Smartphone apps for Total Hip Replacement and Total Knee Replacement surgery patients: a systematic review

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Abstract

Purpose: The aim of this study was to critically examine the content of smartphone apps produced for patients undergoing total hip replacement and total knee replacement surgery.

Materials and methods: A systematic search was conducted across the five most popular smartphone app stores: iTunes; Google Play; Windows Mobile; Blackberry App World; and Nokia Ovi. Apps were identified for screening if they: targeted total hip replacement or total knee replacement patients; were free of charge; and were in English. App quality assessment was conducted independently by three reviewers using the Mobile App Rating Scale.

Results: 15 apps met the inclusion criteria. On the 5-point Mobile App Rating Scale, the mean overall app quality score was 3.1. Within the Mobile App Rating Scale, the "aesthetics" subscale had the most inconsistency across all apps, generating the highest and lowest mean scores (4.7 and 1 respectively). The "functionality" subscale had the highest mean score (3.8) among the four subscales, and the "information" subscale had the lowest mean score (2.7).

Conclusion: This study highlights that despite a wide range of apps currently available to total hip replacement and total knee replacement patients, there is significant variability in their quality. Future efforts should be made to develop apps in partnership with patients, to improve the content, interactivity, and relevance of apps.

Keywords: Smartphone, Apps, Patient information/education, Total hip replacement, Total knee replacement

Introduction

The daily use of smartphones by the general public is now entrenched within society, and the predicted number of worldwide smartphone users is set to reach around 2.5 billion by 2019 [1]. Alongside their use as a communication device, smartphones are also now used within clinical practice by healthcare professionals [2] and they have impacted upon many aspects of patient care [3-4]. In 2017, almost 77% of adults in the United States of America (USA) reported using a smartphone, over double the rate of 35% from 2012 [5]. Although millennials are the biggest users of smartphones, 74% of 50-64 years olds now also own a smartphone [5]. Furthermore those aged 65 and over are increasingly adopting these devices, with this reflected by smartphone ownership in this group increasing from 11% to 42% since 2012 [6].

Currently, more than 97,000 health related apps are available across different operating software (OS) platforms [7]. This has led to smartphones becoming a commonly-used platform to assist the management of patients within the healthcare domain [3]. Apps have been cited as being effective tools for healthcare professionals [2,8] and have been used by patients to self-manage conditions such as: weight loss [9]; lower back pain management [10]; diabetes [11]; sports concussion [12]; biopolar disorder [13]; and depression [14]. Previous systematic reviews have concluded that the use of smartphone apps in healthcare has the potential to improve outcomes by promoting self-management strategies. Given the increasing demand on healthcare services due to a global population which is aging in many countries, the role of healthcare apps that promote self-management of conditions warrants further exploration.

In April 2017, the National Health Service (NHS) launched a Digital App Library to assist patients and clinicians in easily identifying useful and relevant app

[15]. The signposting towards apps in this manner by an organisation as vast as the NHS reflects the increasing role of apps in healthcare, and the potential for a greater adoption of apps by patients. At the time of writing, the Digital App Library features 26 registered apps; however only one app has been stated to be “NHS approved” [15]. This illustrates the challenges involved in the creation of a high-quality healthcare app. Currently in the United Kingdom (UK) there is no associated regulatory control over the content and medical information a healthcare related app provides [16-17], whereas in the USA Food and Drug Administration (FDA) have recently announced a regulatory program, aiming to ensure that the quality of the apps is sufficient before it is available to the public [18]. There have been attempts in recent years to generate recognised methods of evaluating the quality of apps for researchers and clinicians, and the Mobile App Rating Scale (MARS) assessment is one which has been reported upon in several instances [19-20].

Information quality is crucial if orthopaedic related apps are to be successfully implemented to the surgical pathways. Given the high volume of elective orthopaedic surgery conducted within the UK, the recovery of patients carries a large financial burden. A total of 2,055,687 orthopaedic procedures were carried out between 1 April 2003 and 31 December 2015; of which 796,636 were primary total hip replacements (THR) and 871,472 total knee replacements (TKR) [21]. With a shift towards an aging population present in many countries, the volume of elective orthopaedic procedures is likely to continue to increase. To assist with this burden upon healthcare services, the promotion of self-management strategies in rehabilitation following surgery via the use of smartphone apps presents an attractive proposition. Potentially, these technologies could help to promote independence and an accelerated recovery for the patient, and also provide cost-effective treatments for healthcare providers.

