Effects of m-Health interventions on physical activity level and sedentary behavior in pre-hypertensive and hypertensive individuals: a systematic review

Efeitos da utilização de m-Health no nível de atividade física e tempo sedentário em pré-hipertensos e hipertensos: uma revisão sistemática

Efectos del uso de m-Health sobre el nivel de actividad física y el tiempo sedentario en personas prehipertensas e hipertensas: una revisión sistemática

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Aline de Oliveira Martins
ORCID: https://orcid.org/0000-0003-3911-5828
University of Passo Fundo, Brazil
E-mail: 187751@upf.br
Karla Fabiana Goessler
ORCID: https://orcid.org/0000-0002-5934-9819
University of Sao Paulo, Brazil
E-mail: karla.goessler@usp.br
Ana Carolina Bertoletti De Marchi
ORCID: https://orcid.org/0000-0002-7704-3119
University of Passo Fundo, Brazil
E-mail: carolina@upf.br

Abstract
This study aims to identify the effects of m-Health interventions on physical activity (PA) level and sedentary behavior (SB) in pre-hypertensive and hypertensive adults. Therefore, a systematic literature search was conducted according to the guidelines defined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), in the scientific databases Web Of Science, MEDLINE/PubMed, SciELO, Scopus, and ACM Digital Library. Eligibility criteria were: clinical trials; description of the functionalities of m-Health apps (reminders, goals, wearables); description of the intervention characteristics (i.e., duration, expertise of professionals involved in the supervision, and others) and blood pressure assessment. In the end, 1447 studies were identified, of which 147 were duplicates. Through the screening by titles and abstracts, 43 studies were classified as relevant. However, only 12 studies met the eligibility criteria and were included in this systematic review. Most studies presented favorable results with the use of m-Health apps to increase PA and reduce SB. In addition, increasing PA and reducing SB might be an important non-pharmacological therapy to decrease blood pressure in hypertensive patients, when they follow the minimum recommendations proposed by the PA guidelines of the World Health Organization (WHO). However, further studies are still needed to assess the relationship between SB, PA and the use of m-Health interventions.
Keywords: Hypertension; Mobile applications; Sedentary behavior.

Resumo
Esse estudo tem como objetivo identificar os efeitos da utilização de aplicativos m-Health no nível de atividade física (AF) e no tempo sedentário (TS) de adultos com diagnóstico de pré-hipertensão ou hipertensão arterial (HA). Foi conduzida uma revisão sistemática da literatura de acordo com as diretrizes de declaração de Itens de Relatório Preferenciais para Revisões Sistemáticas e Meta-Análise (PRISMA), nas bases de dados Web Of Science, MEDLINE/PubMed, SciELO, Scopus e ACM Digital Library. Os critérios de elegibilidade foram: ensaios clínicos; descrição das funcionalidades dos aplicativos m-Health (lembretes, metas, vestíveis); descrição do processo de intervenção (i.e. duração da intervenção, profissionais envolvidos, entre outros) e avaliação dos valores pressóricos. Foram identificados 1447 artigos, sendo 147 duplicados. Por meio da revisão dos títulos e resumos, 43 estudos mostraram-se potencialmente relevantes. No entanto, apenas 12 estudos atenderam aos critérios de elegibilidade e foram incluídos para análise dos dados. Os dados demonstram que a maioria dos estudos apresentou resultados favoráveis com a utilização de m-Health no aumento da prática da AF e na redução no TS. Além disso, identificou-se que o aumento da AF e diminuição do TS pode favorecer a diminuição de valores pressóricos em pessoas com diagnóstico de HA, quando faziam o mínimo das recomendações proposta pelas diretrizes de AF da Organização Mundial da Saúde (OMS). Contudo, são necessários mais estudos que avaliem a relação do comportamento sedentário e a utilização de m-Health.
Palavras-chave: Pressão alta; Aplicativo móvel; Comportamento sedentário.

