Electronic Journal of Applied Statistical Analysis
EJASA, Electron. J. App. Stat. Anal.
http://siba-ese.unisalento.it/index.php/ejasa/index
e-ISSN: 2070-5948
DOI: 10.1285/i20705948v13n3p682

Smartphone-based interventions for employees' well-being promotion: a systematic review
By Paganin, Simbula

Published: 15 December 2020

Electronic Journal of Applied Statistical Analysis
Vol. 13, Issue 03, December 2020, 682-712
DOI: 10.1285/i20705948v13n3p682

Smartphone-based interventions for employees' well-being promotion: a systematic review

Giulia Paganin*[a,b] and Silvia Simbula[a,b]

[a] *University of Milan-Bicocca, Department of Psychology, Piazza dell'Ateneo Nuovo, 1,20126 Milano MI*
[b] *Bicocca Center for Applied Psychology, University of Milano-Bicocca*

Published: 15 December 2020

Occupational Psychology faces challenges concerning the promotion of employees' well-being and health. The use of emergent technologies (e.g. smartphone) has revealed new opportunities to deliver effective, cheap and early interventions. By following the international PRISMA statement guidelines, this systematic review aims to bring together workplace smartphone-based interventions, targeting employees' well-being and psycho-physical health, to address the lack of studies focused on workplace settings. Results were drawn from 31 quantitative and qualitative studies, testing smartphone applications. The authors extracted multiple information for each article: focus, target, theoretical background, users' engagement and study design. Findings show the lack of theoretical background, reliable study design and the prevalence of physical health interventions. Moreover, our review identifies the importance of users' engagement for an intervention's effectiveness. It is relevant to design specific mHealth interventions, to provide employees with the skills to cope with and manage work-stress and enhance their general health and well-being.

keywords: mHealth; smartphone-based intervention; workers' well-being; systematic review.

*Corresponding author: g.paganin@campus.unimib.it

ISSN: 2070-5948
http://siba-ese.unisalento.it/index.php/ejasa/index

1 Introduction

The occupational structure of the labour market has changed in the last few decades, especially in developed countries (Cortes and Salvatori, 2019; Signore et al., 2019).
The introduction of emerging technology in the workplace has led to several positive elements, such as the reduction in work and production costs (Skoumpopoulou et al., 2018), the facilitating of communication and collaboration among colleagues and knowledge sharing across geographically dispersed offices (Colbert et al., 2016).
On the other hand, the growing use of technology has also given rise to several negative aspects, such as the removal of the boundary between work and non-work domains (Reyt and Wiesenfeld, 2015), and job polarisation between better-paid work, requiring higher skills and a greater educational attainment, and lower-paid work, requiring a lower educational attainment (Acemoglu and Autor, 2011). It is well known that these aspects may increase the risk of developing physical and mental health conditions among employees, due to the exposure to psychosocial risks (van den Heuvel et al., 2018). From a different perspective, the emergent technologies (e.g. smartphone) could help researchers to gain precise and objective data on users' behaviour in a non-intrusive and ecologically valid way (Miller, 2012), as well as help in the treatment of several physical and mental conditions, such as depression, stress, anxiety and weight management, also in the workplace context (De Korte et al., 2018).
For example, several preventive initiatives for implementing lifestyle change and improving mental health and well-being that use new technologies have been proposed; such interventions range from recovery support to the development of positive habits that aim to improve psychological health (Bakker et al., 2016; Balk-Møller et al., 2017a; Bonn et al., 2019; Bostock et al., 2019; Deady et al., 2018; Weisel et al., 2018). However, while there are several studies about internet-based intervention targeting clinical populations (Hedman et al., 2011; Riper et al., 2014), studies on the organisational-related context are still few (de Korte et al., 2018; Ebert et al., 2018; Free et al., 2013). To the best of our knowledge, to date, an overview of smartphone-based intervention in the workplace, as an innovative tool beyond traditional intervention, is still lacking. Therefore, the main aim of this paper is to report a systematic review of qualitative and quantitative studies that have implemented a smartphone-based intervention in the workplace, targeting the employees' physical and mental health, well-being and stress management skills. Additionally, we aim to examine the use of an evidence-based theoretical background for the intervention design and development, as well as presence of an evaluation efficacy process and/or follow-up.

2 Background:Work-Related Stress

Modern working life in Western countries has become more mentally demanding and less physical in nature. New developments in work and changing workloads have led to a rapid increase in the number of employees experiencing health problems related to occupational stress (Sauter et al., 2002).

Indeed, work-related stress has become a major occupational risk factor in all industrialized countries (Hassard et al., 2018). One of the most common job stress definitions (Sauter et al., 1999), described it as detrimental physical and emotional responses which occur when the demands of a job do not coincide with the abilities, needs and resources of the employees. This conception addresses an internal state involving the physical and psychological realm. However, this internal state (the psycho-physical response) is part of a broader interaction between job domain and personal characteristics (e.g., resources, capabilities, needs). All these elements characterise the stress process, triggered by certain workplace factors perceived by the workers as stressful. The psycho-physical response (e.g. negative affective states), that constitutes a short-term reaction, occurs in the case of an overly high request that exceeds the personal resources or capability, or when the work demands conflict with the worker's own needs. When this reaction is too intense or chronic, it can lead to work-related disease (e.g. depression, cardiovascular disease). Moreover, individual characteristics can intervene to strengthen or weaken the relationship between job stressors and strain and consequently have an influence both on stress reactivity and on the likelihood to develop chronic stress-related conditions (Herr et al., 2018).

According to the National Institute for Occupational Safety and Health (NIOSH), exposure to stressful working conditions (job stressors) can have a direct influence on employees' safety and health (see also Sauter et al. 1999). In addition to 'traditional risks', (e.g. physical, biological and chemical risks), which have a direct effect on the health condition of employees, there are 'new risks', also called 'psychosocial risks'. Psychosocial risks have been defined by the World Health Organization as the relationship among work context, work substance and organisational arrangement, and employees' needs, culture, abilities and extra-job attitudes that could influence health, performance and work satisfaction through their experiences and senses (Leka et al., 2010). Such a definition underlines the interaction between the work environment and human factors (International Labour Organizazion; ILO 2016). Work demands, perceived support and control, interpersonal relationship quality, uncertainty of work role, unexpected change or dangerous working conditions, work design, management style and perceived support of superiors, quality of the relationship with co-workers, and concerns about personal and career growth are some of the stressful job factors that may have physiological, physical, behavioural and mental consequences (e.g. high blood pressure, obesity, smoking, poor eating habits, addictions, sedentary habits, burnout, depression), which in turn could results in workers' physical and mental health diseases. Moreover, all these factors and situations could negatively influence the workplace climate, resulting in problem behaviours, such as bullying and mobbing (Cooper and Quick, 2017).

At the organisational level, there are considerable costs related to work stress in terms of economic and productivity loss, absenteeism and high turnover, healthcare consumption and lower job satisfaction (Ebert et al., 2016a; Guarnaccia et al., 2018; Ingusci et al., 2016; Sauter et al., 2002; van Berkel et al., 2013).

3 Work Stress Effects

Several theories, supported by substantial research, highlight that work stress has the added impact of increasing vulnerability to physical and mental health problems, many of which take a further toll on quality of life. Indeed, chronic stress, which is a prevalent phenomenon in Western societies, is linked with several illnesses, such as depression, anxiety, metabolic, cardiovascular, autoimmune and gastrointestinal disease (Chrousos, 2009).

The principal end-effectors of the stress response are cortisol released by the hypothalamic-pituitary-adrenal (HPA) axis and the catecholamine, norepinephrine and epinephrine released by the peripheral sympathetic-adrenomedullary (SAM) system. While the acute stress response provides the organism with the motivation and energy needed to 'fight or flight' in the face of adversity via a highly adaptive cascade of physiological responses (Cannon, 1915), chronic stress may foster the development of pathophysiological changes (e.g. cardiovascular problems), through long-term activation of the same mechanism necessary for immediate survival (Engert et al., 2018). The major change to mental work from physical work (e.g. essential changes in technology and in work organisation) reduces caloric expenditure and may play a role in the development of obesity and several health risks, such as cardiovascular disease (Choi et al., 2010; Solovieva et al., 2013). Work stress may impact weight gain through behaviours such as stress-induced eating and less leisure-time physical activity (Cooper and Quick, 2017), through circadian rhythm disturbance (e.g., sleep disturbances due to shift work), and metabolic changes (Choi et al., 2010; Solovieva et al., 2013).

The concept of mental health (MH) embraces subjective well-being, self-efficacy, autonomy, personal resources and recognition of expertise (Bhardwaj et al., 2008). MH problems are very common among employees and negatively influence employees' well-being and productivity, increasing absenteeism and healthcare costs (Stratton et al., 2017). Workplace-related mental health issues are a source of a wide range of problems: employees report headache and migraine (Cocker et al., 2013; Martin, 2016) , as well as psychological problems contributing to chronic stress, anxiety (Largo-Wight et al., 2011; Rajgopal, 2010), and depression (Stratton et al., 2017), in addition to the physical issues mentioned above.

Broad evidence indicates chronic stress as a risk factor for MH (Herr et al., 2018). MH conditions are one of the principal causes of long-term disability in middle-income and high-income countries. This is mainly caused by the impact of anxiety and mood disorders in individuals of working age. For example, people with severe depressive symptoms report serious difficulties in all domains of their life, including work, home, relationships and social activities (Deady et al., 2018). Finally, a long exposure to stressors at work can lead to burnout which is a strong predictor of several health-related issues (Maslach, 2003; Maslach et al., 2001; Portoghese et al., 2014).

4 Stress Management Interventions in the workplace

The prevention of the negative effects of psychosocial risks (or stress prevention), derived from the medical concept of prevention, namely all the activities planned to reduce the consequences of disease. Workplace stress management interventions refer to several activities aimed to enhance employees' well-being and decrease stress levels, mainly by either addressing the causes of stress (stressors), or by mitigating the impact of stress (Holman et al., 2018). Such interventions can have several benefits both for employers and employees, for example, increased performance, improved relationship quality and reduced sickness and absenteeism rate (De Neve et al., 2013; Holman et al., 2018). Stress management interventions can be classified according to the focus or the level at which they are implemented (Holman et al., 2018). Regarding the focus of stress management, interventions are categorised as primary, secondary or tertiary (Schaufeli and Enzmann, 1998).

The purpose of primary interventions is to remove the potential sources of stress and improve the causes of well-being: indeed, primary interventions are proactive (Tetrick and Winslow, 2015). This intervention concerns the so-called content-factors and context-factors. For example, job redesign, career development, work schedule flexibilisation, goal setting, team building and diversity management (Cooper and Cartwright, 1997).

The role of secondary prevention is essentially 'damage limitation'; for this reason, it often addresses the consequences rather than the sources of stress which may be rooted in the organisational structure or culture. Indeed, secondary interventions aim to modify how individuals react to stressful work situations to mitigate the stress response, decrease the severity or duration of stress once it has occurred and prevent the level of stress from becoming troubling. These interventions are focused on the recognition and management of stressors, increasing awareness and improving the stress management skills of the individual through, for example, training and educational activities. Indeed, individual factors can also alter or modify how employees perceive and react to stressful situations. This stress threshold will change among people and depend on the situation affecting the individual (Cooper and Cartwright, 1997).

