending mHealth-related mobile app in their specialty and staying up-to-date with rising healthcare tools, physicians will become more educated on current healthcare technologies and can therefore help recommend the appropriate mHealth app.

Although the 11 identified apps collectively may have possessed necessary migraine management features, it is important to identify the key characteristics of each app and to note if they are clinically relevant and medically accurate. For a future study, the identified apps should be reviewed by a team of medical professionals to analyze the accuracy of the headache triggers and other corresponding factors when logging a headache.

With our results from this research, we are actively using this information to develop an app to address the weaknesses of popular headache apps. The developing migraine app is designed to achieve high customizability, clinical accuracy, design efficiency, and user engagement to provide clinically relevant content to both the users and the providers. We are not just adding to the plethora of the apps, but we instead hope to make the app useful to a larger population, including pediatrics and in clinical studies. We understand that everyone is different, but we believe that using the information compiled in this paper will allow us to develop a unique product that addresses more migraine sufferers while removing complexities. The app is currently in its early stages of developments; however, preliminary studies indicated an 89% recommendation rate of the current human-computer interaction design (n = 58) [15]. The app is aimed at improving data collection and headache sufferers, especially adolescents, in headache treatment management. A future endeavor includes implementing the app in a clinical setting and using usability assessment tools, such as Health-ITUES for chronic illnesses [16].

Strengths and Limitations

Because there are no guidelines or evidence-based regulations pertaining to migraine apps' content, there are several limitations to this study.

The scope of the content analysis was limited to English-language, free apps of the first five search results. The search methods used were geared toward representing a typical user finding a health-related mobile application for their symptoms. Different apps more inclusive of all criteria may be available beyond the search results limit, in a paid version of the application, in a different language, or in a less popular app searching platform.

The search queries results may additionally differ depending on the search date and country location. Therefore, different websites may be recommended, which would result in differing headache-related apps. At the time, 2/27 apps were discontinued from the app store, indicating that the current apps used in the study may no longer be available in the future. However, the content analysis is still applicable toward analyzing the current headache apps and the features they lack in hopes of improving current and future apps.

The methods for evaluating the apps also have several limitations since the baseline criteria for an ideal headache-tracking app were defined by the authors. Due to availability and time constraints, current headache app users were not consulted about their opinions on current mHealth headache apps. Long-term user retention and the likelihood of a headache mHealth user was not analyzed.

Although this study is limited in several ways, this content analysis provided preliminary data to support certain user-friendly features that headache apps offer. The apps collectively may have possessed necessary migraine management features; however, it is important to analyze current mHealth management features of each popular headache app to improve existing and future headache management apps.

Conclusion

In conclusion, although there is ambiguity in the baseline requirements for mHealth apps, the popular app search engines provided overlapping recommendations, indicating an underlying selection algorithm amongst headache app users and search engines. However, the current headache apps do not meet all four defined app criteria; therefore, there is a significant need to develop clinically appropriate apps that incorporate customizability, user-centered design, and features to enhance patient-physician interaction. The results may be extrapolated to improve the development of future healthcare management apps for other chronic conditions.

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