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REVIEW

EPIDEMIOLOGY AND CLINICAL MEDICINE

Apps to prescribe therapeutic exercise among rehabilitating adults: a systematic review

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ABSTRACT

INTRODUCTION: There is a growing interest across scientific literature on smartphone applications (apps) aiming to modify various health behaviors. Interventions that include behavior change techniques (BCTs) have been advocated to increase their efficacy. The extent to which those techniques are present among apps is unclear. The aim of this review is to analyze the existing apps for prescribing therapeutic exercise (TE) in rehabilitating adults.

EVIDENCE ACQUISITION: The study sample was identified through systematic searches in iTunes (Apple) and Google Play (Android). Applications (apps) were assessed according to the taxonomy of BCTs for the presence/absence of these techniques. Mean and ranges were calculated for the number of observed BCTs. Number of techniques observed in free apps in both stores was calculated, but formal statistical were not conducted due to the exploratory nature of this study.

EVIDENCE SYNTHESIS: Eighteen apps were identified (11 for iPhone, two for Android, and five for both). The average number of BCT included in the eligible apps was 11 (range 4 to 16), with predominance of four techniques: "request the establishment of behavior" (100% of the apps), "providing instructions" (100%), "requesting an implementation" (100%), and "determine graded tasks" (100%). Techniques such as "taking a behavioral contract," "stress management," "prevention of relapse," and "promote the identification of barriers" were not used in the apps reviewed.

CONCLUSIONS: Our work demonstrates that apps prescribing TE among rehabilitating adults applied an average of 11 BCTs. Presence of BCTs varied by app type. No difference in the number of BCTs identified between iOS and Android apps was found.

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KEY WORDS: Mobile applications; Telemedicine; Rehabilitation.

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Introduction

Technology is constantly evolving, and mobile technologies in particular are being adopted at an increasing rate. Mobile phone has become a very important growth factor issue that compensates deficiencies from other infrastructures. Thank to that, information is able to flow freely and quickly, reducing transaction costs and creating more efficient markets.[1] An increased access to new health technologies and power leverages from mobile communications are providing better health solutions worldwide.[2]

Self-management is a therapeutic approach that encourages patients to assume a more proactive role in their care when dealing with their health problem through lifestyle and behavioral changes. It is a widely recognized and recommended option for treating musculoskeletal conditions, and provides patients with the knowledge, and capabilities to improve health levels.[3] Therapeutic exercise (TE) has evolved as an effective and safe self-management approach for these conditions, being recommended by several clinical guidelines and reviews.[4-9] Strong evidence support TE as a valid therapeutic initiative in terms of pain, functional impairment, or quality of life. Actually, its effects are comparable to those offered by other conserva-

tive treatments such as manual therapy,[10] electrotherapy,[11] or medication.[12]

Recent advances in technology during last years, along with the increasing number of smartphone users worldwide, have promoted the irruption of thousands of applications (apps) on many different topics. Among them, health-related apps have become some of the most popular.[13, 14] As an example, by 2015, more than 150,000 health apps were available on the Apple iTunes and Android app stores, and one third of mobile phone owners had one or more health apps on their mobile device.[15] Nowadays, these apps allow clinicians and researchers to conduct both tailored and individual interventions including real-time assessment and feedback, what increases their efficiency.[16] However, only a few studies have attempted to assess the effectiveness of the use of smartphone and apps in relation to health. In addition, limited information on consumer behavior and the use of these apps exists.[17, 18] Various papers can be found in scientific literature linking mobile and apps with various topics related to health, such as smoking cessation,[19] alcohol consumption,[20] caring for chronic wounds such as pressure ulcers,[21] diabetes,[22] adolescent obesity,[23] bipolar disorder,[24] asthma,[25] and aphasia,[26] but there is a shortage of registered reviews focusing on its use and implications in the field of TE. Thus, the purpose of this study was to identify and appraise existing smartphone apps for prescribing TE among rehabilitating adults.

Evidence acquisition

This systematic search was conveniently registered in the international prospective register of systematic reviews (PROSPERO), with registration number CRD42015017869.[27] Additionally, our work was conducted according to the existing criteria.[28] According to its nature and content, the study was exempt from Human Ethics Committee review.