There are many types of secondary intervention: workers may be trained in the recognition and evaluation of their symptoms, in strategies focused on the emotional sphere (e.g. externalisation of one's own negative emotional states, for tension release and to give a sense of proportion to a situation), strategies focused on the physical sphere (e.g. physical exercises in and out of the workplace, meditation and relaxation techniques), and strategies focused on the cognitive sphere (e.g. cognitive-behavioural techniques).

Finally, tertiary interventions involve treatment, rehabilitation and the recovery process of individuals who have developed serious conditions as a response to exposure to stressful situations, besides enhancing the probability of their return-to-work (Cooper and Cartwright, 1997; Holman et al., 2018). Interventions at this level typically involve the provision of counselling services for employee problems in the work or personal domains or medical intervention, in the case of work-related physical or physiological disease (Holman et al., 2018).

With a specific focus on the level of an intervention, a common and simple distinction

is made between the level of the individual and organisation. Individual-level interventions focus on helping employees to build skills to manage, cope with and reduce stress, whereas organisational-level interventions make more consistent changes to organisational practices that either target all workers or a specific group of employees. We can define organisational-level intervention as evidence-based action, intended to remove or change the sources of work stress (Nielsen and Randall, 2013). In the past decades, European legislation has underlined the importance of promoting workers' health, including mental health: for example, in the Italian Decree No. 81/2008 'Testo Unico sulla Salute e Sicurezza sul Lavoro', work-stress is a factor to be considered in risk assessment. Although the importance of workers' health has been recognised, research shows that some studies present inconsistencies in the results, since the effect of interventions are often small or not significant (de Korte et al., 2018). To be specific, most studies focused mainly on the effects of the interventions, neglecting the process evaluation about how interventions were planned and implemented (LaMontagne et al., 2007). For this reason, it is fundamental to focus also on the intervention processes, to provide feedback for enhancing interventions' outcomes, to allow their replication in different context, to reduce any obstacles and to explain the results of the intervention (Goldenhar et al., 2001; Nielsen and Randall, 2013). Moreover, the emphasis on process enables researchers to generalise the results and to implement the intervention successfully in other work settings (Armstrong et al., 2008; Dewe et al., 2010; Nielsen and Randall, 2013).

5 Stress and technology

The growth of digital technology over the last 20 years has touched upon every aspect of modern life, including the workplace (Howarth et al., 2018). Indeed, the development of new technologies has influenced how people work; there also has been a transformation from occupations that requiring moderate-intensity physical activity to those that are sedentary. Several studies (e.g. Ebert et al. 2014) have shown that less physical activity, sedentary behaviour, static postures, and repetitive movements are linked to lower productivity at work, decreased work-ability, increased possibility of musculoskeletal damage, absenteeism and presenteeism. Digital tools give employees some advantages (e.g. increasing perceived autonomy, the shift to remote working, and advanced communication and information sharing). At the same time, however, technology contributes to difficulties in managing the inflow of information, interruptions and task switching, perceived pressure to respond quickly, reduced perceived social support and disruption to the work-life balance (Day et al., 2012). As a result, Occupational Psychology is facing challenges related to the promotion of mental health (thereby reducing the influence of these adverse psychological work conditions, in short, work-related stress). Specifically, there is an interest in providing rapid and adequate health services to those employees who develop mental health problems and to facilitate their return-to-work after a prolonged absence (Lehr et al., 2016). The central tools to prevent mental health risks are early assessment and subsequent appropriate interventions such as job redesign or stress-management training. Nevertheless, achieving these goals is often quite difficult.

For these reasons, much effort has been put into the development and evaluation of interventions in the workplace setting. This includes selective activities to change the individuals' risks, attitudes, behaviour and awareness as well as comprehensive interventions such as workplace health promotion programmes (de Korte et al., 2018). Using technology-assisted programs during the prevention phase allows flexible, cheap, easy, and early access to care: moreover, many of these programs have shown efficacy that is equivalent to that achieved by face-to-face therapies in addressing various problems (Howarth et al., 2018).

5.1 e-Health

The term eHealth is used to indicate the employ of rising information and communications technology (ICT), particularly the internet, to increase or allow health and healthcare (Eng, 2001). Moreover, mental eHealth is defined as a 'form of e-health which deals with mental health and mental health disorders' (Christensen et al. 2002, p. 17). The application of this concept in the organisational environment has led to the term 'occupational e-mental health', which refers the application of e-mental health in the specific life domain of work, to improve the quality of working life, to protect and promote the safety, health and well-being of employees. Another definition includes occupational e-mental health like the use of ICT to deliver psycho-education, health risk assessment, workplace health promotion, preventive interventions, treatments, relapse prevention and return-to-work assistance for the mental health of workers as well as to improve occupational healthcare delivery, professional education (e-learning), and online research in the field of occupational mental health (Lehr et al., 2016). In particular, ICT refers to any electronic device or technology that can gather, store or send information (Steinmueller et al., 2000). Internet interventions are described as treatments based on cognitive and behavioural elements that are operationalised and transformed so that they can be delivered via the internet. Generally, these interventions are highly structured, self- or semi-self-guided, based on effective face-to-face interventions, tailored to the user, interactive, enriched by several multimedia elements and customised to provide follow-up and feedback (Ritterband and Thorndike, 2006). Guidance is usually provided by a healthcare professional. Most Internet interventions are designed for desktop computers (Lehr et al., 2016). Using the Internet to provide self-help interventions could assist in overcoming some of the limitations associated with the common Stress Management Interventions (SMIs), such as limited availability and high cost. The literature underscores some of the advantages of Internet-based interventions: they are more accessible, can guarantee workers' anonymity and allow employees to review the materials used during the sessions; moreover, this kind of procedure could help prevent the onset of severe health problems and may reach a larger population with the expenditure of lowest effort (Ebert et al., 2014). However, only a few interventions have been designed for and assessed with the respect to the working population (Carolan and de Visser, 2018).

5.2 m-Health

During the last years, thanks to the wide availability of smartphones and mobile apps, the distribution of interventions using mobile devices has become possible. Mobile phones enable interventions to be integrated into the daily lives of individuals, making it possible to unobtrusively monitor their activities and environments and, further, enabling interventions to take place at optimal time(s) during the day (Ahtinen et al., 2013).
Mobile Health (mHealth) can thus be regarded as a well-defined part of eHealth (Jimenez and Bregenzer, 2018). The World Health Organization (WHO) has defined mHealth as all the medical and public practices supported by mobile devices such mobile phones, patient monitoring devices, personal digital assistants and any other wireless devices (Bonn et al., 2019; De Korte et al., 2018). Various features make mHealth a good candidate for workplace interventions (de Korte et al., 2018). For example, mobile technology offers the ability to continuously and unobtrusively monitor a user's behaviour (Miller, 2012). These technologies are more effective at evaluating users' needs than other modalities. They also can be calibrated to deliver context-aware, tailored, adaptive, and timely interventions. In addition, they offer the opportunity to deliver interventions in the context where individuals make decisions about their health and encounter obstacles to behaviour change. They might also offer more affordable and convenient interventions, with a high penetration and a broad reach. Finally, they can support an active role on the part of users while, at the same time, reinforcing their responsibility over their own health status (Wang et al., 2016). At the same time, problems with such technologies have been reported. These include engagement quickly declining after initial use of mHealth apps (Imamura et al., 2019; Zarski et al., 2016). However, scientific evidence of mobile apps (mHealth) is still limited (Mistretta et al., 2018). mHealth apps are being developed and evaluated in a variety of domains such as physical activity (PA), obesity and stress management (de Korte et al., 2018). Mobile apps for the monitoring of mental health have been designed and have displayed potential for burnout and stress, anxiety management and workers' education (Bregenzer et al., 2019; Carissoli et al., 2015; Motamed-Jahromi et al., 2017). The most common approaches used in self-help mobile interventions are relaxation training, music and cyber-interventions based on Stress Inoculation Training methodology. These tipically use specific technology to simulate real settings that instruct people on how to cope with psychological stress (Carissoli et al., 2015; Mistretta et al., 2018). However, many of such apps have a limited empirical basis or have been evaluated without adequate scientific methods (De Korte et al., 2018). In recent years, mHealth apps are being developed specifically aimed at risk prevention and healthy behaviours in the work setting. Despite their potential, almost no research has been published on the content used or theoretical bases for same. There is also limited evidence on their efficacy in the workplace (Balk-Møller et al., 2017b; de Korte et al., 2018; Ebert et al., 2016b).
Nonetheless, smartphones offer great potential to collect ecologically valid data on real behaviours in a precise and objective way without requiring individuals to come into labs (Kwok, 2009; Raento et al., 2009). Indeed, one of the methods that can be used to enhance health self-management is Ecological Momentary Interventions (EMIs). The

strength of these interventions is that they can be personalised to the individual and be implemented in real-time. In an important scientific paper, entitled 'Smartphone Psychology Manifesto', the author states that the so-called 'psych-apps', which can be used in any behavioural science, could become one of the main ways to recruit, obtain consensus from, observe, conduct experiments with and debrief any participants, and can be used at any time and place as needed (Miller, 2012). Moreover, the usage of wearable technology may be quite effective in the workplace to monitor psychological and physiological risk factors of employees, enhancing productivity, allowing collaboration between workers in different locations and promoting safety and well-being (Khakurel et al., 2018). Another important issue to take into account when studying workplace smartphone-based interventions is the concept of users' engagement, a precondition for effectiveness (Yardley et al., 2016).