Resumen
Este estudio tiene como objetivo identificar los efectos de las intervenciones de m-Health en el nivel de actividad física (AF) y el comportamiento sedentario (SB) en adultos prehipertensos e hipertensos. Por lo tanto, se realizó una búsqueda bibliográfica sistemática de acuerdo con las pautas definidas por Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), en las bases de datos científicas Web Of Science, MEDLINE/PubMed, SciELO, Scopus y ACM Digital Library. Los criterios de elegibilidad fueron: ensayos clínicos; descripción de las funcionalidades de los apps m-Health (recordatorios, metas, wearables); descripción de las características de la intervención (es decir, duración, experiencia de los profesionales involucrados en la supervisión, y otros) y evaluación de la presión arterial. Al final, se identificaron 1447 estudios, de los cuales 147 eran duplicados. A través de la selección por títulos y resúmenes, 43 estudios fueron clasificados como relevantes. Sin embargo, solo 12 estudios cumplieron con los criterios de elegibilidad y se incluyeron en esta revisión sistemática. La mayoría de los estudios presentaron resultados favorables con el uso de apps m-Health para aumentar la AF y reducir la BS. Además, aumentar la AF y reducir la BS podría ser una importante terapia no farmacológica para disminuir la presión arterial en pacientes hipertensos, cuando se siguen las recomendaciones mínimas propuestas por las guías de AF de la Organización Mundial de la Salud (OMS). Sin embargo, aún se necesitan más estudios para evaluar la relación entre SB, AF y el uso de intervenciones de m-Health.
Palabras clave: Presión alta; Aplicación movil; Comportamiento sedentario.

1. Introduction

Current recommendations of the World Health Organization (WHO) indicate that all adults, aged between 18 and 64 years, should perform physical activity (PA), with at least 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity, to achieve substantial health benefits (Who, 2020). In addition, for the first time, WHO has been concerned with alerting society about the need to reduce sedentary behavior (SB) at all ages.

SB refers to the time that an individual spends on activities of low energy expenditure (≤ 1.5 MET), such as those performed when sitting, reclining, or lying down (Ekelund et al., 2016). The time spent in this type of activity is called SB. Watching TV, using the computer, playing video games, or working in a sitting position are some examples of activities that characterize SB.

The deleterious effects of SB on the individual's health, in different age groups, have already been discussed in the literature (Biswas et al., 2015; Carson et al., 2016; Ekelund et al., 2016). In this perspective, studies have shown that reducing SB has many beneficial effects on all-cause of mortality, cardiovascular mortality, cancer mortality, and incidence of cardiovascular disease (Who, 2020). Additionally, the impact of SB on cardiovascular mortality is also associated with the daily volume of moderate to vigorous PA (MVPA) (Ekelund et al., 2016).

However, most of the population does not meet the minimum recommended PA, with one in four adults and four in five adolescents not practicing enough PA(Who, 2020). This is a recurrent concern of government agencies, as 1 to 3% of national health expenditures are attributed to physical inactivity worldwide (Who, 2018). Previously, it was estimated that each minute of MVPA is associated with five minutes of increased longevity (Singh & Keer, 2020).

The regular practice of PA, in addition to reducing cardiovascular morbidity and mortality, reduces cardiac events, which consequently can be beneficial for primary and secondary prevention of arterial hypertension (AH) (Mazón et al., 2019). According to Brazilian Guidelines on Arterial Hypertension (Barosso et al., 2020), the AH is the top cause of death globally, since it is associated with heart attack, coronary artery disease, chronic kidney disease, hemorrhagic and ischemic stroke.

Moreover, it was demonstrated that physically active hypertensive patients shows improvement in total cholesterol and fractions, body mass index (BMI), and quality of life and decreased body pain, improvement in functional capacity, and vitality (Cobo-Mejía et al., 2016). However, in addition to being poorly adherent to pharmacological treatment (~40 to 60% of adherence) (Kitt et al., 2019), hypertensive patients are also less adherent to regular PA, when compared to their normotensive peers (Singh & Keer, 2020), which can become a concerning issue for public health management.

In terms of costs to Brazil's unified health system (SUS), in 2018 reports estimated expenditures of US$ 523.7 million with hospitalizations, outpatient procedures, and medication as AH consequence (Brasil, 2021). To reduce these costs, strategies must be developed focusing on prevention, treatment, monitoring, and encourage changes in SB in pre-hypertensive and hypertensive patients (Bakris et al., 2019).