Search strategy

A systematic search strategy was used to identify available smartphone apps. The iTunes (Apple) and Google Play (Android) stores were explored using their search engines including keywords from different sources, such as MeSH terms, CINAHL Headings, and general Health Sciences descriptors. Search strategy was based on Boolean logic and included (AND) and (OR). Combinations and synonymous of the following terms were employed: "health," "therapeutic exercise," "injury," and "prescription" "physical therapy." All of them were used both in English and Spanish, to cover all possible existing apps in both languages.

Eligibility criteria

Apps were considered for inclusion in the study if they were available for English and/or Spanish speaking users; designed and/or marketed for prescribing TE in adults; introduced after January 2003; promoted interactions between professionals and patients. Apps were excluded if their primary function was unrelated to TE (*e.g.*, games and brain training apps), if they were essentially sporting apps, if they were designed purely for the dissemination of information on exercise or sport, or those requesting a prepayment for either downloading or subsequent registration.

To be included the review apps had to be available through the two currently major application stores for smartphones, such as iTunes (for iOS devices) and Google Play (for Android).

Screening procedure

The review was conducted by two researchers (SS-G, IM-P), separately but simultaneously in time, and the evaluation was conducted sticking to the inclusion criteria mentioned above and based on the rating of behavior change techniques (BCT) interventions.[29-31] The screening procedure was adapted to each store and summarized in Figure

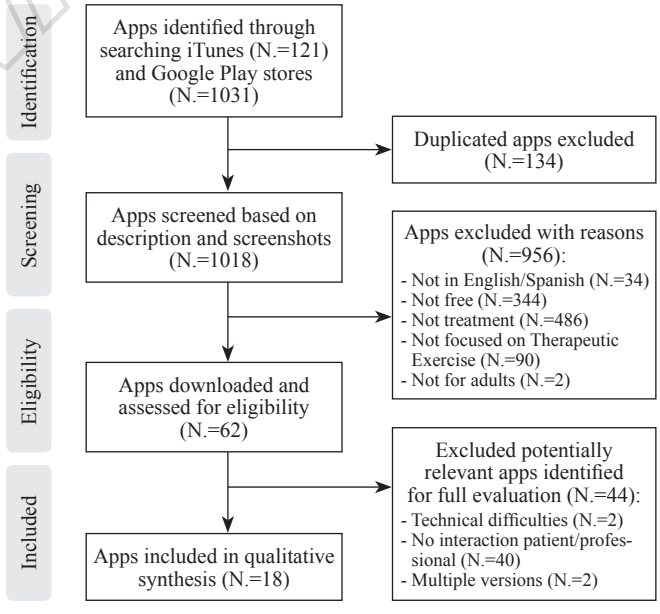

Figure 1.—PRISMA flow diagram of search results.

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1. For both iTunes and Google Play, the identification and eligibility phases of screening were performed by two researchers (SS-G and IM-P), and differences between the two reviewers were resolved by discussion and/or involving a third part when necessary. If the same version of an app was available in iTunes and in Google Play, the iTunes version was downloaded and assessed for eligibility since there was greater access to this device by the reviewers. Since the procedure for selecting Google Play differs somewhat from iTunes, it was carried out separately.

The selection phase was made based on the description, abstract and existing screen captures in the search. In this case, they were excluded all those that were presented in a non-English/Spanish language, which were unrelated to treatment, not to prescribe TE and those that were not designed for adults.

During the election, selected apps were downloaded and evaluated, so that, at first, all those who do not allow downloading and requesting a payment before use despite being downloaded for free were excluded. Additionally, those presenting with multiple versions or apps 'key' (it is necessary downloading various apps for the main one could be used), those whose version was outdated and had not been modified in the last five years, and those including physiotherapist-patient interaction in either one or two senses of communication, such as chat, video or email were also discarded. Finally, the bundled apps were downloaded both in a BQ Android device and an iPhone 5, and described according to their functions and features.

Those cases where, despite having a free download, a payment for any reason was requested during app use and evaluation they were studied until that time. When only a payment use was allowed and no free trial period existed, apps were excluded from the study.