6 Users' Engagement

Researchers have pointed out multiple advantages of digital health interventions, such as anonymity and accessibility, allowing individuals to access the intervention at the most appropriate moment (Carolan and de Visser, 2018). For these reasons, digital health interventions are well-suited for the workplace. Several studies have demonstrated that health improvement is greater when individuals are engaged in these interventions (Bidargaddi et al., 2018). During the last years, smartphone apps have emerged as an effective channel for health and stress management interventions (Coulon et al., 2016): specifically, smartphones are useful for detecting users' everyday context and discovering the most suitable moments to deliver the intervention. Engagement could be described and studied in terms of interventions' usability and utilisation and the factors that influence them. It could be defined as the 'quality of users' experiences with technology' (O'Brien and Toms, 2008) and detailed in several dimensions, such challenges, aesthetics, feedback, interactivity and perceived control (Yardley et al., 2016), or as the subjective quality of user experiences with the app, which can be influenced by design elements (Kelders et al., 2012). A pressing concern for mHealth is the high level of disengagement among people who opt to install an app. After doing so, over 80% of users use it; only one time and sooner or later delete it, and only a small percentage of users remain involved beyond a month. However, even among those who use the apps, the amount of use depends on an individual's health and behavioural characteristics. This behavior is underpinned, undermined and shaped by context and social influences, in addition to individual characteristics (e.g. age, gender, education levels, state of health). It is common knowledge that these factors influence the adoption of the mHealth app (Bidargaddi et al., 2018; Yardley et al., 2016). There are many engagement models, but they are still untested (Yardley et al., 2016). Nevertheless, it is possible to identify the key elements to promote user engagement in smartphone-based interventions. For instance, in recent studies (e.g. Kraaij et al., 2019; Bidargaddi et al., 2018), among the various elements, the importance of self-monitoring, that is, the action by users of documenting activities and mental/physical conditions over a long period of time, has been shown

to positively influence well-being and health user's behaviour. Prompts such as push notifications or messages have proved to be promising in promoting initial engagement with health behaviour-change interventions and their sustained use – especially when the prompts include feedback or informational content (Morrison et al., 2017) and/or when they include messages or notifications related to the user's goals and achievements. Indeed, self-monitoring and goal-setting, feedback on results and behaviour are the most often-reported techniques in effective behavioural change interventions (Bardus et al., 2018). Moreover, the timing of interventions could also affect the dropout rate: if users perceive that the intervention does not meet their own expectations and needs at the right time, they could quit using the app (Zhang and Elhadad, 2016). As reported at the beginning of this section, smartphone-based interventions allow the continuous monitoring of user behaviour and the context around them. In the field of health behaviour change promotion, the Just-In-Time Adaptation Intervention (JITAI) showed great potential. The JITAI is an intervention design characterised by adapting the provision of support (e.g. the type, timing, intensity) based on '[the] individual's changing status and contexts' to deliver support 'at the moment and in the context that the person needs it most and is most likely to be responsive' (Nahum-Shani et al. 2018, p. 1). The 'context aware approach', namely, the detection of the users' behaviours and context by smartphone sensors (e.g. GPS, heartbeat detector, etc.), enables an increase in the usability and effectiveness of the intervention and also enabling its personalisation. The tailoring of the intervention (e.g. both content and feedback; Fuller-Tyszkiewicz et al. 2018), is crucial, given the number of individual differences that occur in fostering or limiting engagement with it and consequently its impact (Kraaij et al., 2019). Another measurement method for collect valid contextual health data is ecological momentary assessment (EMA). Using EMA, researchers are able to collect repeated random data on users' behaviour and experiences in a real-time ecological setting. The main feature of EMA is the possibility of tracking, several times during the day, data on users' activities, feelings, thoughts, and environmental surroundings. Subsequently, these data could allow researchers to recognise correlations among environment, mood, activities, and other users and their context characteristics (Engelen et al., 2017). An additional strategy to promote users' motivation and engagement consists of incorporating elements such as the 'daily challenge': every time the users complete this challenge, they earn a 'reward' (Deady et al., 2018). Indeed, a framework of challenges has been shown to improve the general attractiveness of an app (Bakker et al., 2016). Also, the literature on gamification, namely the use of the gamification mechanism in non-game contexts with the aim of influencing user behaviour and emotions (e.g. Hammedi et al. 2017) shows some positive effects on user engagement level. Some research suggests that Human-Centred Design (also referred to as 'User-Centred Design') are the best approaches to design and implement interventions. The main feature of these approaches are iterative design processes, where users are involved at every stage of interventions, from the first draft of the project to the prototyping of the intervention to the final testing phase. These approaches take into account user's behaviour and their context; as well, they set clear usability and user-experience goals, which can be measured empirically (Kraaij et al., 2019; Narváez et al., 2016).

7 Objective

As far as we know, there is no review specifically focused on workplace interventions using smartphone-based apps targeting work-stress management interventions and mental health. This systematic review aims to identify workplace interventions, targeting employees' work-related stress, well-being, and psycho-physical health, as delivered by smartphone application, to compensate for the lack of similar studies focused on workplace settings. To achieve this, qualitative and quantitative studies on smartphone-based interventions, as utilised in workplace settings, were systematically reviewed and synthesised. The following research questions were formulated:

1. What does the smartphone-based intervention address? 2. What is the smartphone-based theoretical background (if present)? 3. What is the smartphone-based intervention efficacy and, if applicable, how is it evaluated?

8 Method

A systematic review of the literature related to smartphone-based apps targeting work-stress management interventions and mental health was conducted. Before starting, registered and/or work in progress studies on this topic were searched for in the International Prospective Register of Systematic Reviews (PROSPERO). Since no recent comparable research was found, the systematic review protocol was recorded in this register (ID= CRD42020153817). The checklist of Preferred Items for Systematic Reviews (PRISMA Statement) was used to structure this examination, i.e. to identify smartphone-based apps targeting the workplace and employees' health and well-being (Moher et al., 2010).

8.1 Search Strategy

We focused our research on the academic databases, Scopus and PsycInfo, using key words relating to the workplace, digital tools, and well-being ('Mental Health Intervention'; 'Digital Health Intervention'; 'Occupational Health'; 'Mobile Intervention'; 'Stress Management'; 'Internet-Based'; 'Mobile Device'; 'Mobile Phone'; 'Intervention'; 'Work Stress'; 'Employees'; 'Prevention'; 'Workplace'; 'Internet'; 'Mobile'; 'Digital'; 'iSmi'), in articles published from 2009 to 2019. Article selection was performed in two rounds. Firstly, title and abstract screening were performed. Secondly, full texts were independently read by both authors to select the final studies included in the review. Finally, the authors came to an agreement on the main results to report.

8.2 Article Selection

The inclusion criteria were: (1) smartphone-based intervention, (2) availability of smartphone-based description, (3) publication in a peer-reviewed journal, (4) both quantitative or qualitative research design, (5) the article was clearly addressed to workers and (6)

physical/mental health and/or well-being and/or job-related measure and outcome. We also included the registered research protocols and proceedings to be informed of the smartphone-based interventions in progress. We removed dissertations and books to limit the number of results. We excluded virtual/augmented reality-based interventions to restrict the research field. Finally, we did not take into account interventions that used tablets, because this is not a device that individuals normally carry with them throughout the day (Danaher et al., 2015).

9 Results

Studies Included

A total of 1,264 quantitative and qualitative studies targeting smartphone-based interventions focused on employees' health and well-being, were identified (Figure 1). After removing duplicates, 1,126 were screened for title and abstract; of these, 961 were excluded. The reasons for the papers' exclusion, during this first screening phase, were numerous. In order of frequency, the reasons were: (1) the outcomes' focus, related for example to human resources management (e.g. recruiting or in-company training) or clinical symptoms management (e.g. personality disorders); (2) the sample composed by non-workers (students, military, clinical patients); (3) the interventions' delivery modalities (PC or tablet). The remaining 165 studies were full-text screened; ultimately, 31 studies met all inclusion criteria. During the second screening phase, we realised that some of the selected papers in the first phase actually did not meet all the inclusion criteria. After a full-text reading we were able to eliminate those articles that took into consideration samples of non-workers; strategies and outcomes related to in-company training or human resources management; articles that focused on techno-stress or acceptance of m-health interventions; and interventions not provided via smartphone. As a synthesis, the authors extracted different kinds of information for each article: the interventions' focus, the interventions' target and presence of a control group (see Table 1). Moreover, the authors checked for the interventions' theoretical background, and users' engagement features (see Table 2). In particular, 15 studies have a more specific focus on physical health and healthy lifestyle promotion; 8 studies have a focus on well-being promotion and stress management; the last 8 have a focus on symptoms treatment and management. However, it should be stressed that some interventions have a focus on several dimensions at the same time. Regarding the intervention's target, 11 studies considered general workers, 8 studies involved social and healthcare workers, 5 had office-based workers as participants, 2 involved high tech company workers, and the remaining studies considered middle managers (1), construction workers (1), airplane pilots (1), faculty members (1) and generic workers with serious mental illness (1).
The theories used as theoretical background were numerous: Behavioural Change Techniques (5), Lazarus and Folkman's Transactional Model of Stress (3), Mindfulness (3), Cognitive Behavioural Therapy (2), Effort-Reward Imbalance Model (1), Acceptance and Commitment Therapy (1), Cognitive Evaluation Theory (1), General Awareness

Training (1), Stress Inoculation Training (1), Stress Management and Resilience Training/Relaxation Response Resilience Programme/Positive Psychology elements (1); the remaining studies (12) did not report specific theories beyond the smartphone-based interventions. Concerning the smartphone-based interventions' efficacy, we take into account the control group presence: 15 out of 25 studies had foreseen the control group presence. Among them, 10 studies were designed as Randomized Controlled Trial. Among the 6 Research Protocol (RP) studies considered in the review, 5 included Randomized Controlled Trial (see Table 1). Regarding the users' engagement elements or strategies, the majority of the interventions used a combination of them: for example, researchers reported self-monitoring, the presence of feedback and reminders, the users' ability to tailor the intervention, the presence of social features and challenges, the presence of an e-coach or a virtual support network, synchronisation between different devices, Human Centered-Design Approach, Just in Time Adaptive Intervention's Model, Ecological Momentary Assessment's Model and gamification.

10 Discussion

The spread of new technologies in the workplace has led to several benefits, such as communication facilitation and knowledge sharing, as well as job polarisation, removal of the boundary between the work and non-work domain. All of these factors result in an increase of work-related physical and mental health conditions, experienced by workers.However, emerging technologies such as smartphone applications could change how researchers study users' behaviours, help mitigate against employees' adverse health conditions and, as well, foster their well-being. Only recently, researchers have begun to direct their interest towards organisational smartphone-based interventions that are cheaper and easier to develop than traditional interventions, and to consider not only the intervention efficacy but also several features involved in users' adherence and engagement level with the app, preconditions for its effectiveness. However, many of the studies published do not provide an evidence-based theoretical background and a reliable evaluation process. To our knowledge, to date, there is no systematic review of a smartphone-based intervention targeting work-related stress and/or physical and mental health promotion in the workplace. Overall, our systematic review confirms that smartphone-based interventions are not so common: starting from 1,264 results, only 31 were possible to include in our work. Our research questions were addressed to (1) categorise the results based on the focus of the smartphone-based interventions, (2) identify the theoretical background behind the intervention design, and (3) give an overview of the effectiveness of the reviewed app-based interventions.