Previously, a projection study showed that pre-hypertensive patients with unhealthy lifestyle habits have 90% of chance to develop AH at 55 years (Franklin et al., 2001). Another study highlighted that without any changes in healthy habits, 60% of the population with pre-hypertension might develop AH within four years (Donahue et al., 2014). These insights concern health authorities and raise awareness about situations that could overload the health system and increase public health costs.

Thus, strategies for engaging the patient in self-management of their own health might become a challenge (Debon et al., 2019; Veiga et al., 2017). Among these strategies, the use of technology has been considered a rising alternative to conventional treatments (Freene et al., 2020; Hamari et al., 2016). Technology as a component of health management might be an adequate strategy to motivate changes in behavior and engage users to complete tasks and achieve goals more adequately (Fiordelli et al., 2013). The use of mobile wireless technologies for public health, such as m-Health application (mobile health), can assist healthcare professionals and support patient care.

Furthermore, m-Health is used to promote healthy diets (Senarath et al., 2019), improve medication adherence (Senarath et al., 2019), and increase PA level (Sharma et al., 2019). In addition, WHO highlights that e-Health-based interventions are a valid alternative to increase PA rates (WHO, 2015), but they need further investigation and more consolidated results to validate the scientific evidence and assess their effectiveness.

Recently, it was demonstrated that m-Health interventions have the potential to promote short-term changes in PA and SB in hypertensive individuals. In the literature, there is relevant evidence from systematic reviews with m-Health interventions associated with SB, PA, and fitness in the elderly (Yerrakalva et al., 2019), and promising results on the effectiveness of using m-Health in self-management of blood pressure (BP) (Alessa et al., 2019). However, systematic reviews that directly address the effects of m-Health on the PA and SB levels in pre-hypertensive and hypertensive adults have not been identified.

Thus, there is a need to investigate and find evidence to support the most appropriate theoretical principles that will be used to propose these interventions. Furthermore, the relationship between the practice of regular PA and the reduction of SB as a health benefit for patients with AH must be investigated. Therefore, this study aims to identify the effects of using m-Health applications on the level of PA and SB in adults diagnosed with pre-hypertension or AH.

2. Methodology

This study is a systematic review of the literature conducted according to the guidelines defined by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma, 2019).

2.1 Research Questions

The following research questions were defined according to the purpose of this study: Q1: Can m-Health modify the PA and/or SB levels of people diagnosed with AH? Q2: What are the effects of using m-Health applications on the PA level? Q3: Can m-Health modify SB? Q4: What features of m-Health applications can help change SB and/or PA level? Q5: Can m-Health applications that encourage increased PA and/or decreased SB reduce blood pressure values?

2.2 Eligibility Criteria

Eligibility criteria for inclusion were defined as: (1) clinical trials; (2) detailed description of the m-Health features and functionalities (reminders, goals, wearables); (3) description of the intervention characteristics (duration, type, health care professionals involved in the supervision) and (4) blood pressure data.

2.3 Scientific Databases

Scientific search was performed in the following databases: Web Of Science, Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed), Scientific Electronic Library Online (SciELO), Scopus (Elsevier), and ACM Digital Library were used to search for studies. The search was conducted until February 2021. The choice of databases was based on a similar systematic review, which focused on the elderly25.

The search strategy included a combination of terms from the Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS). The search strings were organized based on the particularities of each database, using the Boolean indicators AND and OR.

2.4 Search Strategy

The search strategy was based on the PICO methodology. For population (P) the following descriptors were included: hypertensive, hypertension, prehypertension, prehypertensions, pre-hypertension, “pre hypertension”, pre-hypertensions, “blood pressure high”, “blood pressures high”, “high blood pressure” and “high blood pressures”; for intervention (I) the terms used were: m-health, “mobile health”,mhealth, “tele health”, ehealth, “mobile health”, app, smartphone, “application mobile”, “applications mobile”, “mobile application”, “mobile apps”, “app mobile”, “apps mobile” and for the outcome (O), the following terms were used: exercise, exercises, “physical activities”, “physical activity”, “physical fitness”, “behavior sedentary”, “sedentary behaviors”, “sedentary behaviour”, “sedentary behavior”, “sedentary behaviours”, “sedentary lifestyle”, “lifestyle sedentary”, “physical inactivity”, “inactivity physical”, “sedentary time”, “sitting time” and “screen time”.