Scoring

App content were evaluated based on behavior change technique (BCT) taxonomy.[31] This was created to identify potentially effective BCTs used in interventions, but later translated techniques from reviewers, concepts applicable to the field of study contained in this review. BCT taxonomy distinguishes 26 BCTs, three of whom have shown low-rated reliability and were, therefore, not included. Thus, apps included in this review were independently evaluated and scored by both reviewers (SS-G, IM-P) following the modified 23 item-taxonomy. Each one received a score between 0 and 23, representing the number of BCTs identified in them. Techniques were classified as either present or absent. Prior to assessment, all evaluators read BCT definitions carefully and discuss them when necessary in order to ensure a clear differentiation between techniques. After running each app, reviewers assessed independently every menu function to identify the presence or absence of BCTs according to the checklist. Any lack of agreement was discussed with a third reviewer when necessary until consensus was reached.

Data extraction and analyses

Metadata from all included apps were summarized into a standard Microsoft Excel spreadsheet. The source for all metadata was the respective app store where the app was identified. The name of the app, the date it was downloaded, and the name of the app store were collected for each app. The app's score based on the number of BCT it used was recorded as well. Means and ranges were calculated for the sum BCT scores.

Evidence synthesis

Since both reviewers (SS-G, IM-P) search conducted simultaneously, the number of apps detected was similar. These were pooled finally leaving 121 and 1031 on iTunes and Google Play, respectively. A total of 1018 apps were evaluated after eliminating duplicates. After the initial screening based on the name and the app description, 956 apps were excluded. The primary reasons for exclusion at this stage were as follows: apps were not free, and apps were not designed for treatment purposes. A total of 62 apps were downloaded for a full evaluation based on the above-mentioned inclusion criteria, and further 44 apps were excluded. Of these, most of them (40 of 44, 90%) were discarded because no interaction between patient and professional was allowed, whereas a small percentage were excluded for having multiple versions (two of 44, 5%) or not providing technical difficulties when downloading (two of 44). Finally, 18 apps were included in this study.

Of the 18 apps included in this review, 10 (55.5%) were found on iTunes exclusively, two (11.1%) on Google Play exclusively, and 6 (33.3%) were found on both app stores. Consequently, almost 90% of them ran with iOS operational system. The dominating app language was English (100%, 18 of 18).

The average number of techniques including behavioral changes in eligible apps was 11 (range 4 to 16). Table I gathers BCT scores for each app. The most commonly included BCTs were "request the establishment of behavior" (N.=18), "providing instructions" (N.=18), "requesting an implementation" (N.=18), and "determine graded tasks"

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TABLE I.—*Characteristics of included applications.*

App	App store	Date of download	Professional prior identification	BCT score
Insta aide	iTunes	May 2015	Yes	16
Track Active	iTunes	May 2015	No	16
PT Pal Pro	iTunes/Google Play	April 2015	Yes	12
Smart PT	iTunes/Google Play	May 2015	No	12
Blue Jay	iTunes/Google Play	April 2015	Yes	11
Fizzio Fit	iTunes	May 2015	Yes	11
Force Patient	iTunes/Google Play	May 2015	Yes	11
iRehab	iTunes	May 2015	No	11
My physio	iTunes/Google Play	April 2015	Yes	11
Physigo For	iTunes	May 2015	No	11
Wellpepper	iTunes	May 2015	No	11
iHab	iTunes	May 2015	No	10
Perfom Rehab	Google Play	May 2015	Yes	10
PT Tracker	Google Play	June 2015	Yes	10
Rehab Guru	iTunes/Google Play	May 2015	Yes	10
Salaso	iTunes	May 2015	Yes	10
Rehab minder	iTunes	May 2015	No	8
Physio Cam Free	iTunes	May 2015	No	4

BCT: behavior change technique.