10.1 Smartphone-based interventions' focus

As far as the first research question is concerned, most smartphone-based interventions reviewed here have a physical health focus, followed by interventions with a focus on well-being promotion and stress management, and a focus on symptom treatment and

management. The studies targeting physical health take into account several dimensions, such as weight management (Bardus et al., 2018), healthy lifestyle promotion (Balk-Møller et al., 2017b, Yu et al., 2017), diabetes and cardiovascular diseases (Wilson et al., 2017), physical activity promotion (Blake et al., 2017, Gremaud et al., 2018), fatigue and circadian disruption (van Drongelen et al., 2014), physical health and well-being (de Korte et al., 2018), cardiovascular disease and other comorbidity (Senecal et al., 2018) occupational sitting time, posture and activities tracking (Arrogi et al., 2019, Bootsman et al., 2019, Brakenridge et al., 2018, Engelen et al., 2017). Overall, smartphone-based interventions on physical health have similar features, like interactivity, constant monitoring, personalised design, feedback and notification. Five of the above-mentioned studies also used other devices such as personal activity trackers and posture belt trackers. The second category includes studies targeting the promotion of psychological well-being (Koldijk et al., 2016, Meyer et al., 2018), and stress management (Ebert et al., 2016a, Zarski et al., 2016), with other outcomes such as resilience (Kim et al., 2018) and burnout (Mistretta et al., 2018), as well as intervention focusing on work stress and well-being together (Bostock et al., 2019). Finally, the last category encompasses interventions focused on depressive symptoms (Deady et al., 2018), anxiety and stress (Imamura et al., 2019, Weisel et al., 2018). A study by Villani et al. (2013), considered only anxiety whereas a study by Milner et al. (2019) examined suicide prevention. Finally, there are app-based interventions on the treatment and management of anxiety, burnout and dissatisfaction (Versluis et al., 2018), symptoms of general mental conditions (Nicholson et al., 2018) and burnout (Narváez et al., 2016).
It is possible to observe that, as in traditional stress management interventions, although organisational-level interventions are one way of managing stress and promoting well-being, they are rarely used. In our review the main focus of the interventions was the individual. This means that even in the realm of smartphone-based interventions, implementing organisational-level interventions may be difficult and complex.

10.2 Smartphone-based interventions' theoretical background

Regarding the theoretical background behind the intervention design, it should be noted that more than one-third of the studies did not report specific theories. Some studies underline this lack of theoretical basis in the design of the smartphone-based interventions (de Korte et al., 2018). The development of such technological supports should be based on those theories that best explain stress development. Moreover, it is important to underline the need for customers to refer only to those interventions in which evidence-based strategies are present in the app (Coulon et al., 2016). 19 of the 31 evaluated studies delivered at least one evidence-based stress management strategy. It should be noted that such theoretical backgrounds have already shown their effectiveness in traditional interventions aimed to promote psycho-physical well-being and/or stress management, both in clinical and organisational contexts. For example, most of the interventions are based on behavioral change techniques and they give to users tailored feedback based on the personal health profile (e.g. Lark Pro, Bardus et al., 2018; Health Integrator system, Bonn et al., 2019; Bright, de Korte et al., 2018).The use of tailored

feedback is a technique acknowledged as effective, particularly when associated with effective real-time monitoring using intelligent sensors and algorithms; moreover, the users' participatory role is important to enhance their responsibility for their performance and health (de Korte et al., 2018). Other applications involve the use of mindfulness (e.g. HeadSpace, Bostock et al., 2019; Mistretta et al., 2018). Mindfulness-based interventions have shown beneficial effects in the workplace. For instance, such activities have been associated with an increased positive mental health and job satisfaction, and a growth of the workers' mindfulness level (Mistretta et al., 2018). Moreover, mindfulness training may improve the ability to reappraisal in a positive way the stressful circumstance and may contribute to the recovery from adverse events (Bostock et al., 2019). Cognitive Behavioral Therapy (CBT) is implemented in Imamura et al. (2019). CBT is applied in stress management interventions, and it has shown effectiveness in decrease depression/anxiety symptoms among employees (Imamura et al., 2019). Another theory applied in designing mHealth interventions is the Acceptance and Commitment Therapy (ACT; e.g. Viary, Ly et al., 2014). Actually, the use of ACT has been found to be effective in reducing stress in the workplace (Ly et al., 2014). Positive Thinking Training Programme is applied in Motamed-Jahromi et al. (2017). Positive Thinking Training is described as a technique with an impact on people coping behavior toward stressful experiences that may help them to overcome this negative experience (Motamed-Jahromi et al., 2017). Broadly speaking, positive psychological interventions encompass activities directed to improve positive emotions, perception and consequently positive behaviors (Sin and Lyubomirsky, 2009). Stress Inoculation Training (SIT) has also been used as the theoretical basis for an mHealth intervention. Villani et al. (2013) for example found that SIT may lead to burnout reduction through the modification of people's manner of processing information about a stressful situation.

10.3 Smartphone-based interventions' effectiveness

Concerning our third research question, most of the studies reported positive results on intervention effectiveness, usability, and feasibility of the smartphone-app, although all studies reported various limitations regarding the drop-out rate, the number of participants and the lack of follow-up evaluations. Before considering the results in more detail, it should be noted that 6 of the articles selected for the review are registered protocol, and therefore have not included results in their papers. By considering the interventions on the basis of their focus, those grounded on physical health revealed encouraging results: stAPP (Arrogi et al., 2019) and Map Track (Gremaud et al., 2018) both decreased the sitting time and increased the daily step count and the amount of active daily minutes. Lumo Back seems to exert an influence on supporting employees in reducing the amount of prolonged sitting time during the intervention, but it is not significantly associated with changes in the standing, stepping or sitting behaviour patterns (an effect that probably is related to the lack of other associated behavioural strategies or the limited use of the tool and smartphone-application; Brakenridge et al. 2018). The Omada Health Programme (Wilson et al., 2017) has been found to be effective at reducing diabetes and cardiovascular risk factors, likely through the decreasing of weight

and blood glucose levels in the workforce. The Physical Activity (PA) application (Yu et al., 2017) showed a small but significant reduction in the body mass index (BMI), but not in the cholesterol and blood pressure ratings. The Get.On Stress app-based intervention's results suggest that it can provide modest but statistically significant effect in weight loss, compared to other traditional interventions (Balk-Møller et al., 2017b); the Active8 intervention showed a significant increase of daily physical activities, also after 1 month from the end, but not a significant improvement in the perceived Health-Related Quality of Life (Blake et al., 2017); the Digital Health intervention's results by Senecal et al. (2018), indicated a significant effect on weight loss and blood pressure level, even if not clinically significant. Finally, Back-Up showed contrasting but promising results and positive impact on workers' posture (Bootsman et al., 2019).

For well-being and stress management, there are other hopeful results: the Virgin Pulse Global Challenge, with its simultaneous focus on several domains, is associated with good improvements in work-related stress, quality of sleep and psychological well-being, in the case of older workers; psychological well-being enhancements in particular were found for female workers (Meyer et al., 2018). The Mindfulness-On-The-Go smartphone-based intervention's participation was related with a small-to-moderate improvement of well-being level and a decrease in the distress level of workers (Bostock et al., 2019); the Smartphone Resilience Training, tested by Mistretta et al. (2018), has shown to have a significant impact on participants' well-being, both following the intervention and at 3 month follow-up, but not significant on stress at follow-up; Get.on Stress results indicated that it is an effective self-guided stress management intervention both for the reduction of perceived stress and for mental health, work-related health and skill-related outcomes (Ebert et al., 2016a). The Acceptance and Commitment Therapy app-based intervention by Ly et al. (2014) had a moderate effect on stress but no effect on transformative leadership. Finally, the symptom treatment and management smartphone-based interventions have had varying results. The Stress Inoculation Training app-based intervention by Villani et al. (2013) showed preliminary but promising results, pointing to a significant decrease in anxiety and an increase in coping skills-acquisition. Stress reduction and resilience-enhancement through mobile video conference-based intervention have shown significant efficacy (but with no difference between mobile intervention and in-person intervention; see Kim et al. 2018). The app called Get.On Stress, again, was found to have moderate to large effects on depression, anxiety, emotional exhaustion, and insomnia symptoms in a severely burdened sample of workers, both post-assessment and at 6-month follow-up (Weisel et al., 2018). However, the anxiety-reduction intervention's results indicate that there was no change over time in heart rate variability or unconscious stress (Versluis et al., 2018). In addition, some of the included papers also considered the issue of user engagement with the intervention(s) as a critical factor in their effectiveness. In this regard, Zarski et al. (2016) focused their study on adherence, namely the 'extent to which individuals experience the intervention content' (Christensen et al. 2009, p. 2), and content-focused guidance. Concerning the latter factor, results showed that the participants had a better adherence level with guided treatments in comparison to unguided treatments. Eng (2001) studied the application of ecological momentary assessment (EMA), through the smartphone app, in relation to health

evaluation in the workplace. They also examined the feasibility of this intervention. The results indicated that EMA had good potential as an office-based health evaluation addition. van Drongelen et al. (2014) reported the process evaluation of a personalised mobile health intervention (More Energy-app) targeting airline pilots, e.g. on reach (comparison between participants and nonparticipants); dose delivered (amount of intervention materials distributed); compliance (dose received, namely the extent to which intervention participants actively engaged with the study); fidelity (the extent to which the intervention programme looked the same as at the beginning), satisfaction, barriers, and facilitators (context; all of the social, physical, and political environment features that could directly or indirectly influence an intervention programme); and adherence (how participants applied the smartphone-app advice in daily life). It was found that the participants were younger than nonparticipants and also that female pilots were overrepresented. The dose delivered and initial compliance were high; however, compliance during the whole intervention was low: moreover, the results on fidelity were conflicting. Finally, not all participants were in accord with the statement, 'the devices are easy to apply in daily life'. Narváez et al. (2016) described the user-centred design (UCD), an iterative design process which engaged the user from the project initation to the developmental phases. A multidisciplinary group comprised of designers, developers, occupational health specialists, social communicators, usability experts, and some workers collaborated in the design. The researchers tried to understand and specify the context of use, developed different types of the app prototype, and evaluated each prototype following usability-testing guidelines. Bort-Roig et al. (2019) assessed the validity of an mHealth tool to monitor the sedentary patterns in office-based employees, finding that the Walk@Work app was accurate in measuring desk-based sitting, especially for a prolonged period. de Korte et al. (2018) used a mixed-method qualitative study to evaluate the factors influencing the use and the effectiveness of an mHealth app (Bright) for health and well-being promotion in a sample of a high-tech company's workers. The researchers found that there were several drivers and barriers for using the mHealth intervention in the workplace: (1) first, technology features, such as high battery use or system failure, have a great impact on adoption and adherence with the app, as well as the perceived quality of information delivered. Also, (2) users' characteristics influence the use of the app and should be taken into account in the design and implementation phase. Finally, (3) the nature of the work context plays a fundamental role in the workers' decision to participate in the interventions, as do the privacy and autonomy related to the app- use. Finally, Koldijk et al. (2016) tried to give a global and precise framework that could be used to develop and design pervasive technologies, useful for reducing workers' stress. As we noted in subsection 10.1, even in the realm of smartphone-based interventions, implementing organisational-level interventions may be difficult and complex. However, an important aspect of primary interventions that seek to change organisational practice is the efficacy of the implementation process (Nielsen and Randall, 2013). The participatory approach is seen as a desirable intervention strategy; participation in the design of health-promoting actions is also included in the World Health Organization (WHO) and the European Network for Workplace Health Promotion's guidelines (for Workplace Health Promotion, ENWHP). By examining the content and process mechanism that

makes an organisational intervention effective, researchers can better understand how interventions (of all kinds) achieve the desired outcomes of improving employee health and well-being (Nielsen and Miraglia, 2017). In our view the same approach could be efficiently applied for smartphone-based interventions.