Traditionally, self-management post-THR/TKR surgery has been facilitated through the provision of written materials and patient information booklets. Previous studies have found fundamental deficiencies in the literature routinely provided following THR/TKR, despite high levels of details and information provided by some books and leaflets [22-23]. Although there are now increasing numbers of smartphone apps available for THR and TKR patients, the quality of these apps has not been evaluated. Therefore, the aim of this review was to systematically retrieve and critically examine the quality of smartphone apps targeted towards THR and TKR patients, in order to gain a greater understanding of the apps which are currently available to the general public.

Methodology

A systematic search strategy was employed to capture the apps for analysis. As this study utilised information that was freely available in the public domain and there was no interaction with patients or retrieval of personal data, the Health Research Authority (HRA) ethics database [24] confirmed ethics approval was not required and therefore it was not sought.

Inclusion/Exclusion criteria

Apps were retrieved for screening if they were identified using the search terms listed below in "*Search strategy*". Apps that were subsequently included for evaluation were those which were: targeted towards patients; focused on THR or TKR surgery; free of charge so as to reflect the current trends in app downloads [25-27]; and available in English. Apps were excluded from evaluation if: their primary focus was professional practice (i.e. apps targeted towards surgeons/clinicians rather than patients); they were not available in the UK; required purchasing/special login access; outlined general physiotherapy exercises only; were a game (rather than an information app); were not in English; were an advertisement for a company; were solely journal or conference-related; or were not related to THR or TKR.

Search strategy

The lead author (SB) searched the following sources for relevant apps: the App Store (version 11) [28]; Google Play [29]; Blackberry App World [30]; Ovi Store (for Nokia/Symbian brands) [31]; and Windows Mobile Marketplace [32]. These searches were conducted on the 25th April 2017, and the search terms employed were intended to encompass the range of phrases a patient may use when seeking apps related to THR and TKR. The search terms used were: “Hip replacement”; “Hip arthroplasty”; “Hip Surgery”; “Knee replacement”; “Knee arthroplasty”; and “Knee surgery”. The search strategy and inclusion/exclusion processes are outlined in Figure 1.

Figure 1 near here

Figure 1. Flow chart to show retrieval and inclusion/exclusion of apps.

Following the initial stage of identifying apps using the search terms, the resulting apps were tabulated and duplicates were removed. Where the same app was available on different OS [33] (i.e. iOS or Android) only one version of the app was retained for analysis, with the Android platform being preferred as a default for consistency. Apps were then excluded from those retrieved on the basis of the exclusion criteria defined in “*Inclusion/Exclusion Criteria*”. Those apps which met the inclusion criteria were downloaded onto a Sony Xperia smartphone device (Android 5.1.1) if available through

Google Play, Blackberry Passport smartphone for Blackberry World, or the iPhone 6 Plus (version 10.3.2) if available through the iTunes Store.

Data extraction

The lead author (SB) downloaded each of the apps included for evaluation, and extracted additional information for each app from the app stores. For each of the included apps the platform that they were available on was recorded, along with the clinical focus of the app (i.e. THR, TKR, or both) and the nature of the app (i.e. an information or exercise focus). The quality assessment of each app was derived from the MARS, with this approach being similar to that used in similar app review [33-34].

Following the guidance by the creators of the MARS [18], the lead author (SB) undertook video training in the use of the MARS using sample rating exercises to practice, and compared results against creators' ratings [35]. The MARS ratings from the lead author (SB) were then repeated by one of the other members of the research team (TW/OA), with verification occurring from cross-checking for consistency. Where differences of greater than one point on the MARS scale existed, the third member of the research team was used to help reach consensus. In addition, a two way mixed, intraclass correlation (ICC) analysis using SPSS software [IBM, 2010] was used to analyse the consistency of three raters.

Data analysis:

The MARS (Supplementary material 1) consists of 19 items grouped into four sections: "Engagement" (entertainment, interest, customisation, interactivity, and target group); "Functionality" (performance, ease of use, navigation, gestural design); "Aesthetics" (layout, graphics, visual appeal); "Information quality" (accuracy of app description, goals, quality and quantity of information, visual information, credibility, evidence base). All items of the MARS are rated on a 5-point scale, from “1: Inadequate” to “5: Excellent”. Section D also has not applicable (N/A) option for irrelevant components. Each of the four sections is rated by calculating the mean of the scores for questions in each of the sections [18].

Results

Descriptive Characteristic

The 15 apps included for analysis are outlined in Table 1.