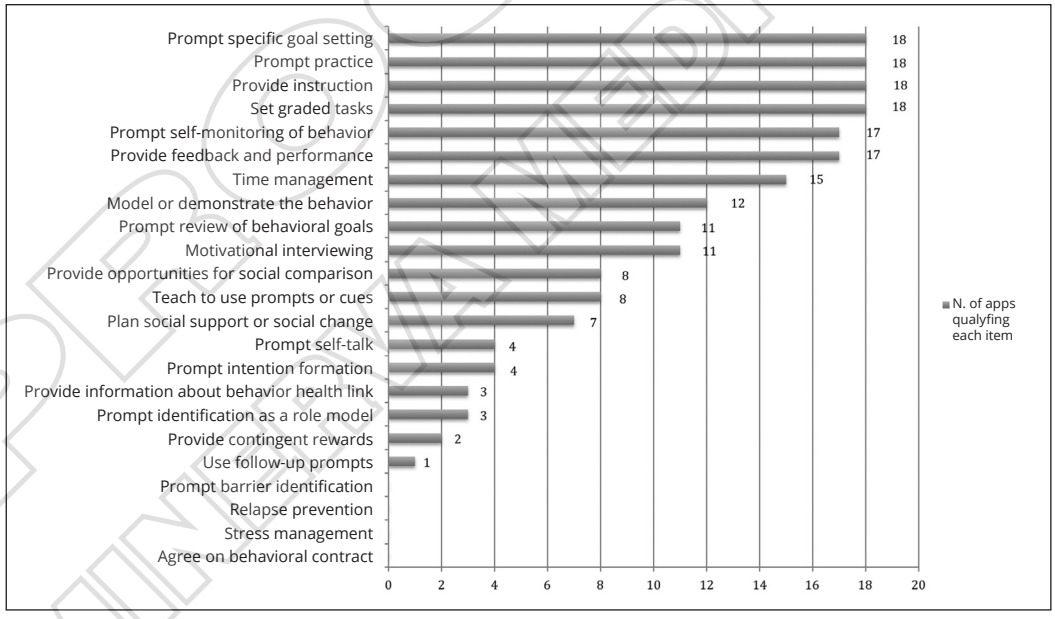

Figure 2.—Frequency of behavior change techniques used in applications.

(N.=18). On the other hand, "taking a behavioral contract," "stress management," "prevention of relapse," and "promote the identification of barriers" were not used in any of the apps included in the study. No differences were found regarding the number of BCTs used in the available apps for both stores. Figure 2 gathers the number of applied BCTs in apps.

The purpose of this review was to evaluate the use of BCTs in available apps through two large tents — iTunes and Google Play — allowing to prescribe TE in the context of adult rehabilitation, and using adapted feedback related to an established taxonomy of those BCTs.[16] A systematic approach was employed to identify these elements. Our results showed a fair number of available apps focusing on the prescription of TE in rehabilitating adults exist in both stores. To the best of our knowledge, this is the first review that evaluates existing apps for this topic.

Identifying and classifying the BCTs used in the apps

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have been employed in the past as a valid approach to analyze their content.[32] Previously, a taxonomy of BCTs was developed in order to generate a bundle of techniques, and it was presented in a short size, in order to improve the specification, replication, and implementation of behavioral interventions. According to this, assessing apps for inclusion of these BCTs could help in detecting relevant apps for specific behavior change objectives. Previous studies have demonstrated that certain BCTs are associated with more favorable results. Middelweerd *et al.* showed that physical activity apps incorporated five of the 23 BCTs (22%) as an average,[16] whereas Conroy *et al.* demonstrated that app on the same topic employed 4.2 of the 26 BCTs (16%) as an average as well.[33] There was substantial variation in the numbers of BCTs present in our review. All eighteen apps included in the review used an average of 11 different BCTs per app, and none of them uses more than 16 or less than 4. "Provide instructions," "prompt practice," "prompt specific goal setting," and "set graded tasks" were BCTs most frequently used.

Revisions applying the aforesaid taxonomy and assessing the number of BCTs used in interventions identified an average of 6 to 8 BCTs. Among them[16, 34-36], "feedback and self-monitoring of behavior" are most frequently used BCTs, which greatly differs to those prevailing in our review. Interestingly, part of these studies has come to the conclusion that the proposed theory by these techniques is not confirmed.[34-36] For example, West *et al.* concluded that professionals have to be careful when recommending the use of health apps, since most of them do not meet the BCT and may not be effective.[36] Similarly, Cowan *et al.* found that BCT taxonomy is rarely used in apps that target physical activity, which can be added has not been conducted, to date, those that allow prescribe TE.[34] Finally, Crane *et al.* warned that BCT interventions are associated with users, so that the great variation in design, complexity and functionality of apps along with contexts in which they are used, can lead to lower scores on them.[35] To date, to our knowledge no previous study regarding BCTs on TE has been published. We highlighted and employed exercise/physical activity apps[34, 37] as the closest subject matter to be compared to.