Selection Process

The study selection process was divided into three stages:

1) Identification: search string performed in the selected databases;

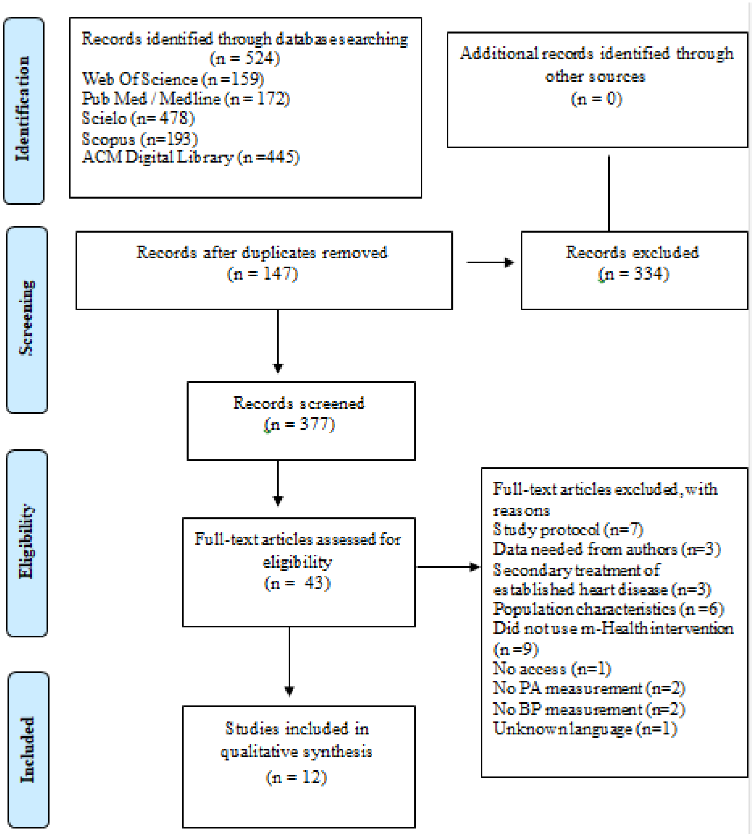
2) Screening: title and abstract of studies reviewed as a preliminary analysis to determine if they contained relevant information to the research questions;

3) Eligibility: full reading to verify the eligibility criteria, resulting in the studies included in this review.

A researcher performed the selection process and imported the studies to Mendeley (Mendeley Ltda), a reference management software. Two independent researchers (AOM and KG) reviewed the selected studies and assessed the eligibility criteria. Disagreements between both reviewers were discussed and resolved by consensus.

A PRISMA flow diagram of the literature search and selection is summarized in Figure 1. The search returned 1447 studies, of which 147 were duplicates. Through the review of titles and abstracts, were identified 43 studies that were relevant to this review. However, only 12 studies met all the inclusion criteria and underwent data extraction.

Figure 1: PRISMA flow diagram for studies screening.



Font: Adaptation of Prism diagram (Prisma, 2019).

3. Results

Twelve studies met the eligibility criteria and were included in this systematic review. A total of 1240 subjects allocated to m-Health intervention and 948 subjects to control groups were analyzed. Table 1 describes intervention and control group characteristics. Overall, studies were carried out between 2014 and 2020, in different countries: United States (5) Lv et al., 2017; Persell et al., 2020; Staffileno, Tangney, Fogg, 2018; Kim et al., 2016; Dorough et al., 2014), Canadá (1) (Petrella et al., 2014), Argentina, Peru, Guatemala (1) (Rubinstein et al., 2016), Japan (1) (Okura et al., 2016), Korea (1) (Cho et al., 2020), Australia (1) (Mainsbridge et al., 2018), Canada, England, United Kingdom (1) (Liu et al., 2020) and Asia (1) (Jahan et al., 2020). Sample sizes ranged from 12 to 287 individuals per group, with higher prevalence for women participants.