Table 1 near here

MARS App Quality Scores

The MARS ratings for the apps included for analysis are shown in Table 2. Item 19 on the MARS scale (“Evidence base”) was not included for analysis as there was no evidence of any of the included apps being tested in the scientific literature.

All of the apps were cross-checked by the members of the research team. The ICC for overall MARS ratings was 0.981 (95% CI 0.886 – 0.997) for the apps indicating a consistency in rating of the apps by the three raters. The overall MARS mean score for all of the included apps was 3.1 out of 5. Of the 4 subscales included, “aesthetics” had the most inconsistency across all apps generating both the highest and lowest mean score ratings (4.7 and 1 respectively). “functionality” had the highest mean score (3.78) and lowest standard deviation (0.53) among the 4 subscales for all of the apps. The ‘My Knee Guide’ app had the highest mean MARS total (4.23), whilst the ‘Know About Surgery treatment’ app had the lowest mean MARS total (1.96).

Table 2 near here

Discussion

At the time of writing, this study is the first to have systematically reviewed and independently evaluated the quality of commercially available, patient-focused apps for THR and TKR surgery. There have been numerous other reviews published which have explored smartphone apps supporting a range of conditions including heart failure [36], rheumatoid arthritis [37] and mental health [38]. Given the ever-increasing number of health apps available to patients and the potential negative effect of apps [39], it is essential that the quality of these apps is evaluated appropriately.

The MARS used in this review is a reliable, multidimensional measure for classifying and evaluating smartphone apps [19]. The THR and TKR apps retrieved in this study were shown to be of a moderate quality. The findings of this study were consistent with similar smartphone app reviews [40-42] with “functionality” achieving the highest score across the MARS subscales followed by “aesthetics” and “engagement”, and “information quality” scoring the lowest. From a simplistic standpoint, it could be argued that the high aesthetics scores in these reviews demonstrate that smartphone apps can be a visually attractive method of presenting information; however the low information quality scores suggest that inadequate attention has been paid to the content hosted in these apps. This inference of style-over-substance is of concern, and in order for patients to truly benefit from this medium, the information shared needs to be accurate and of a high-quality.

For patients undergoing THR and TKR surgery, smartphone apps could represent an accessible, efficient, and cost-effective means of enhancing care.

Unfortunately, none of the information presented on the THR and TKR apps in this study was underpinned by evidence-based scientific literature. In addition, the majority of the apps identified were developed by private companies. Although this in itself is not a cause for concern, thought and consideration should be given to the potential commercial implications or bias underpinning information from these sources.

At the time of writing, none of the apps included in our review have been included in the 'NHS approved' list [43] nor had any shown evidence that they had volunteered to take part in the FDA software and app precertification program. The star ratings from the descriptive characteristics of the apps analysis (in Table 1) also highlight misleading information. For example the app 'My THR' had five star ratings in the App store, yet scored below average (2.9) in the MARS assessment in this study. This is an important point to note as the rapid rate at which smartphone apps emerge imposes a challenge over the quality and reliability of the information available to patients through these apps.

For those apps included in this study, there were no instances where apps were created with any input from patients, and none of the apps made reference to any patient engagement during the design phase. In the authors' opinion, this is a major weakness of the currently-available THR and TKR apps available. In order to overcome this inadequacy we recommend a shift to a user-centred design [44]. A user-centred design is often a multistage process and it refers to the broad category of methods through which end users, including patients, can have an effect on technology design. The inclusion of patients at all stages of the design and testing processes through user focus groups or interviews can facilitate the generation of a higher quality of THR and TKR apps.

Whilst there is inconclusive evidence for progressive resistance strength training programmes pre and post THR and TKR, the rationale seems sensible, and is appealing to patients [23]. This may explain the focus of the majority of the included apps being towards physiotherapy and exercise training. Approaches to rehabilitation following surgery vary greatly and evidence is limited with regard to successful interventions [45]. Two of the apps included in this review ('BeeWell Orthopaedic Hip' and 'BeeWell Orthopaedic Knee') gave app users access to this information, however they provided no customization in order to create tailored training. Given the individual requirements of each patient following surgery, greater attention needs to be paid towards enabling clinicians and patients to have more control over this essential aspect of their recovery. It is important to note that this review did not include those apps that were not openly available; this includes those that required payment, referral from a clinician, or enrolment into a specific hospital or healthcare plan. Such apps may have options for personalised care/rehab plans.