This review did not include payment apps, as previously mentioned studies.[16, 34-36] Previous research has postulated that higher app prices are not necessarily associated with higher app quality.[38] In parallel, we do agree with the fact of promoting accessibility by any patient beyond his/her purchasing power.

At least four BCTs change in each of the 18 apps included in our review, suggesting that application developers attempt to use the theory of behavior change to a certain extent were identified. However, the results also indicate that the inclusion of BCT set is far from optimal in most apps because they are not designed specifically for it. Additionally, the fact that most apps´ contents are present within them themselves, which allows a quicker identification of advantages/disadvantages, makes assessment susceptible to bias evaluator.

As many others, our study could be labelled as having low reliability due to the taxonomy of Abraham and Michie[31] was originally designed to qualify other behavior change interventions that are not based interventions smartphone apps. Taxonomy used for apps requires the researcher to adapt items to a context where they can be applied in order to properly classify them. Following this logic, the researcher had to score each application based on what he/she observed. Although they were carefully reviewed, strategies for behavior change may have been overlooked or interpreted differently in each application, so some may be more obvious than others. This may mean that certain techniques may be hidden in the characteristics of the app and may therefore have not been detected.

Formal statistical comparisons (*e.g.* differences in the number of BCTs between apps) were not conducted due to the exploratory nature of our study. Conversely, research actions to determine whether an existing taxonomy could be used to assess BCTs among mobile phone apps were assumed. This study evaluated the use of BCTs in apps that target the prescription of TE, but provides no information on the effectiveness of these apps. In this sense, it has been advocated that the higher an app score the more effective it is.[34, 39] As scores obtained in the present review are superior to other similar studies,[16, 36] one may interpret that a superior efficacy is expected when dealing with apps for TE prescription.

Apps showed similar functions in most cases. For example, all of them provide a website where the therapist can keep track and create records for every patient, including personal and condition data. In addition, therapists are able to assume treatment prescription either through videos made by the same professional, predetermined videos by app, or pictures supported by written information; patients' achievements when performing prescribed exercises can also be estimated. Oppositely, some apps are identified as having particular characteristics that differentiate them from the others.

The results of this study showed that apps could be substantially improved to the as regard to number of applied

techniques. It would therefore be interesting that, when carrying out the app creating process, the forming team would be comprised not only by application developers, but also by health professionals and experts in behavior change experts. Consequently, both quality of collected data from health apps and the number of BCTs integrated therein would increase. This would result in a significant increase in the efficiency of the use of these resources.

All this may suggest that networking between app developers, health professionals, and experts in behavior change may increase the use of BCTs in apps and, therefore, open a new range of possibilities in promoting health and, more specifically, TE prescription.

Strengths and limitations of the study

The strengths of this review include the comprehensive search strategy employed, which sticks to a very strict inclusion criteria, along with the inclusion of both iTunes and Google Play. The use of an established instrument to systematically rate the presence of BCTs in the respective apps may be another strong point. Moreover, an after-download rating were used assessing every app´s function rather than screen shots alone.

However, there are some drawbacks to our review. First, the scope of the review was limited to the English/Spanish-language apps available, and only two most popular mobile phone platform app stores were used, which limits the generalizability of our findings. One should consider that different apps may be available in other countries and languages, and other apps may exist on less popular platforms. Excluding pre-payable apps represent a major weakness in our study, as they are likely to feature more complex functionalities than free ones do, creating more shadows to the light of our findings. Secondly, our work is focused strictly on mobile apps, and did not consider any other formats available for prescribing TE in rehabilitating adults, as other reviews have done.[25] Another limitation arises from the fact that this review evaluated the use of BCTs in apps that target TE among rehabilitating adults but provides no information about the effectiveness of these apps. Further research is needed to assess the effectiveness of apps focusing on TE. A fourth weakness was that the authors focused on mobile diary apps because of their portability, which is key for a self-monitoring tool. Oppositely this fact may facilitate increased adherence. A final weakness includes an after-download rating so that full functionality of the application was used rather than through screenshots. This meant that, although some apps had a restriction on the number of days allowed to be used for free, the veracity of the videos and photos as well as the procedure for prescribing in each app were checked. One should consider that drawbacks to this review really reflect limitations and concerns with the medical app market in general. A lack of quality standards with limited transparency in the app development process is attributable to this emerging field.

