International Journal of Medical Informatics 111 (2018) 7–16

Contents lists available at ScienceDirect

International Journal of Medical Informatics

journal homepage: www.elsevier.com/locate/ijmedinf

Review article

Computerised decision support in physical activity interventions: A systematic literature review

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ARTICLE INFO

Keywords:
Computerised decision support
Coaching
Physical activity
Exercise
Review

ABSTRACT

Background: The benefits of regular physical activity for health and quality of life are unarguable. New information, sensing and communication technologies have the potential to play a critical role in computerised decision support and coaching for physical activity.

Objectives: We provide a literature review of recent research in the development of physical activity interventions employing computerised decision support, their feasibility and effectiveness in healthy and diseased individuals, and map out challenges and future research directions.

Methods: We searched the bibliographic databases of PubMed and Scopus to identify physical activity interventions with computerised decision support utilised in a real-life context. Studies were synthesized according to the target user group, the technological format (e.g., web-based or mobile-based) and decision-support features of the intervention, the theoretical model for decision support in health behaviour change, the study design, the primary outcome, the number of participants and their engagement with the intervention, as well as the total follow-up duration.

Results: From the 24 studies included in the review, the highest percentage (n = 7, 29%) targeted sedentary healthy individuals followed by patients with prediabetes/diabetes (n = 4, 17%) or overweight individuals (n = 4, 17%). Most randomized controlled trials reported significantly positive effects of the interventions, i.e., increase in physical activity (n = 7, 100%) for 7 studies assessing physical activity measures, weight loss (n = 3, 75%) for 4 studies assessing diet, and reductions in glycosylated hemoglobin (n = 2, 66%) for 3 studies assessing glycose concentration. Accelerometers/pedometers were used in almost half of the studies (n = 11, 46%). Most adopted decision support features included personalised goal-setting (n = 16, 67%) and motivational feedback sent to the users (n = 15, 63%). Fewer adopted features were integration with electronic health records (n = 3, 13%) and alerts sent to caregivers (n = 4, 17%). Theoretical models of decision support in health behaviour to drive the development of the intervention were not reported in most studies (n = 14, 58%).

Conclusions: Interventions employing computerised decision support have the potential to promote physical activity and result in health benefits for both diseased and healthy individuals, and help healthcare providers to monitor patients more closely. Objectively measured activity through sensing devices, integration with clinical systems used by healthcare providers and theoretical frameworks for health behaviour change need to be employed in a larger scale in future studies in order to realise the development of evidence-based computerised systems for physical activity monitoring and coaching.

1. Introduction

Regular physical activity reduces mortality and improves the quality of life of healthy individuals as well as patients with chronic conditions such as cardiovascular disease, diabetes, and chronic obstructive pulmonary disease [1,2]. Regular physical activity results amongst other benefits in the improvement of cardiovascular and respiratory function as well as overall functional capacity, thereby enhancing well-being,

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https://doi.org/10.1016/j.ijmedinf.2017.12.012
Received 22 May 2017; Received in revised form 5 November 2017; Accepted 16 December 2017
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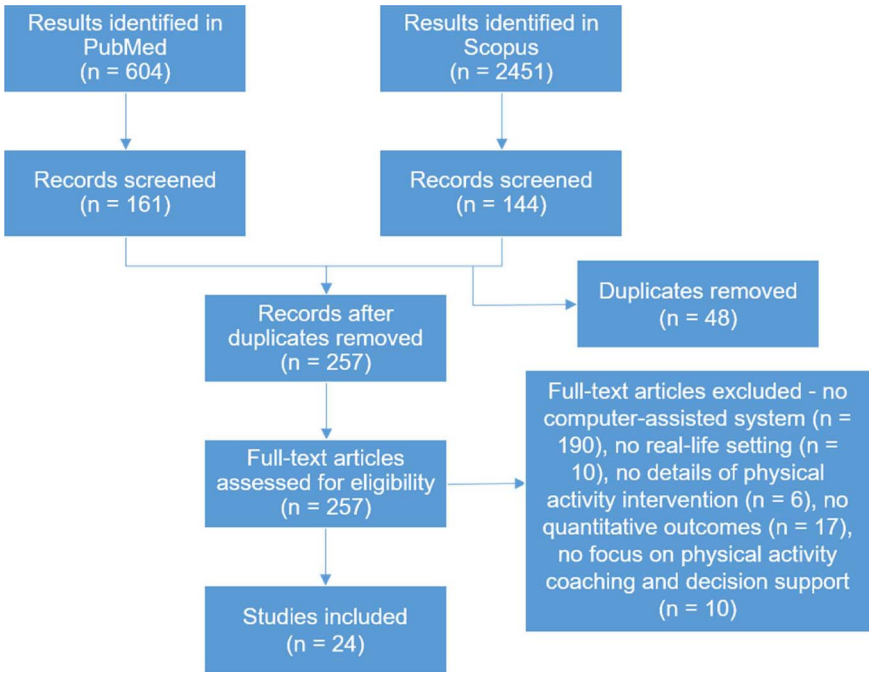