Intervention's characteristics and outcomes measurement are detailed in Table 2.

Table 1: Characterization of subjects in studies

Nº	Study	Subject characteristics (Intervention Group)	Subject characteristics (Control Group)
1	Lv et al. (2017)	N=149 (M/F); 62,2±9,5 years; hypertensive.	-
2	Petrella et al. (02014)	N=75 (M/F); 55,7±10,1 years; BP > 135mmhg, 85mmHg.	N=74 (M/F); 57,8±8,7 years; BP > 135mmhg, 85mmHg.
3	Persell et al. (2020)	N=144 (M/F); 59,6±12,4 years; BP > 135mmhg, 85mmHg.	N=153 (M/F); 58,3 ±13,2 years; BP > 135mmhg, 85mmHg
4	Rubinstein et al. (2016)	N=266 (M/F); 43,6±8,4 years; prehypertensive.	N=287 (M/F); 43,2±8,4 years; prehypertensive.
5	Stpafileno; Tangney; Fogg (2018)	N=14 (F); 35,3±8,1 years; prehypertensive.	N=12 (F); 35,1±1,6 years; prehypertensive.
6	Kim; Wineinger; Steinhubl (2016)	N=52 (M/F); 57,5±8,6 years; hypertensive.	N=43 (M/F); 57,7±8,7 years; hypertensive.
7	Okura et al. (2016)	N=69 (M/F); hypertensive.	-
8	Cho et al. (2020)	N=43 (M/F); 48,9±7,8 years (application group + personalized coaching); BP > 135mmhg, 85mmHg.	N=45 (M/F); 49,2±7,5 years (application group) N=41 (M/F); 49±7,9 years; BP > 135mmhg, 85mmHg.
9	Dorough et al. (2014)	N=12 (M/F); 54,3 years; prehypertensive.	N=15 (M/F); 54,3 years; prehypertensive.
10	Mainsbridge et al.(2018)	N=94 (M/F); 45,1±10,5 years: N=32 (normotensive), N=37 (prehypertensive); N=25 (hypertensive).	-
11	Liu et al. (2020)	N=100 (M/F); 57,2 years; hypertensive.	N=97 (M/F); 58 years; hypertensive.
12	Jahan et al. (2020)	N=209 (M/F); 46,4±8,3 years; hypertensive.	N=211 (M/F); 47,8±8,6 years; hypertensive.

M=male, F=female, BP= blood pressure. Source: Authors.

Table 2: Intervention's characteristics and outcomes of included studies in pre-hypertensive and hypertensive patients.

Study Identification Number	Duration of intervention			m-Health Features and Functionalities								BP measurement		PA/SB measure ment		↓ BP		↑ PA		↓ SB		Health care professionals				
	≤3 months	5 – 6 months	≥ 12 months	Reminders	Chat	Text Messages	Feedbacks/ Goals	PA ↑ Alert	Health Information	Data Visualization	Phone Calls	S baseline and post-intervention assessment	Values imported systematically	Subjective (self-reported)	Objective	Yes	No	Yes	No	Yes	No	Nurse	Pharmacist	Nutritionist	Community Health Worker	Exercise Specialist
1		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓				✓	✓	✓		
2			✓	✓			✓	✓				✓	✓	✓	✓	✓		✓								✓
3		✓		✓	✓		✓	✓	✓	✓			✓	✓	✓		✓		✓							
4			✓			✓	✓		✓		✓	✓		✓			✓		✓					✓		
5	✓				✓		✓		✓			✓		✓	✓		✓	✓								
6		✓		✓	✓				✓			✓	✓	✓		✓			✓			✓				
7			✓									✓	✓		✓	✓ *		✓								
8		✓				✓	✓		✓			✓		✓			✓		✓							
9	✓						✓		✓	✓					✓	✓		✓						✓		
10			✓	✓					✓			✓			✓	✓		-	-	✓						
11			✓		✓	✓			✓			✓			✓	✓		✓				✓	✓	✓		✓
12		✓				✓			✓			✓		✓		✓		✓							✓	

✓* only SBP change. BP= blood pressure; PA= physical activity; SB= sedentary behavior. Source: Authors.

