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Summary

Smartphone applications (or apps) are becoming increasingly popular. The lack of regulation or guidance for health-related apps means that the validity and reliability of their content is unknown. We have conducted a review of available apps relating to the generic condition of pain. The official application stores for five major smartphone platforms were searched: iPhone, Android, Blackberry, Nokia/Symbian and Windows Mobile. Apps were included if they reported a focus on pain education, management or relief, and were not solely aimed at health-care professionals (HCPs). A total of 111 apps met the inclusion criteria. The majority of apps reviewed claimed some information provision or electronic manual component. Diary tracking of pain variables was also a common feature. There was a low level of stated HCP involvement in app development and content. Despite an increasing number of apps being released, the frequency of HCP involvement is not increasing. Pain apps appear to be able to promise pain relief without any concern for the effectiveness of the product, or for possible adverse effects of product use. In a population often desperate for a solution to distressing and debilitating pain conditions, there is considerable risk of individuals being misled.

Introduction

A systematic review of controlled trials of health care delivered by mobile phone found that the targeted conditions ranged from diabetes to orthodontics.[1] Typically there was evidence only for short-term benefits. Mobile interventions can also include a website component, which contributes to data transfer and viewing.[2] The advent of smartphones, devices which combine features of mobile phones with computer capabilities, has reduced the divide between the advantages of both technologies.

Apps are downloadable programs designed to run on the smartphone operating system. In terms of medical usage, health-care apps offer instant access to multimedia information, including medical references, calculators, medication databases and relevant news updates.[3] The estimated total number of health-care apps is 5820 and is increasing rapidly.[4] There is, however, no regulatory or consumer body evaluating and approving the release of health-care apps.[5]

There is a need for the medical community to better understand which smartphone applications are available to patients searching for assistance and how these might facilitate self-management. We have conducted a review of available apps relating to the generic condition of pain, a common human experience,[6] and the primary reason given for seeking medical help. A wide variety of technologies have been employed in pain assessment, management and relief[7] but there has been no previous review of the contribution of smartphone apps.

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Methods

The search was conducted between June and August 2010 on the official application stores for five major smartphones: iPhone (App Store), Android (Android Market), Blackberry (App World), Nokia/Symbian (Ovi) and Windows Mobile (Marketplace). The health/lifestyle and medical categories, when present, were searched. In addition, search terms relating to pain, both generic and condition-specific (e.g. pain, migraine), were employed to identify any remaining relevant applications.

Inclusion and exclusion criteria

Apps were selected based on the following criteria. Included apps claimed some informational, management facilitating or curative capacity relating to pain. The app description was written in English, and pain featured within the keywords or text description. Apps were only included if they were aimed at patient consumers rather than health-care professionals alone. Applications unrelated to pain or unrelated to pain components of a specific condition were excluded, as were those which potentially could be applied to pain but were not advertised as such. One hundred and eleven apps met these criteria.

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Data coding and extraction

Information was collected from the store description summarizing the reviewed apps. This included basic commercial information (e.g. year of release, cost and file size), condition- and treatment-specific information (e.g. pain type and application purpose) and medical validity information (e.g. source of app information and level of medical professional involvement). Data were sourced from the app description only. Apps were accessed from the UK.

Further examination

For descriptive purposes a random selection of five of the 111 apps was made. These apps were purchased in full and were analysed in more detail to give an indication of the level of available data, and the relationship between content and content description.

Results

Of the 111 apps that met the selection criteria, the majority were available through the iPhone (79%). The remaining apps were available through Android (16%) or Blackberry (5%); no relevant apps were found through Nokia/Symbian or Windows Mobile. Only two apps were found to be available on multiple phone platforms. One was available on iPhone, Blackberry and Android; the other on iPhone and Blackberry.

The cost of the apps varied, although most were priced at about £1.19. Thirty apps were free to download; one app was free for ten days from initial download, followed by a $10 per month subscription fee. Of those available for free download, eight were trial versions of the full pay-for-download application. These apps typically offered a limited version of the app, restricting access to some features, e.g. no capacity to export data via email, limited capacity for storing recorded data.

Application file size ranged from 41 kB to 205 MB, with a median of 1.1 MB. There was no significant relation between file size and download cost ($r = -0.03$). The date of release for the reviewed apps ranged from 29 January 2009 to 11 May 2010. Release date information was not available, however, for Android apps. The number of available applications had increased rapidly, see Figure 1. Half of the apps had been released after March 2010.