Fig. 1. Flow diagram for study inclusion.

and increasing life expectancy [3].

New information and communication technologies have the potential to play a key role in enhancing physical activity interventions and motivating individuals toward adoption of a more active lifestyle. Computer-assisted services based on recently available low-cost Internet-linked, mobile and sensing devices for the continuous monitoring of parameters such as activity, heart rate, respiration, and so on, can be utilized and used at home or anywhere-anytime [4,5]. The recent widespread use of commercial wearable devices for physical activity monitoring such as chest belts and smart watches has enabled physical activity quantification and self-tracking on a daily basis [6]. Through the collection, processing and evaluation of physical activity data along with potentially available other demographic and clinical information, useful outcomes can be derived regarding individual's behaviour and progress, and individualised coaching can be realized. In the context of this review, we refer to such computer-assisted services for user support in self-assessment and decision-making as "Computerised Decision Support" (CDS) [7].

Literature reviews conducted in the area of CDS for physical activity promotion have been scarce, despite the unarguable benefits of CDS adoption found in several healthcare applications [8,9]. This work is different from a previous review which focused on coaching systems for physical activity but did not consider their evaluation in a real-life context [10]. Another review considered only web-based interventions for physical activity targeted at chronic patients [11], whereas in this review there is a broader scope of technologies (web-based, mobile-based, phone call-based, electronic health records) and the focus is both on healthy and diseased target groups. Other recent reviews focused only on mobile-based interventions [12,13]. Thus, this review explores a knowledge gap in the area of CDS-based physical activity interventions by highlighting recent research in the development of CDS, describing the current knowledge about the type of CDS-based physical activity interventions, their feasibility and effectiveness, and mapping out challenges and future research directions.

2. Methodology

We searched the bibliographic databases of PubMed and Scopus to identify the state-of-the-art in physical activity interventions with CDS, as reported in studies published in the period from January 2012 to January 2017, and we used keywords to drive our exploration. The following eligibility criteria for study inclusion were used: a) a physical activity intervention with CDS deployed in a real-life setting should be described and evaluated with either healthy or diseased individuals, b) quantitative outcomes with respect to the use of the intervention or the health outcomes should be presented, c) the paper should be written in English. The string *("physical activity" OR "exercise") AND ("decision support" OR "decision making" OR "coaching")* was used for search within the title, abstract and keywords of the manuscripts. Case reports; surveys or reviews; laboratory or simulation studies; studies describing protocols; and qualitative studies; were excluded from the review. We targeted to explore a wide spectrum of physical activity interventions and therefore; besides the eligibility criteria; we placed no further quality criteria or restrictions on specific primary outcomes and participant characteristics. These are more appropriate for systematic reviews and *meta*-analyses which consider a specific health condition; as presented; for example; in the studies by El-Gayar et al. [14] and Zwisler et al. [15].

The papers were selected and reviewed by two reviewers (AT and DF) in order to verify their relevance according to the inclusion criteria, and minimise possible errors or bias in their selection. After receiving the results of our search of the literature, a screening process of reading the abstracts and the full manuscripts was followed, in which studies not meeting the eligibility criteria were excluded and studies were included only if consensus between the reviewers could be reached.

The included studies were synthesised (AT) according to the target user group, the technological form (e.g., web-based or mobile-based) and decision-support features of the intervention, the theoretical model for health behaviour change, the study design, the primary outcome and whether this has a significant positive change, the number of participants and their engagement with the intervention, and the total follow-up duration. Quality assessment was conducted by the two reviewers using the Effective Public Health Practice Project (EPHPP) tool for quantitative studies which can be used for both randomized and non-randomized designs of trials, and has been found to be reliable [16].

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