11 Conclusion

The workplace is an optimal site to carry out health promotion initiatives. Indeed, organisations are frequently a place for actions aimed to promote the health and well-being of workers. The development and growing use of new technologies has affected the way tasks are carried out and interactions occur in the workplace (Skoumpopoulou et al., 2018). Several studies (e.g. Colbert et al. 2016) have shown that smartphones offer advantages in the form of more accessible interactions and collaborations among colleagues, more flexible work schedules, increased work productivity. At the same time, various studies (Ghislieri et al., 2017; Miglioretti and Simbula, 2019; Reyt and Wiesenfeld, 2015) underscore increased supervisory control, loss of autonomy, and the resulting perception of intrusion in those parts of one's life that are not work-related, For these reasons, smartphone work-related use could be associated with the technostress highlighted in considerations of their efficacy (Ghislieri et al., 2017). At the same time, the development of new technologies has enabled the dissemination and design, also in the workplace, of interventions aimed at promoting the health and well-being of workers, delivered through mobile devices: the so-called mobile health (mHealth) interventions. Despite it potential, the benefits of mobile health cannot be fully realised if the worker does not understand its benefits (Sari et al., 2018). When a company decides to introduce an innovation as an mHealth intervention, they should investigate acceptance of this technology by employees to guard against attitudinal barriers (Talukder, 2012). Although the related obstacles, such as perceived risks to one's privacy, lack of requisite skills related to the use of technology, the literature shows us how such mHealth interventions for health promotion, well-being, and work-related stress management are still effective (see Sari et al. 2018). Indeed, smartphone-based interventions have shown promising efficacy in the clinical and educational context, even compared to face-to-face intervention. This study has endeavoured to provide a general overview of workplace health and well-being promotion through smartphone-based interventions. Our results were drawn from 31 studies that tested various smartphone apps, based on different theories and targeting different employees. Overall, the mHealth interventions aimed to promote employees' physical and mental health, to foster the acquisition of stress management skills (and specifically work-stress coping abilities), and to enhance the global level of well-being. All of this aims to minimise the economic cost for occupational health promotion, to increase the employees' well-being (and in consequence their work productivity), and to facilitate workers' participation in a health promotion initiative, in an easy and anonymous way (cf. Ebert et al. 2016a; Khakurel et al. 2018). Several studies under- lined the efficacy of smartphone-based interventions in the workplace, but the study results have been contradictory. Frequently, the apps are not founded

on evidence-based theories or sound methodological approaches. Moreover, it seems necessary to identify which factors of these models are most powerful for engagement (Yardley et al., 2016). The preliminary phases that precede the intervention development are important: for example, van Gemert-Pijnen et al. (2011) individuated a holistic framework for the development of eHealth technologies that could help researchers design more effective interventions. Some principles that can also be easily applied in the workplace context are the role of a participatory process, because the stakeholders' involvement is fundamental from the intervention's ideation to operationalisation. The importance of a continuous evaluation cycle, because technology interventions frequently need to be reshaped to better match human, organisational and technology factors; the usefulness of considering the implementation phase from the beginning, to avoid several last-minute obstacles; persuasive design techniques are essential to motivate or inspire users to engage in self-management interventions; finally, mixed-method research design seems to be the best choice to integrate data from different sources and better assess the impact of technology-driven interventions. For these reasons, other studies are needed to complete the scientific literature. These should specifically target workers' engagement with smartphone apps for health and well-being promotion, in order to overcome the natural initial diffidence with this alternative intervention strategy (cf. Dunkl and Jiménez 2017; Muuraiskangas et al. 2016). They also should consider the ad-hoc design and development of mHealth interventions for employees, as a means of providing them the skills to cope with and manage work-based stress and improve their general health and well-being.

Declaration of Interest

The authors declare no conflict of interest in the work reported here.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Acemoglu, D. and Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In *Handbook of labor economics*, volume 4, pages 1043–1171. Elsevier.

Ahtinen, A., Mattila, E., Välkkynen, P., Kaipainen, K., Vanhala, T., Ermes, M., Sairanen, E., Myllymäki, T., and Lappalainen, R. (2013). Mobile mental wellness training for stress management: feasibility and design implications based on a one-month field study. *JMIR mHealth and uHealth*, 1(2):e11.

Armstrong, R., Waters, E., Moore, L., Riggs, E., Cuervo, L. G., Lumbiganon, P., and Hawe, P. (2008). Improving the reporting of public health intervention research: advancing trend and consort. *Journal of public health*, 30(1):103–109.

Arrogi, A., Boen, F., and Seghers, J. (2019). Validation of a smart chair and corresponding smartphone app as an objective measure of desk-based sitting. *Journal of occupational health*, 61(1):121–127.

Bakker, D., Kazantzis, N., Rickwood, D., and Rickard, N. (2016). Mental health smartphone apps: review and evidence-based recommendations for future developments. *JMIR mental health*, 3(1):e7.

Balk-Møller, N. C., Larsen, T. M., and Holm, L. (2017a). Experiences from a web-and app-based workplace health promotion intervention among employees in the social and health care sector based on use-data and qualitative interviews. *Journal of medical Internet research*, 19(10):e350.

Balk-Møller, N. C., Poulsen, S. K., and Larsen, T. M. (2017b). Effect of a nine-month web-and app-based workplace intervention to promote healthy lifestyle and weight loss for employees in the social welfare and health care sector: a randomized controlled trial. *Journal of medical Internet research*, 19(4):e108.

Bardus, M., Hamadeh, G., Hayek, B., and Al Kherfan, R. (2018). A self-directed mobile intervention (waznapp) to promote weight control among employees at a lebanese university: protocol for a feasibility pilot randomized controlled trial. *JMIR research protocols*, 7(5):e133.

Bhardwaj, A., Srivastava, A., et al. (2008). Occupational health and psychological well-being of industrial employees. *Industrial Psychiatry Journal*, 17(1):28.

Bidargaddi, N., Almirall, D., Murphy, S., Nahum-Shani, I., Kovalcik, M., Pituch, T., Maaieh, H., and Strecher, V. (2018). To prompt or not to prompt? a microrandomized trial of time-varying push notifications to increase proximal engagement with a mobile health app. *JMIR mHealth and uHealth*, 6(11):e10123.

Blake, H., Suggs, L. S., Coman, E., Aguirre, L., and Batt, M. E. (2017). Active8! technology-based intervention to promote physical activity in hospital employees. *American Journal of Health Promotion*, 31(2):109–118.

Bonn, S. E., Löf, M., Östenson, C.-G., and Lagerros, Y. T. (2019). App-technology to improve lifestyle behaviors among working adults-the health integrator study, a randomized controlled trial. *BMC public health*, 19(1):273.

Bootsman, R., Markopoulos, P., Qi, Q., Wang, Q., and Timmermans, A. A. (2019). Wearable technology for posture monitoring at the workplace. *International Journal of Human-Computer Studies*, 132:99–111.

Bort-Roig, J., Puig-Ribera, A., Contreras, R. S., Chirveches-Pérez, E., Martori, J. C., Gilson, N. D., and McKenna, J. (2019). Monitoring sedentary patterns in office employees: validity of an m-health tool (walk@ work-app) for occupational health. *Gaceta sanitaria*, 32:563–566.

Bostock, S., Crosswell, A. D., Prather, A. A., and Steptoe, A. (2019). Mindfulness on-the-go: Effects of a mindfulness meditation app on work stress and well-being. *Journal*

of occupational health psychology, 24(1):127.

Brakenridge, C. L., Healy, G. N., Winkler, E. A., and Fjeldsoe, B. S. (2018). Usage, acceptability, and effectiveness of an activity tracker in a randomized trial of a workplace sitting intervention: mixed-methods evaluation. *Interactive journal of medical research*, 7(1):e5.

Bregenzer, A., Wagner-Hartl, V., and Jiménez, P. (2019). Who uses apps in health promotion? a target group analysis of leaders. *Health informatics journal*, 25(3):1038–1052.

Carissoli, C., Villani, D., and Riva, G. (2015). Does a meditation protocol supported by a mobile application help people reduce stress? suggestions from a controlled pragmatic trial. *Cyberpsychology, Behavior, and Social Networking*, 18(1):46–53.

Carolan, S. and de Visser, R. O. (2018). Employees' perspectives on the facilitators and barriers to engaging with digital mental health interventions in the workplace: qualitative study. *JMIR mental health*, 5(1):e8.

Choi, B., Schnall, P. L., Yang, H., Dobson, M., Landsbergis, P., Israel, L., Karasek, R., and Baker, D. (2010). Sedentary work, low physical job demand, and obesity in us workers. *American journal of industrial medicine*, 53(11):1088–1101.

Christensen, H., Griffiths, K., Evans, K., et al. (2002). *e-Mental health in Australia: Implications of the Internet and related technologies for policy*. Commonwealth Department of Health and Ageing Canberra.

Christensen, H., Griffiths, K. M., and Farrer, L. (2009). Adherence in internet interventions for anxiety and depression: systematic review. *Journal of medical Internet research*, 11(2):e13.

Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature reviews endocrinology*, 5(7):374.

Cocker, F., Martin, A., Scott, J., Venn, A., and Sanderson, K. (2013). Psychological distress, related work attendance, and productivity loss in small-to-medium enterprise owner/managers. *International journal of environmental research and public health*, 10(10):5062–5082.

Colbert, A., Yee, N., and George, G. (2016). The digital workforce and the workplace of the future.

Cooper, C. and Quick, J. C. (2017). *The handbook of stress and health: A guide to research and practice*. John Wiley & Sons.

Cooper, C. L. and Cartwright, S. (1997). An intervention strategy for workplace stress. *Journal of psychosomatic research*, 43(1):7–16.

Cortes, G. M. and Salvatori, A. (2019). Delving into the demand side: Changes in workplace specialization and job polarization. *Labour economics*, 57:164–176.

Coulon, S. M., Monroe, C. M., and West, D. S. (2016). A systematic, multi-domain review of mobile smartphone apps for evidence-based stress management. *American journal of preventive medicine*, 51(1):95–105.

Danaher, B. G., Brendryen, H., Seeley, J. R., Tyler, M. S., and Woolley, T. (2015). From

black box to toolbox: outlining device functionality, engagement activities, and the pervasive information architecture of mhealth interventions. *Internet interventions*, 2(1):91–101.

Day, A., Paquet, S., Scott, N., and Hambley, L. (2012). Perceived information and communication technology (ict) demands on employee outcomes: The moderating effect of organizational ict support. *Journal of occupational health psychology*, 17(4):473.

De Korte, E., Wiezer, N., Roozeboom, M. B., Vink, P., and Kraaij, W. (2018). Behavior change techniques in mhealth apps for the mental and physical health of employees: Systematic assessment. *JMIR mHealth and uHealth*, 6(10):e167.

de Korte, E. M., Wiezer, N., Janssen, J. H., Vink, P., and Kraaij, W. (2018). Evaluating an mhealth app for health and well-being at work: mixed-method qualitative study. *JMIR mHealth and uHealth*, 6(3):e72.