Intervention duration between included studies was 2,5 months (n=1) (Dorough et al., 2014), 3 months (n=1) (Staffileno; Tangney; Fogg, 2018), 5 months (n=1) (Jahan et al., 2020), 6 months (n=4) (Cho et al., 2020; Kim et al., 2016; Lv et al., 2017; Persell et al., 2020), 12 months (n=4) (Liu et al., 2020; Mainsbridge et al., 2018; Okura et al., 2016; Rubinstein et al., 2016) and 13 months (n=1) (Petrella et al., 2014). The sample was hypertensive patients (n=5) (Lv et al., 2017; Kim; Wineinger; Steinhubl, 2016; Okura et al., 2016; Mainsbridge et al., 2018; Jahan et al., 2020), prehypertensive (n=3) (Rubinstein et al., 2016; Staffileno et al., 2018; Dorough et al., 2014), and both pre-hypertensive and hypertensive (n=4) (Petrella et al., 2014; Persell et al, 2020; Cho et al., 2020; Mainsbridge et al, 2018). Of the 12 studies included in this review, most (n=7) reported the interventions were monitored by health professionals, such as nurses, pharmacists, nutritionists, community health workers, and exercise specialists.

Regarding to interventions, different outcomes related to the m-Health functionality were observed, with a predominance of change in BP levels (n=7) (Lv et al., 2017; Kim et al., 2016; Dorough et al., 2014; Petrella et al., 2014; Mainsbrifge et al., 2018; Liu et al., 2020; Jahan et al., 2020) and another for change in SBP (n=1) (Okura et al., 2016). Most of included studies (n=8) showed positive results following a m-Health intervention to reduce SB and increase PA level among pre-hypertensive and hypertensive patients. Regarding to the method used among studies to measure PA and SB, some of them used subjective, self-reported and validated tools (Lv et al., 2017; Staffileno; Tangney; Fogg, 2018; Kim; Wineinger; Steinhubl, 2016; Petrella et al., 2014; Rubinstein et al., 2016; Okura et al., 2016; Cho et al., 2020; Mainsbridge et al., 2018; Liu et al., 2020; Jahan et al., 2020) and others assessed these outcomes using pedometer and/or smartphone sensors (Lv et al., 2017; Persell et al., 2020; Petrella et al., 2014; Okura et al., 2016; Cho et al., 2020).

Overall, m-Health interventions included different functionalities to measure PA levels and BP. In addition, applications including chat directly the research team, text message with tips to have a healthy lifestyle and informative handouts. Others studies also included feedbacks and users could also check their data and receiving alerts if they AF and/or BP were not meeting the goals (Table 2).

4. Discussion

4.1 Effects of using m-Health applications on PA and SB:

Of the 12 studies included in this review, 8 showed positive benefits of use m-Health interventions to reduce SB and increase PA levels. Of these 8 studies, 5 had informative material with content about patient care and health information, and another 5 were monitored by a health care professional.

Our findings showed that the duration of the intervention might not be determinant for its effectiveness, since studies with different durations had similar results. This finding was also found in a systematic review evaluating m-Health effects on SB, PA, and physical fitness in elderly (Yerrakalva et al., 2019). The authors identified that interventions with m-Health applications may be associated with SB reduction (SMD = −0.49), increases in PA (506 steps/day) and fitness (SMD = 0.31) in interventions lasting 3 months or less, and increases in PA (753 steps/day) after 6 months or more of m-Health intervention.

This review also highlights the variety of features and functionalities. All interventions were composed by a combination of features. The most common were feedbacks/goals and health information. The presence of these features corroborates with a previous study (Alessa et al., 2018), demonstrating that most m-Health applications included basic educational information about how healthy lifestyle habits can encourage an increase in PA and reduction in BP. As feedback functionality, the authors highlight the use of feedback, either through self-care messages and notifications or through the representation of data in different color codes to inform the user if the measurements diverged from the mean. In addition, it was shown that applications with combination of features are potentially more effective (Alessa et al., 2019).