Where a full version of the trial app was available on the same platform the latter was excluded from subsequent analyses to prevent over-representation. Seven of the eight trial apps met this exclusion criterion. In one case the full version of the trial app was yet to be released at the time of review and so was not excluded. The following selections review the remaining apps ($n = 104$).

Target pain and health conditions

The apps available targeted a range of pain types and specific health conditions with pain implications, with some overlap (i.e. multiple pain types targeted in the same app). Based on the app description, 79% were classified as primarily designed to be pain-relevant. The remaining apps included pain as a secondary focus, such as the inclusion of pain as a monitored variable in a general health journal. Thirty-nine percent of apps reported broadly targeting general pain. This included common aches and pains, and in some cases unspecified generic pain. Of the specified pain types, headache and migraine were the most commonly targeted (39%), with back pain the second most frequently reported, although with less than half as many apps as the former (16%). Ten apps reported some focus on chronic pain, of which seven were related to specific long-term health conditions such as fibromyalgia, arthritis and degenerative disc disease. A number of additional pain types were reported although infrequently, these ranged from neck and chest pain, to dental and menstrual pain.

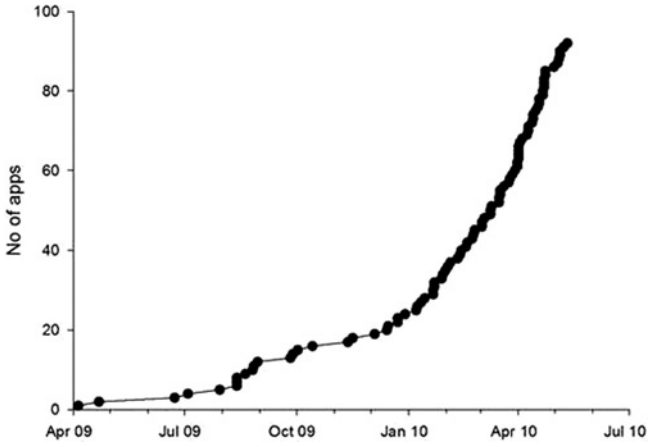

Figure 1 Number of available pain-related apps

Application purpose and content

Predominantly the reported app purpose was either pain relief or educational information about pain, sometimes in conjunction with information relating to other health conditions. Table 1 summarizes app content in relation to its presumed therapeutic components.

Over half of the apps (54%) reported content including some information provision about pain (e.g. general information, symptoms and causes) or electronic manualisation relating to pain reduction techniques, such as information on acupuncture, acupressure tutorials and headache prevention. Informational content was presented through a variety of media. Although the majority were text-based, several applications also included images, video and/or animations to illustrate content. Although information provision and education formed the majority of this content, some skills training was also present. The majority of apps containing skills training content were aimed at demonstrating strengthening and tension relieving exercises. Two apps used the mobile phone as a monitor of posture. Relaxation techniques were also commonly presented, usually taking the form of meditation

Table 1 Primary function and content of pain applications

Self-management component	Application content	Application focus	Number of applications*
Education skills training	Information provision Electronic manual	(a) Condition/disease information (b) Symptoms and trigger information (c) Treatment information (d) Exercise training (e) Relaxation/meditation training (f) Other non-medical (e.g. acupressure)	56
Self-monitoring	Diary tracking	(a) Condition tracking over time (b) Medication (c) Appointment reminder	25
	Pain scale only	Pain intensity assessment	2
	Posture monitoring	Body angle reading and response	2
Relaxation training	Audio relaxation (e.g. binaural/ isochronic tones)	Relaxation Meditation Hypnosis	18
	Vibration massage	Physical massage provision	3
-	Light/colour therapy	Light/colour therapy provision	3

*Figures exclude trial apps replicating the content of full applications on the same platform. A small number of apps documented dual components that could not be reduced to one primary focus

and massage tutorials. One app entitled Habit Changer: Pain Reduction described a 42-day programme to break cycles of pain. The details of the framework underpinning the programme were not fully described, although a cognitive behavioural approach was implied.

About one-quarter of the apps (24%) reported a diary or journal tracking facility. Diary facilities allow user input of variable data, chronicled over time, to enable monitoring of potential triggers and pain levels, as well as providing pragmatic assistance such as medication record and medical appointment reminders. One app allowed voluntary anonymous sharing of diary data with health-care professionals and researchers.