De Neve, J.-E., Diener, E., Tay, L., and Xuereb, C. (2013). The objective benefits of subjective well-being. *World happiness report*.

Deady, M., Johnston, D. A., Glozier, N., Milne, D., Choi, I., Mackinnon, A., Mykletun, A., Calvo, R. A., Gayed, A., Bryant, R., et al. (2018). Smartphone application for preventing depression: study protocol for a workplace randomised controlled trial. *BMJ open*, 8(7):e020510.

Dewe, P. J., O'Driscoll, M. P., and Cooper, C. (2010). *Coping with work stress: A review and critique*. John Wiley & Sons.

Dunkl, A. and Jiménez, P. (2017). Using smartphone-based applications (apps) in workplace health promotion: the opinion of german and austrian leaders. *Health informatics journal*, 23(1):44–55.

Ebert, D. D., Heber, E., Berking, M., Riper, H., Cuijpers, P., Funk, B., and Lehr, D. (2016a). Self-guided internet-based and mobile-based stress management for employees: results of a randomised controlled trial. *Occupational and environmental medicine*, 73(5):315–323.

Ebert, D. D., Kählke, F., Buntrock, C., Berking, M., Smit, F., Heber, E., Baumeister, H., Funk, B., Riper, H., and Lehr, D. (2018). A health economic outcome evaluation of an internet-based mobile-supported stress management intervention for employees. *Scandinavian journal of work, environment & health*, 44(2).

Ebert, D. D., Lehr, D., Heber, E., Riper, H., Cuijpers, P., and Berking, M. (2016b). Internet-and mobile-based stress management for employees with adherence-focused guidance: efficacy and mechanism of change. *Scandinavian journal of work, environment & health*, pages 382–394.

Ebert, D. D., Lehr, D., Smit, F., Zarski, A.-C., Riper, H., Heber, E., Cuijpers, P., and Berking, M. (2014). Efficacy and cost-effectiveness of minimal guided and unguided internet-based mobile supported stress-management in employees with occupational stress: a three-armed randomised controlled trial. *BMC Public Health*, 14(1):807.

Eng, T. R. (2001). The ehealth landscape: a terrain map of emerging information and communication technologies in health and health care.

Engelen, L., Chau, J. Y., Burks-Young, S., and Bauman, A. (2017). Application of ecological momentary assessment in workplace health evaluation. *Health Promotion Journal of Australia*, 27(3):259–263.

Engert, V., Kok, B. E., Puhlmann, L. M., Stalder, T., Kirschbaum, C., Apostolakou, F., Papanastasopoulou, C., Papassotiriou, I., Pervanidou, P., Chrousos, G. P., et al. (2018). Exploring the multidimensional complex systems structure of the stress response and its relation to health and sleep outcomes. *Brain, behavior, and immunity*, 73:390–402.

Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, V., and Haines, A. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS med*, 10(1):e1001362.

Fuller-Tyszkiewicz, M., Richardson, B., Klein, B., Skouteris, H., Christensen, H., Austin, D., Castle, D., Mihalopoulos, C., O'Donnell, R., Arulkadacham, L., et al. (2018). A mobile app–based intervention for depression: End-user and expert usability testing study. *JMIR mental health*, 5(3):e54.

Ghislieri, C., Emanuel, F., Molino, M., Cortese, C. G., and Colombo, L. (2017). New technologies smart, or harm work-family boundaries management? gender differences in conflict and enrichment using the jd-r theory. *Frontiers in psychology*, 8:1070.

Goldenhar, L. M., LaMontagne, A. D., Katz, T., Heaney, C., and Landsbergis, P. (2001). The intervention research process in occupational safety and health: an overview from the national occupational research agenda intervention effectiveness research team. *Journal of occupational and environmental medicine*, 43(7):616–622.

Gremaud, A. L., Carr, L. J., Simmering, J. E., Evans, N. J., Cremer, J. F., Segre, A. M., Polgreen, L. A., and Polgreen, P. M. (2018). Gamifying accelerometer use increases physical activity levels of sedentary office workers. *Journal of the American Heart Association*, 7(13):e007735.

Guarnaccia, C., Scrima, F., Civilleri, A., and Salerno, L. (2018). The role of occupational self-efficacy in mediating the effect of job insecurity on work engagement, satisfaction and general health. *Current Psychology*, 37(3):488–497.

Hammedi, W., Leclerq, T., and Van Riel, A. C. (2017). The use of gamification mechanics to increase employee and user engagement in participative healthcare services. *Journal of Service Management*.

Hassard, J., Teoh, K. R., Visockaite, G., Dewe, P., and Cox, T. (2018). The cost of work-related stress to society: A systematic review. *Journal of occupational health psychology*, 23(1):1.

Hedman, E., Andersson, G., Ljótsson, B., Andersson, E., Rück, C., Mörtberg, E., and Lindefors, N. (2011). Internet-based cognitive behavior therapy vs. cognitive behavioral group therapy for social anxiety disorder: a randomized controlled non-inferiority trial. *PloS one*, 6(3).

Herr, R. M., Barrech, A., Riedel, N., Gündel, H., Angerer, P., and Li, J. (2018). Long-term effectiveness of stress management at work: Effects of the changes in perceived

stress reactivity on mental health and sleep problems seven years later. *International journal of environmental research and public health*, 15(2):255.

Holman, D., Johnson, S., and O'Connor, E. (2018). Stress management interventions: Improving subjective psychological well-being in the workplace. *Handbook of well-being. Salt Lake City, UT: DEF Publishers. DOI: nobascholar. com.*

Howarth, A., Quesada, J., Silva, J., Judycki, S., and Mills, P. R. (2018). The impact of digital health interventions on health-related outcomes in the workplace: A systematic review. *Digital health*, 4:2055207618770861.

ILO, I. (2016). Workplace stress: A collective challenge.

Imamura, K., Tran, T. T. T., Nguyen, H. T., Kuribayashi, K., Sakuraya, A., Nguyen, A. Q., Bui, T. M., Nguyen, Q. T., Nguyen, K. T., Nguyen, G. T. H., et al. (2019). Effects of two types of smartphone-based stress management programmes on depressive and anxiety symptoms among hospital nurses in vietnam: a protocol for three-arm randomised controlled trial. *BMJ open*, 9(4):e025138.

Ingusci, E., Callea, A., Chirumbolo, A., and Urbini, F. (2016). Job crafting and job satisfaction in a sample of italian teachers: the mediating role of perceived organizational support. *Electronic Journal of Applied Statistical Analysis*, 9(4):675–687.

Jimenez, P. and Bregenzer, A. (2018). Integration of ehealth tools in the process of workplace health promotion: proposal for design and implementation. *Journal of medical Internet research*, 20(2):e65.

Kelders, S. M., Kok, R. N., Ossebaard, H. C., and Van Gemert-Pijnen, J. E. (2012). Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of medical Internet research*, 14(6):e152.

Khakurel, J., Melkas, H., and Porras, J. (2018). Tapping into the wearable device revolution in the work environment: a systematic review. *Information Technology & People*.

Kim, J. I., Yun, J.-Y., Park, H., Park, S.-Y., Ahn, Y., Lee, H., Kim, T.-K., Yoon, S., Lee, Y.-J., Oh, S., et al. (2018). A mobile videoconference-based intervention on stress reduction and resilience enhancement in employees: randomized controlled trial. *Journal of medical Internet research*, 20(10):e10760.

Koldijk, S., Kraaij, W., and Neerincx, M. A. (2016). Deriving requirements for pervasive well-being technology from work stress and intervention theory: framework and case study. *JMIR mHealth and uHealth*, 4(3):e79.

Kraaij, W., Verberne, S., Koldijk, S., de Korte, E., van Dantzig, S., Sappelli, M., Shoaib, M., Bosems, S., Achterkamp, R., Bonomi, A., et al. (2019). Personalized support for well-being at work: an overview of the swell project. *User modeling and user-adapted interaction*, pages 1–34.

Kwok, R. (2009). Personal technology: Phoning in data.

LaMontagne, A. D., Keegel, T., Louie, A. M., Ostry, A., and Landsbergis, P. A. (2007). A systematic review of the job-stress intervention evaluation literature, 1990–2005. *International journal of occupational and environmental health*, 13(3):268–280.

Largo-Wight, E., Chen, W. W., Dodd, V., and Weiler, R. (2011). Healthy workplaces: The effects of nature contact at work on employee stress and health. *Public Health Reports*, 126(1_suppl):124–130.

Lehr, D., Heber, E., Sieland, B., Hillert, A., Funk, B., and Ebert, D. D. (2016). Occupational emental health and teachers' health. a meta-analytic review on the efficacy of internet-based intervention for promoting mental health in teachers. *Pravention und Gesundheitsforderung*, 11(3):182–192.

Leka, S., Jain, A., Organization, W. H., et al. (2010). Health impact of psychosocial hazards at work: an overview.

Ly, K. H., Asplund, K., and Andersson, G. (2014). Stress management for middle managers via an acceptance and commitment-based smartphone application: A randomized controlled trial. *Internet Interventions*, 1(3):95–101.

Martin, P. R. (2016). Stress and primary headache: review of the research and clinical management. *Current pain and headache reports*, 20(7):45.

Maslach, C. (2003). Job burnout: New directions in research and intervention. *Current directions in psychological science*, 12(5):189–192.

Maslach, C., Schaufeli, W. B., and Leiter, M. P. (2001). Job burnout. *Annual review of psychology*, 52(1):397–422.

Meyer, D., Jayawardana, M. W., Muir, S. D., Ho, D. Y.-T., and Sackett, O. (2018). Promoting psychological well-being at work by reducing stress and improving sleep: Mixed-methods analysis. *Journal of medical Internet research*, 20(10):e267.

Miglioretti, M. and Simbula, S. (2019). Le tecnologie al lavoro e il loro impatto sullo stress e la salute dei lavoratori. *Giornale italiano di psicologia*, 46(1-2):141–146.

Miller, G. (2012). The smartphone psychology manifesto. *Perspectives on psychological science*, 7(3):221–237.

Milner, A., King, T., Scovelle, A., Batterham, P., Kelly, B., LaMontagne, A., Harvey, S., Gullestrup, J., and Lockwood, C. (2019). A blended face-to-face and smartphone intervention for suicide prevention in the construction industry: protocol for a randomized controlled trial with mates in construction. *BMC psychiatry*, 19(1):146.

Mistretta, E. G., Davis, M. C., Temkit, M., Lorenz, C., Darby, B., Stonnington, C. M., et al. (2018). Resilience training for work-related stress among health care workers: results of a randomized clinical trial comparing in-person and smartphone-delivered interventions. *Journal of occupational and environmental medicine*, 60(6):559–568.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., et al. (2010). Preferred reporting items for systematic reviews and meta-analyses: the prisma statement. *Int J Surg*, 8(5):336–341.

Morrison, L. G., Hargood, C., Pejovic, V., Geraghty, A. W., Lloyd, S., Goodman, N., Michaelides, D. T., Weston, A., Musolesi, M., Weal, M. J., et al. (2017). The effect of timing and frequency of push notifications on usage of a smartphone-based stress management intervention: an exploratory trial. *PloS one*, 12(1):e0169162.