Conclusions

Our work demonstrates that apps prescribing TE among rehabilitating adults applied an average of 11 BCTs. In addition, there was no difference in the number of BCTs identified between iOS and Android apps. The most frequently used BCTs in these apps were provide instructions, prompt practice and prompt specific goal setting, and set graded tasks. What it is not yet clear whether the lack of BCTs used in apps is due to differences when understanding them or may other factors play a significant role. Our findings suggest that apps prescribing TE arise as a useful tool for health professionals, but a substantial improvement regarding the number of applied techniques should be promoted.

References

1. Blumenstock J, Cadamuro G, On R. Predicting poverty and wealth from mobile phone metadata. Science 2015;350:1073–6.

2. James J, Versteeg M. Mobile phones in Africa: how much do we really know? Soc Indic Res 2007;84:117–26.

3. Grady PA, Gough LL. Self-management: a comprehensive approach to management of chronic conditions. Am J Public Health 2014;104:e25–31.

4. Iversen MD. Managing Hip and Knee Osteoarthritis with Exercise: What is the Best Prescription? Ther Adv Musculoskelet Dis 2010;2:279–90.

5. Álvarez-Gallardo IC, Bidonde J, Busch A, Westby M, Kenny GP, Delgado-Fernández M, *et al.* Therapeutic validity of exercise interventions in the management of fibromyalgia. J Sports Med Phys Fitness 2019;59:828–38.

6. O'Neil J, McEwen D, Del Bel MJ, Jo D, Thevenot O, MacKiddie OS, *et al.* Assessment of the content reporting for therapeutic exercise interventions among existing randomized controlled trials on knee osteoarthritis. Clin Rehabil 2018;32:980–4.

7. Philadelphia Panel. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder pain. Phys Ther 2001;81:1719–30.

8. UK National Clinical Guideline Centre. (2014) Osteoarthritis: Care and Management in Adults. National Institute for Health and Care Excellence (UK), London.

9. UK National Collaborating Centre for Primary Care. (2009) Low Back Pain: Early Management of Persistent Non-specific Low Back Pain. Royal College of General Practitioners (UK), London.

10. Armijo-Olivo S, Pitance L, Singh V, Neto F, Thie N, Michelotti A. Effectiveness of Manual Therapy and Therapeutic Exercise for Temporomandibular Disorders: Systematic Review and Meta-Analysis. Phys Ther 2016;96:9–25.

11. Mizusaki Imoto A, Peccin S, Gomes da Silva KN, de Paiva Teixeira

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LE, Abrahão MI, Fernandes Moça Trevisani V. Effects of neuromuscular electrical stimulation combined with exercises versus an exercise program on the pain and the function in patients with knee osteoarthritis: a randomized controlled trial. BioMed Res Int 2013;2013:272018.

12. Takahashi N, Omata JI, Iwabuchi M, Fukuda H, Shirado O. Therapeutic efficacy of nonsteroidal anti-inflammatory drug therapy versus exercise therapy in patients with chronic nonspecific low back pain: a prospective study. Fukushima J Med Sci 2017;63:8–15.

13. World Health Organization. mHealth: New horizons for health through mobile technologies: second global survey on eHealth. Geneva: World Health Organization; 2011.

14. de la Vega R, Miró J. mHealth: a strategic field without a solid scientific soul. a systematic review of pain-related apps. PLoS One 2014;9:e101312.

15. Jake-Schoffman DE, Silfee VJ, Waring ME, Boudreaux ED, Sadasivam RS, Mullen SP, *et al.* Methods for Evaluating the Content, Usability, and Efficacy of Commercial Mobile Health Apps. JMIR Mhealth Uhealth 2017;5:e190.

16. Middelweerd A, Mollee JS, van der Wal CN, Brug J, Te Velde SJ. Apps to promote physical activity among adults: a review and content analysis. Int J Behav Nutr Phys Act 2014;11:97.

17. BinDhim NF, Hawkey A, Trevena L. A systematic review of quality assessment methods for smartphone health apps. Telemed J E Health 2015;21:97–104.

18. Huckvale K, Car M, Morrison C, Car J. Apps for asthma self-management: a systematic assessment of content and tools. BMC Med 2012;10:144.