A relaxation, meditation and hypnosis component of content was also relatively commonly reported (17%). This content was delivered through audio, such as binaural/ isochronic tones, white noise and other supposedly relaxing sounds. The remaining content of the reviewed apps involved directly employing attributes of the mobile phone to reduce pain. This content claimed light/colour therapy (3%), through light emitted by the phone screen held to the face, supposedly soothing and relieving pain; and apps utilising the vibration capacity of the phone as a massage function (3%). Finally, two apps provided basic measurement of pain level by visual analogue scale (VAS) or Wong-Baker pain faces.[8]

Five selected applications

Of the five apps which were purchased and downloaded in full, one focused on changing lifestyle habits, one on exercise training, two on recording pain state and related activities, and one on posture.

(1) *Habit Changer: Pain Reduction (Natural Guides, LLC)*. The Habit Changer app was the only one whose description implied a focus on cognitive behavioural components of pain management. No specific psychological framework was given or referenced. No report of any trial of its effectiveness was given. A 42-day programme is provided designed to challenge behaviours and beliefs associated with pain which are thought to reduce quality of life. A simple interface provides tasks and daily messages relating to different aspects of the biopsychosocial experience of pain. The information and tasks are serialised and guide the individual through the programme of self-management techniques. Additional functions include: (1) Help: generic supportive comments that can be accessed at any time, (2) Thoughts: a comment paraphrases the daily message and task so that it can be considered from a different angle, and (3) Support: an option to share progress through email, Facebook and Twitter. A daily reminder alert to use the programme can also be set.

(2) *Pocket Therapy (ScavoMed)*. The Pocket Therapy app provides a list of painful injuries. Information on cause, location and symptoms associated with each injury is provided, along with exercises to improve range of motion and strength. Each exercise is demonstrated through a combination of photographs and text. Video demonstration is also available for some exercises. Additional information is provided on reducing pain through other techniques, including temperature manipulation, non-steroid anti-inflammatory drugs (NSAIDs) and massage.

(3) *Chronic Pain Tracker (Chronic Stimulation, LLC)*. The Chronic Pain Tracker app allows the recoding of pain, including pain intensity, location, type, medications taken and free-text notes. Pain intensity is rated on a 0–10 Likert scale. Pain location can be drawn on an image of the human body. Multiple entries over time can be reviewed in a variety of forms, from numerical to graphical presentation and the information can be exported via email to a computer. Finally, user data are anonymously transferred to the developers. This

function can be disabled, but its default setting is active. No advice or instruction is given on how to understand the summarized data.

(4) *My Pain Diary (Damon Lynn)*. The My Pain Diary app is similar to the Chronic Pain Tracker, although simpler. It allows entry of many of the same variables: pain intensity, location, type, trigger, remedy taken and free-text notes. Pain intensity is rated on a scale from 0–10. Feedback is limited to a summary of responses for each entry. Previous responses can be browsed by date and flagged where appropriate, and data can be exported to a computer. There is also a function to share data anonymously with other people such as health-care professionals. The full details of how and who receives the data were not specified. Unlike the previous diary application, the default setting for data sharing is disabled.

(5) *Iposture (Gongxing Wu)*. The Iposture app makes use of the sensors built into smartphones to measure the angle of the phone from an upright position. The purpose of the application is to alert the user when their posture slumps. Consequently, when in use the phone must be placed in a shirt pocket or around the neck for the application to work correctly. Iposture is a basic application which provides limited functionality and no additional pain-related information or support.

App development

Of the apps reviewed, 86% reported no health-care professional involvement, either directly as the app creator or indirectly as a source of information or evaluation of app content. Twelve apps (12%) reported the author of the app to be a physician. Chiropractors and physical therapists accounted for the creation of 2% and 1% of apps respectively. Of the apps reporting a non-health-care professional author, there were equal numbers of athletic trainers (3%) and alternative medicine representatives (3%). Alternative medicine professionals reported expertise in naturopathy, hypnosis and the Rossiter technique. Of the apps that were not directly developed by the groups outlined above, 95% did not report the source of the app content. Those that did reported using content from recognized pain or health societies (e.g. American College of Physicians, American Pain Society, International Headache Society) or a validated scale (e.g. Wong-Baker faces). It should be noted, however, that no direct association between the named bodies and app developer was suggested.

A comparison of health-care professional involvement in app development and content between the half most recently released apps and the remaining half demonstrated no significant increase in frequency of involvement ($t = 0.63$, $P = 0.53$). This suggests that, based on the provided descriptions, there remains a lack of validated expertise and content underpinning available pain-related apps.