Motamed-Jahromi, M., Fereidouni, Z., and Dehghan, A. (2017). Effectiveness of pos-

itive thinking training program on nurses' quality of work life through smartphone applications. *International scholarly research notices*, 2017.

Muuraiskangas, S., Harjumaa, M., Kaipainen, K., and Ermes, M. (2016). Process and effects evaluation of a digital mental health intervention targeted at improving occupational well-being: lessons from an intervention study with failed adoption. *JMIR mental health*, 3(2):e13.

Nahum-Shani, I., Smith, S. N., Spring, B. J., Collins, L. M., Witkiewitz, K., Tewari, A., and Murphy, S. A. (2018). Just-in-time adaptive interventions (jitais) in mobile health: key components and design principles for ongoing health behavior support. *Annals of Behavioral Medicine*, 52(6):446–462.

Narváez, S., Tobar, Á. M., López, D. M., and Blobel, B. (2016). Human-centered design of an mhealth app for the prevention of burnout syndrome. In *MIE*, pages 215–219.

Nicholson, J., Wright, S. M., and Carlisle, A. M. (2018). Pre-post, mixed-methods feasibility study of the workingwell mobile support tool for individuals with serious mental illness in the usa: a pilot study protocol. *BMJ open*, 8(2):e019936.

Nielsen, K. and Miraglia, M. (2017). What works for whom in which circumstances? on the need to move beyond the 'what works?'question in organizational intervention research. *Human relations*, 70(1):40–62.

Nielsen, K. and Randall, R. (2013). Opening the black box: Presenting a model for evaluating organizational-level interventions. *European Journal of Work and Organizational Psychology*, 22(5):601–617.

O'Brien, H. L. and Toms, E. G. (2008). What is user engagement? a conceptual framework for defining user engagement with technology. *Journal of the American society for Information Science and Technology*, 59(6):938–955.

Portoghese, I., Galletta, M., Coppola, R. C., Finco, G., and Campagna, M. (2014). Burnout and workload among health care workers: the moderating role of job control. *Safety and health at work*, 5(3):152–157.

Raento, M., Oulasvirta, A., and Eagle, N. (2009). Smartphones: An emerging tool for social scientists. *Sociological methods & research*, 37(3):426–454.

Rajgopal, T. (2010). Mental well-being at the workplace. *Indian journal of occupational and environmental medicine*, 14(3):63.

Reyt, J.-N. and Wiesenfeld, B. M. (2015). Seeing the forest for the trees: Exploratory learning, mobile technology, and knowledge workers' role integration behaviors. *Academy of Management Journal*, 58(3):739–762.

Riper, H., Blankers, M., Hadiwijaya, H., Cunningham, J., Clarke, S., Wiers, R., Ebert, D., and Cuijpers, P. (2014). Effectiveness of guided and unguided low-intensity internet interventions for adult alcohol misuse: a meta-analysis. *PloS one*, 9(6).

Ritterband, L. M. and Thorndike, F. (2006). Internet interventions or patient education web sites? *Journal of medical Internet research*, 8(3):e18.

Sari, H., Othman, M., and Al-Ghaili, A. M. (2018). A proposed conceptual framework for mobile health technology adoption among employees at workplaces in malaysia.

In *International Conference of Reliable Information and Communication Technology*, pages 736–748. Springer.

Sauter, S., Murphy, L., Colligan, M., Swanson, N., Hurrell Jr, J., Schaf Jr, F., et al. (1999). Stress at work. niosh publication no. 99–101. *National Institute for Occupational Safety and Health, Cincinatti*.

Sauter, S. L., Brightwell, W. S., Colligan, M. J., Hurrell, J., and Katz, T. M. (2002). Changing organization of work and the safety and health of working people.

Schaufeli, W. and Enzmann, D. (1998). *The burnout companion to study and practice: A critical analysis*. CRC press.

Senecal, C., Widmer, R. J., Bailey, K., Lerman, L. O., and Lerman, A. (2018). Usage of a digital health workplace intervention based on socioeconomic environment and race: Retrospective secondary cross-sectional study. *Journal of medical Internet research*, 20(4):e145.

Signore, F., Catalano, A., De Carlo, E., Madaro, A., and Ingusci, E. (2019). The role of employability in students during academic experience: a preliminary study through pls-pm technique. *Electronic Journal of Applied Statistical Analysis*, 12(4):720–747.

Sin, N. L. and Lyubomirsky, S. (2009). Enhancing well-being and alleviating depressive symptoms with positive psychology interventions: A practice-friendly meta-analysis. *Journal of clinical psychology*, 65(5):467–487.

Skoumpopoulou, D., Wong, A., Ng, P., and Lo, M. (2018). Factors that affect the acceptance of new technologies in the workplace: a cross case analysis between two universities. *International Journal of Education and Development using ICT*, 14(3).

Solovieva, S., Lallukka, T., Virtanen, M., and Viikari-Juntura, E. (2013). Psychosocial factors at work, long work hours, and obesity: a systematic review. *Scandinavian journal of work, environment & health*, pages 241–258.

Steinmueller, W. E. et al. (2000). Will new information and communication technologies improve the'codification'of knowledge? *Industrial and Corporate Change*, 9(2):361–376.

Stratton, E., Lampit, A., Choi, I., Calvo, R. A., Harvey, S. B., and Glozier, N. (2017). Effectiveness of ehealth interventions for reducing mental health conditions in employees: A systematic review and meta-analysis. *PloS one*, 12(12).

Talukder, M. (2012). Factors affecting the adoption of technological innovation by individual employees: An australian study. *Procedia-Social and Behavioral Sciences*, 40:52–57.

Tetrick, L. E. and Winslow, C. J. (2015). Workplace stress management interventions and health promotion. *Annu. Rev. Organ. Psychol. Organ. Behav.*, 2(1):583–603.

van Berkel, J., Boot, C. R., Proper, K. I., Bongers, P. M., and van der Beek, A. J. (2013). Process evaluation of a workplace health promotion intervention aimed at improving work engagement and energy balance. *Journal of Occupational and Environmental Medicine*, 55(1):19–26.

van den Heuvel, S., Roozeboom, B., Eekhout, I., and Houtman, I. (2018). Manage-

ment of psychosocial risks in european workplaces; drivers and barriers in a national and cultural context: abstract and presentation. *Proceedings of the 13th European Academy of Occupational Health Psychology ((EAOHP), Adapting to rapid changes in today's workplace 5-7 September 2018 in Lisbon, Portugal*.

van Drongelen, A., Boot, C. R., Hlobil, H., Twisk, J. W., Smid, T., and van der Beek, A. J. (2014). Evaluation of an mhealth intervention aiming to improve health-related behavior and sleep and reduce fatigue among airline pilots. *Scandinavian journal of work, environment & health*, pages 557–568.

van Gemert-Pijnen, J. E., Nijland, N., van Limburg, M., Ossebaard, H. C., Kelders, S. M., Eysenbach, G., and Seydel, E. R. (2011). A holistic framework to improve the uptake and impact of ehealth technologies. *Journal of medical Internet research*, 13(4):e111.

Versluis, A., Verkuil, B., Spinhoven, P., and F Brosschot, J. (2018). Effectiveness of a smartphone-based worry-reduction training for stress reduction: A randomized-controlled trial. *Psychology & health*, 33(9):1079–1099.

Villani, D., Grassi, A., Cognetta, C., Toniolo, D., Cipresso, P., and Riva, G. (2013). Self-help stress management training through mobile phones: An experience with oncology nurses. *Psychological Services*, 10(3):315.

Wang, C.-C., Yang, Y. Y.-H., and Tseng, C.-Y. (2016). Always on duty? the positive and negative effects of using mobile social networking tools for work. In *PACIS*, page 270.

Weisel, K. K., Lehr, D., Heber, E., Zarski, A.-C., Berking, M., Riper, H., and Ebert, D. D. (2018). Severely burdened individuals do not need to be excluded from internet-based and mobile-based stress management: effect modifiers of treatment outcomes from three randomized controlled trials. *Journal of medical Internet research*, 20(6):e211.

Wilson, M. G., Sweet, C. M. C., Edge, M. D., Madero, E. N., McGuire, M., Pilsmaker, M., Carpenter, D., and Kirschner, S. (2017). Evaluation of a digital behavioral counseling program for reducing risk factors for chronic disease in a workforce. *Journal of occupational and environmental medicine*, 59(8):e150.

Yardley, L., Spring, B. J., Riper, H., Morrison, L. G., Crane, D. H., Curtis, K., Merchant, G. C., Naughton, F., and Blandford, A. (2016). Understanding and promoting effective engagement with digital behavior change interventions. *American journal of preventive medicine*, 51(5):833–842.

Yu, J., Abraham, J. M., Dowd, B., Higuera, L. F., and Nyman, J. A. (2017). Impact of a workplace physical activity tracking program on biometric health outcomes. *Preventive medicine*, 105:135–141.

Zarski, A.-C., Lehr, D., Berking, M., Riper, H., Cuijpers, P., and Ebert, D. D. (2016). Adherence to internet-based mobile-supported stress management: a pooled analysis of individual participant data from three randomized controlled trials. *Journal of medical Internet research*, 18(6):e146.

Zhang, S. and Elhadad, N. (2016). Factors contributing to dropping-out in an online

health community: static and longitudinal analyses. In *AMIA Annual Symposium Proceedings*, volume 2016, page 2090. American Medical Informatics Association.

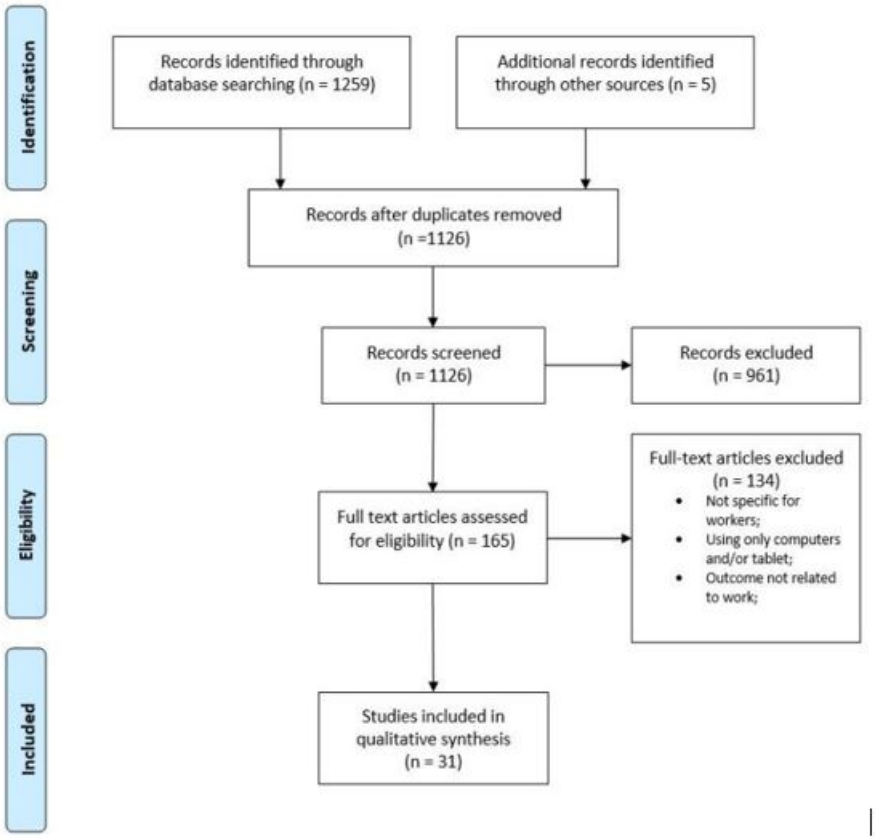

Figure 1: Flow diagram of records identified, screened and included in the systematic review, according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines.