19. Abroms LC, Lee Westmaas J, Bontemps-Jones J, Ramani R, Mellerson J. A content analysis of popular smartphone apps for smoking cessation. Am J Prev Med 2013;45:732–6.

20. Garnett C, Crane D, West R, Brown J, Michie S. Identification of Behavior Change Techniques and Engagement Strategies to Design a Smartphone App to Reduce Alcohol Consumption Using a Formal Consensus Method. JMIR Mhealth Uhealth 2015;3:e73.

21. Friesen MR, Hamel C, McLeod RD. A mHealth application for chronic wound care: findings of a user trial. Int J Environ Res Public Health 2013;10:6199–214.

22. Brandell B, Ford C. Diabetes professionals must seize the opportunity in mobile health. J Diabetes Sci Technol 2013;7:1616–20.

23. O'Malley G, Clarke M, Burls A, Murphy S, Murphy N, Perry IJ. A smartphone intervention for adolescent obesity: study protocol for a randomised controlled non-inferiority trial. Trials 2014;15:43.

24. Nicholas J, Larsen ME, Proudfoot J, Christensen H. Mobile Apps for Bipolar Disorder: A Systematic Review of Features and Content Quality. J Med Internet Res 2015;17:e198.

25. Marcano Belisario JS, Huckvale K, Greenfield G, Car J, Gunn LH. Smartphone and tablet self management apps for asthma. Cochrane Database Syst Rev 2013;(11):CD010013.

26. Kurland J, Wilkins AR, Stokes P. iPractice: piloting the effectiveness of a tablet-based home practice program in aphasia treatment. Semin Speech Lang 2014;35:51–63.

27. Sancho-Garcia S, Medina-Porqueres I. Apps to prescribe therapeutic exercise among rehabilitating athletes: a systematic review and content analysis. PROSPERO CRD42015017869; 2015 [Internet]. Available from: www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42015017869 [cited 2020, Feb 5].

28. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. Health Info Libr J 2009;26:91–108.

29. Cooper ID. What is a "mapping study?". J Med Libr Assoc 2016;104:76–8.

30. Perryman CL. Mapping studies. J Med Libr Assoc 2016;104:79–82.

31. Abraham C, Michie S. A taxonomy of behavior change techniques used in interventions. Health Psychol 2008;27:379–87.

32. McKay FH, Cheng C, Wright A, Shill J, Stephens H, Uccellini M. Evaluating mobile phone applications for health behaviour change: A systematic review. J Telemed Telecare 2018;24:22–30.

33. Conroy DE, Yang CH, Maher JP. Behavior change techniques in top-ranked mobile apps for physical activity. Am J Prev Med 2014;46:649–52.

34. Cowan LT, Van Wagenen SA, Brown BA, Hedin RJ, Seino-Stephan Y, Hall PC, *et al.* Apps of steel: are exercise apps providing consumers with realistic expectations?: a content analysis of exercise apps for presence of behavior change theory. Health Educ Behav 2013;40:133–9.

35. Crane D, Garnett C, Brown J, West R, Michie S. Behavior change techniques in popular alcohol reduction apps: content analysis. J Med Internet Res 2015;17:e118.

36. West JH, Hall PC, Hanson CL, Barnes MD, Giraud-Carrier C, Barrett J. There's an app for that: content analysis of paid health and fitness apps. J Med Internet Res 2012;14:e72.

37. Middleton S, Guyver P, Boyd M, Brinsden M. Patient reported outcome measures in military patients with shoulder instability. J R Army Med Corps 2013;159:271–3.

38. Mangone ER, Lebrun V, Muessig KE. Mobile Phone Apps for the Prevention of Unintended Pregnancy: A Systematic Review and Content Analysis. JMIR Mhealth Uhealth 2016;4:e6.

39. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res 2010;12:e4.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Sara Sancho-Garcia contributed to study design, data extraction, evidence synthesis, and editing, reviewed the study protocol, and incorporated all feedback. Sofia Sanz-de Diego made suggestions that improve the design, devised search strategies, and helped draft the manuscript. Ivan Medina-Porqueres conceived, coordinated and designed the study, contributed to data extraction, evidence synthesis, and prepared and drafted the manuscript. All contributed to the final version. All authors have read and approved the current manuscript.

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