Finally, no app reported a randomized controlled trial of content delivery or impact. One app reported uncontrolled evaluation but failed to provide basic participant details or methodology. No trials or evaluations of apps for pain have been identified in systematic reviews of e-health or mobile health interventions.[1,9,10]

Discussion

The results of the present review support previous reports of a substantial and increasing number of health-focused apps being made available for patients.[4] The majority of reviewed apps were available on the iPhone, which is unsurprising given its dominance in the smartphone market. Although a range of types of pains and conditions were targeted by the apps, the type of function provided was relatively limited. The majority of apps were designed to provide manualised information relating to pain or a specific health condition. Many apps utilized the multimedia capacity of the smartphone to illustrate content through image, video and/or audio. Content was frequently information provision or self-report diary tracking of variables, such as medications and pain level.

The content and function of the reviewed apps can be related to components of self-management, namely condition education and self-monitoring. These components were, however, typically isolated in separate applications and there was a lack of intelligent combination of the information provided with patient data collected. The interpretation of patient progress based on app diary entries was a patient task.

There is little evidence that informational interventions can change pain behaviour.[11] Where complex behaviour change is the aim, information alone is insufficient.[12] Cognitive behavioural content is necessary. Some workers have attempted to provide similar content to that reported in trials of cognitive behavioural interventions. Unfortunately, these have typically been restricted to a description of the mechanics of undertaking a behavioural exercise, rather than a programme of content delivered within a therapeutic framework.

In general, there is little evidence to support the use of pain apps. It appears that most apps have been developed without reference to the literature on trials and evaluations of behaviour change treatments for the management of pain.

Other more promising features of the applications reviewed included optional sharing of data collected by the user with health-care professionals and researchers. The default activation of data sharing on one application, although anonymous, emphasises the ethical problems involved and the need for transparency and patient consent. Some apps also included the ability to share data through social networking websites, which may facilitate social support. Finally, some apps utilized the built-in smartphone sensor technology to provide behavioural assessment, albeit in a limited capacity.

Overall, the reviewed apps only exploited part of the potential for smartphones to deliver self-management assistance. There was a general lack of intelligent response, component integration and an absence of the psychological and behavioural components underpinning many self-management interventions. This may be due to a lack of health-care expertise in pain self-management during development. This is concerning for two reasons: first, self-management should be considered a collaboration between patient and health-care professional;[13,14] not a deference of information or responsibility but a transference of expertise and useful skills. Second, of the existing apps, there are few reports of the origin of content and validity. Since there are no additional regulatory requirements on the production or marketing of health-care apps, the accuracy and reliability of content cannot be assumed.[5] The FDA in the USA has demonstrated awareness of the need to consider regulation of smartphone apps.[15] In the related area of Internet health advice there are a number of voluntary quality control schemes, but we are not aware of any scheme for apps.[16]

The absence of evidence of app effectiveness and the lack of discussion or consideration of the importance of evidence within app descriptions is concerning. For example, the Hands-On Pain Relief app claims 'fast, simple, safe and effective pain relief for almost every painful condition at your finger tips!' Although such marketing claims are not uncommon for unregulated consumer non-pharmaceutical health-care products, they should be taken seriously.[17] Regulation is tighter for products that are classed as medicinal with evidence needing to be established. Pain apps appear to be able to promise pain relief without any concern for the effectiveness of the product, or for possible adverse effects of product use. In a population often desperate for a solution to distressing and debilitating pain conditions, there is considerable risk of individuals being misled.

Study limitations

The present study had some limitations. First, the review was restricted to commercial descriptions and did not evaluate the effectiveness or accuracy of app content other than through the marketing claims. It is possible that in some cases health-care professional involvement might be documented within the actual content but not the description. Future research might evaluate app usage following purchase, and any treatment or adverse effects of app usage. Second, the inclusion criteria were limited to pain-related apps directed at consumers rather than health-care professionals. Apps with alternative health foci may provide more varied utilization of smartphone technology than documented in this review. Furthermore, there are no restrictions on patient consumers downloading apps designed specifically for health-care professionals not included in this review. Finally, the review was performed in the UK, and on English language apps.

Conclusions

The potential benefits of health-care apps are wide. Pain self-management is an excellent candidate for new product development. The commercial descriptions of early attempts, however, depict content that is primitive. Future research may shed further light on the impact, benefit or disappointment this content may have on the patient consumer. There is a need for people with appropriate expertise to guide app development and content. Smartphone devices raise new challenges both in terms of effective regulation and data security.[18,19] A regulated environment may be required that can balance the importance of evidence-based clinical content and expert support without obstructing the progress mobile health-care technologies may provide.

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