Table. 1 *Literature review results: smartphone-based intervention's focus and target and control group's presence*

	AUTHORS	APP'S NAME	CONTROL GROUP	FOCUS	TARGET
1.	Arrogi, Boen, \& Seghers (2019)	Axia Smart Active (ASA)App	Yes	Physical Health and Lifestyle	Office-Based Workers
2.	Balk-Møller, Poulsen, \& Larsen (2017)	SoSu-life tool	Yes (RCT)	Physical Health and Lifestyle	Social And Health Care Workers
3.	Bardus, Hamadeh, Hayek, \& Al Kherfan (2018)	Lark Pro	Yes (RCT; RP)	Physical Health and Lifestyle	Generic Workers
4.	Blake, Suggs, Coman, Aguirre, \& Batt (2017)	Active8!	Yes	Physical Health and Lifestyle	Social And Health Care Workers
5.	Bonn, Löf, Östenson, \& Lagerros (2019)	Health Integrator system	Yes (RCT; RP)	Physical Health and Lifestyle	Office-Based Workers
6.	Bootsman, Markopoulos, Qi, Wang, \& Timmermans (2019)	BackUp	No	Physical Health and Lifestyle	Social And Health Care Workers
7.	Bort-Roig, et al. (2018)	Walk@work	No	Physical Health and Lifestyle	Office-Based Workers
8.	Brakenridge, Healy, Winkler, \& Fjeldsoe (2018)	LumoBack Tracker	Yes (RCT)	Physical Health and Lifestyle	Office-Based Workers
9.	de Korte, Wiezer, Janssen, Vink, \& Kraaij (2018)	Brightr	No	Physical Health and Lifestyle	High Tech Company Workers
10.	Engelen, Chau, Burks-Young, \& Bauman (2017)	LifeData RealLife Exp application	No	Physical Health and Lifestyle	Office-Based Workers
11.	Gremaud, et al. (2018)	MapTrek App	Yes	Physical Health and Lifestyle	Generic Workers
12.	Senecal, Widmer, Bailey, Lerman, \& Lerman (2018)	Best Health	No	Physical Health and Lifestyle	Generic Workers
13.	van Drongelen, Boot, Hlobil, Twisk, Smid, \& van der Beek (2014)	More energy app	Yes	Physical Health and Lifestyle	Airline Pilots
14.	Wilson, et al. (2017)	Omada Health Program	Yes	Physical Health and Lifestyle	Generic Workers
15.	Yu, Abraham, Dowd, Higuera, \& Nyman (2017)	No Name	No	Physical Health and Lifestyle	Generic Workers
16.	Deady, et al. (2018)	HeadGear	Yes (RCT; RP)	Symptoms Treatment and Management	Generic Workers
17.	Imamura, et al. (2019)	No name A \& B	Yes (RCT; RP)	Symptoms Treatment and Management	Generic Workers
18.	Milner, et al. (2019)	MATESmobile	Yes (RCT; RP)	Symptoms Treatment and Management	Construction Workers
19.	Narváez, Tobar, López, \& Blobel (2016)	"POP 2.0 - Prototyping on Paper"	No	Symptoms Treatment and Management	Faculty Members
20.	Nicholson, Wright, \& Carlisle (2018)	WorkingWell	No (RP)	Symptoms Treatment and Management	Employees With Serious Mental Illness
21.	Versluis, Verkuil, Spinhoven, \& Brosschot (2018)	MovisensXS	Yes (RCT)	Symptoms Treatment and Management	Social And Health Care Workers
22.	Villani, Grassi, Cognetta, Toniolo, Cipresso, \& Riva (2018)	Mobile Stress Inoculation Training	No	Symptoms Treatment and Management	Social And Health Care Workers
23.	Weisel, et al. (2018)	GET.ON Stress Intervention	Yes (RCT)	Symptoms Treatment and Management	Social And Health Care Workers
24.	Bostock, Crosswell, Prather, \& Steptoe, (2019)	Headspace	Yes (RCT)	Well-being Promotion and Stress Management	High Tech Company Workers
25.	Ebert, et al. (2016)	GET.ON Stress	Yes (RCT)	Well-being Promotion and Stress Management	Generic Workers
26.	Kim, et al. (2018)	Hello Mindcare	Yes (RCT)	Well-being Promotion and Stress Management	Social And Health Care Workers
27.	Koldijk, Kraaij, \& Neerincx (2016)	SWELL NiceWork app	No	Well-being Promotion and Stress Management	Generic Workers
28.	Ly, Asplund, \& Andersson (2014)	Viary	Yes (RCT)	Well-being Promotion and Stress Management	Middle Managers
29.	Meyer, Jayawardana, Muir, Ho, \& Sackett (2018)	Virgin Pulse Global Challenge	No	Well-being Promotion and Stress Management	Generic Workers
30.	Mistretta, Davis, Temkit, Lorenz, Darby, \& Stonnington (2018)	Smartphone Resiliency Training	Yes (RCT)	Well-being Promotion and Stress Management	Social And Health Care Workers
31.	Zarski, et al. (2016)	GET.ON Stress	Yes (RCT)	Well-being Promotion and Stress Management	Generic Workers

Note. RCT = Randomized Controlled Trial; RP = Research Protocol

Table. 2 *Literature review results: smartphone-based intervention's users' engagement elements and theoretical background*

	AUTHORS	APP'S NAME	USERS' ENGAGEMENT ELEMENTS	THEORETICAL BACKGROUND
1.	Arrogi, Boen, & Seghers (2019)	Axia Smart Active (ASA)App	Real Time Monitoring;	Behavioural Change Techniques
2.	Balk-Møller, Poulsen, & Larsen (2017)	SoSu-life tool	Self-monitoring; social features; suggestion for activities;	X
3.	Bardus, Hamadeh, Hayek, & Al Kherfan (2018)	Lark Pro	Tailored Intervention; interactive coaching;Just-in-Time Adaptive interventions;	Behavioural Change Technique;
4.	Blake, Suggs, Coman, Aguirre, & Batt (2017)	Active8!	Tailored Messages/Feedback;	X
5.	Bonn, Löf, Östenson, & Lagerros (2019)	Health Integrator system	Tailored Intervention;	Behavioural Change Technique;
6.	Bootsman, Markopoulos, Qi, Wang, & Timmermans (2019)	BackUp	Tailored Messages/Feedback;	Behavioural Change Technique;
7.	Bort-Roig, et al. (2018)	Walk@work	Tailored Messages/Feedback; ambulatory activities tracking;	X
8.	Bostock, Crosswell, Prather, & Steptoe (2019)	Headspace	User friendly design;	Mindfulness meditation;
9.	Brakenridge, Healy, Winkler, & Fjeldsoe (2018)	LumoBack Tracker	Real-time Tailored Messages/Feedback, vibrating alerts;	X
10.	de Korte, Wiezer, Janssen, Vink, & Kraaij (2018)	Brightr	Tailored Messages/Feedback; continuous monitoring;	X
11.	Deady, et al. (2018)	HeadGear	Daily Challenge;	Behavioural Activation; Mindfulness;
12.	Ebert, et al. (2016)	GET.ON Stress	Human support (eCoach);	Lazarus and Folkman's Transactional model of stress;
13.	Engelen, Chau, Burks-Young, & Bauman (2017)	LifeData RealLife Exp application	Ecological Momentary Assessment (EMA);	X
14.	Gremaud, et al. (2018)	MapTrek App	Weekly virtual walking races; self-monitoring; tailored Messages/Feedback;	Cognitive Evaluation Theory;
15.	Imamura, et al. (2019)	No name A & B	Free –choice Program;	Cognitive Behavioural Therapy
16.	Kim, et al. (2018)	Hello Mindcare	X	Stress Management and Resilience Training; Relaxation Response Resilience Program; Cognitive Behavioural Therapy; Positive Psychology elements;
17.	Koldijk, Kraaij, & Neerincx (2016)	SWELL NiceWork app	X	Effort-Reward Imbalance Model;
18.	Ly, Asplund, & Andersson (2014)	Viary	Combining text and audio files; therapist message;	Acceptance and Commitment Therapy;
19.	Meyer, Jayawardana, Muir, Ho, & Sackett (2018)	Virgin Pulse Global Challenge	Global Approach; Gamification; Personalized goal setting; Positive Reinforcement;	X
20.	Milner, et al. (2019)	MATESmobile	Reinforces Messages; Informational Resources;	General Awareness Training;
21.	Mistretta, Davis, Temkit, Lorenz, Darby, & Stonnington (2018)	Smartphone Resiliency Training	Daily Tailored Messages/Feedback;	Mindfulness-Based Resilience Training (MBRT);
22.	Narváez, Tobar, López, & Blobel (2016)	"POP 2.0 - Prototyping on Paper"	Human Centered-Design;	X
23.	Nicholson, Wright, & Carlisle (2018)	WorkingWell	Personalized goal setting; goal reminder; coping skills; tips;	Behavioural Change Technique;
24.	Senecal, Widmer, Bailey, Lerman, & Lerman (2018)	Best Health	Tailored Intervention; e-mail and short messages;	X
25.	van Drongelen, Boot, Hlobil, Twisk, Smid, & van der Beek (2014)	More energy app	Tailored Messages/Feedback, reminders;	X
26.	Versluis, Verkuil, Spinhoven, & Brosschot (2018)	MovisensXS	Ecological Momentary Intervention (EMA);	Mindfulness;
27.	Villani, Grassi, Cognetta, Toniolo, Cipresso, & Riva (2013)	Mobile Stress Inoculation Training	Self-help approach;	Stress Inoculation Training;
28.	Weisel, et al. (2018)	GET.ON Stress Intervention	Human support (eCoach);	Lazarus and Folkman's Transactional model of stress;
29.	Wilson, et al. (2017)	Omada Health Program	Private online social network; individual counselling;	X
30.	Yu, Abraham, Dowd, Higuera, & Nyman (2017)	No Name	Synchronization between online platform and mobile or wearable devices;	X
31.	Zarski, et al. (2016)	GET.ON Stress	Human support (eCoach);	Lazarus and Folkman's Transactional model of stress;

Note. The "X" means that the field was not possible to fill with the information reported in the papers