The findings from this study show a clear need for personalised and medical accurate smartphone apps, preferably created by public health institutions with no commercial bias. Given that many of the apps seen had a low "engagement" subscale score, future apps for THR and TKR could consider in-built incentivisation into the app to encourage increased used. Several of our key recommendations for the creation of future THR and TKR apps (and other healthcare related apps) are highlighted in Figure 2. In order to generate smartphone apps which are likely to have more clinical utility for THR and TKR patients, it is imperative that app developers, clinicians, and patients work closer together to create adjuncts that are better suited for purpose.

Figure 2 near here

Figure 2. H-appy (Health app) recommendations.

Conclusion

The findings of this systematic review indicate that despite a wide range of smartphone apps being available to TKR and THR patients, their quality is lacking. All subscales of the MARS used to evaluate the apps in this study showed scope for improvement. This introductory review highlights the need for clinicians and patients to work collaboratively with smartphone app developers in order to create apps that are of true clinical benefit. The creation of appropriate methods of evaluating smartphone apps in clinical practice will help to provide evidence as to the effect that these apps could play in improving patient outcomes following surgery.

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App name	Platform	Focus of app (THR or TKR or both)	Category of app (Information, exercise, both)	Number of downloads	Star rating	Last updated	Version
BeeWell Orthopaedic Hip	Apple iTunes	THR	Information	Not recorded	None reported	22-Jun-17	1
Hip Miss Samantha Z Troos	Apple iTunes	Both	Information	Not recorded	None reported	10-Nov-16	3.0.1
BeeWell Orthopaedic Knee	Apple iTunes	TKR	Information	Not recorded	None reported	22-Jun-17	1
GreenCare Guide for Knee	Apple iTunes	TKR	Both	Not recorded	None reported	13-Sep-16	0.0.8
My Knee	Apple iTunes	TKR	Both	Not recorded	None reported	11-Aug-17	1.7
My Knee Guide	Apple iTunes	TKR	Both	Not recorded	4.5	07-Jun-16	1.8
My THR	Google Play	THR	Both	500-1000	5	15-Mar-17	1
CommonSurgeries	Google Play	Both	Information	1,000-5,000	3.9	05-Mar-15	1
Pocket Physio	Google Play	Both	Both	10,000-50,000	4.3	06-Apr-16	2.0.2
Knee Pain Relieving	Google Play	TKR	Both	10,000-50,000	4.6	31-Dec-16	1
Knee Pain Protocol	Google Play	TKR	Both	1,000-5,000	4.9	19-Apr-17	0.2
Sport Injury Clinic	Google Play	Both	Both	10,000-50,000	4.2	20-Apr-12	14.18
Ortho Physical	Google Play	TKR	Information	500-1,000	3.7	03-Jun-17	1.3
Know About Surgery treatment	Google Play	Both	Information	10-50	3.4	30-May-17	1
Healthy Knee	Blackberry	TKR	Information	Not recorded	None reported	05-Aug-15	0.0.1.1

Table 1. The descriptive characteristics of apps retrieved for analysis.

App name	MARS Engagement	MARS Functionality	MARS Aesthetics	MARS Information	MARS mean score
My Knee Guide	4.80	4.25	4.00	3.86	4.23
BeeWell Orthopaedic Hip	2.60	4.50	4.70	3.29	3.77
Hip Miss Samantha Z Troos	4.20	4.00	3.60	3.29	3.77
BeeWell Orthopaedic Knee	2.40	4.50	4.70	3.29	3.72
My Knee	3.80	4.00	3.30	3.14	3.56
Pocket Physio	3.60	4.25	3.30	2.57	3.43
Sport Injury Clinic	2.40	3.50	3.60	3.00	3.13
GreenCare Guide for Knee	2.80	3.75	2.67	3.00	3.06
Ortho Physical	3.00	3.75	3.30	1.86	2.98
Knee Pain Protocol	2.40	3.25	3.00	3.00	2.91
My THR	3.00	3.00	2.30	3.29	2.90
Healthy Knee	2.80	3.25	2.67	2.57	2.82
Knee Pain Relieving	1.40	2.75	2.70	2.29	2.28
CommonSurgeries	1.60	4.00	1.00	1.43	2.01
Know About Surgery treatment	1.40	4.00	1.00	1.43	1.96
Average MARS score (SD)	2.81 (0.98)	3.78 (0.53)	3.06 (1.09)	2.75 (0.72)	3.10 (0.67)

Table 2: MARS assessment (overall scores and subscale score).

Figure 2. H-appy (Health app) recommendations.