Although included studies have evaluated PA and SB through objective and subjective tools, similar results between them were observed. From 4 studies that did not show an increase in PA level, 3 of them had only subjective assessments, using self-report instruments (Kim et al., 2016; Rubinstein et al., 2016; Cho et al., 2020). Only one study (Perssel et al., 2020) objectively accessed PA and also not identified any changes in PA level. Thus, the authors used a smartphone motion detector to monitor daily movements, in which the data had to be imported into the application by the user. In this application, users could enter their PA manually but were instructed to consider at least moderate activities, without considering daily life movement activities, an important indicator of sedentary behavior. It is important to highlight that applications that are user's dependent are limited regarding to reliability and higher chance to lost information in case of the user does not import the data.

Only one study directly assessed SB (Mainsbridge et al., 2018). The authors proposed an assessment of the possible health effects associated with long sitting time, with strategies for taking short PA breaks at work environment. Every 45 minutes a visual prompt appeared on the subject's screen, as reminder to break the sedentary time with 10 minutes of light PA. According to the authors, SB breaking SB with short bouts of light PA was effective in reducing blood pressure in prehypertensive and hypertensive individuals.

Petrella et al. (2014) also indirectly addressed SB in the intervention. The authors encouraged the participants to have small moments of movement and practice activities with low intensity during the day, lasting at least 10 minutes. The results showed an improvement in PA and a decrease in blood pressure levels. This finding indicates that for those who are suffering or at risk for cardiovascular disease but are unable or unwilling to participate in the exercise to meet the recommendations, regular low-intensity movements may become a viable alternative. Although Cho et al. (2020) and Kim et al. (2016) used a questionnaire to assess and monitor this issue, they did not address it in their discussions. Nevertheless, the deleterious effects of SB on the individual's health, in different age groups, have already been proven in the literature (Biswas et al., 2015; Carson et al., 2016; Ekelund et al., 2016).

From this perspective, the evidence shows that reducing SB can decrease the risk of all-cause mortality, cardiovascular mortality, cancer mortality, and incidence of cardiovascular disease (Who, 2020). Additionally, the impact of SB on cardiovascular mortality is also associated with the daily volume of moderate to vigorous PA (MVPA), since the individual who performs little MVPA plus the time spent in a sitting position has a significant impact on CV2 mortality (Ekelund et al., 2016).

4.2 Effects of using m-Health applications on BP:

The benefits of being regularly active for the prevention and treatment of AH are well documented (Mazón et al., 2019). Moreover, according to Who (2020) recommendation adults individuals should engage in at least 150-300 minutes of moderate-intensity physical exercise or at least 75-150 minutes of vigorous-intensity PA for substantial health benefits. However, to have these benefits from PA, avoid SB is also important.

Thus, lifestyle changes in patients diagnosed with prehypertension and hypertension are extremely necessary, as projections show that prehypertensive individuals without healthy habits have a 90% chance of being diagnosed with AH at 55 years of age (Franklin et al., 2011).

Four studies included in this review did not observed BP reduction (Persell et al., 2020; Staffileno et al., 2018; Dorough et al., 2014; Rubinstein et al., 2016) and 3 of them also not found higher levels of PA following intervention (Persell et al., 2020; Dorough et al., 2014; Rubinstein et al., 2016). Although Okura's (2016) study showed an increase in PA, the values were still below those recommended by the current PA guidelines for substantial health benefits (Who, 2020), which may have influenced no significative changes in BP. Additionally, PA levels below those recommended by the guidelines were also observed in another study, which identified SBP reduction (Stefilling et al., 2018). In comparison, individuals who met the recommendations by Who (2020) had decreased blood pressure values (Lv et al., 2020; Dorough et al., 2014; Petrella et al., 2014), which confirms the importance of practicing the minimum PA recommended by the guidelines to improve cardiovascular outcomes.

In pre-hypertensive women, Staffileno et al. (2018) demonstrated BP maintenance and increase in PA following intervention. Moreover, the intervention included a functionality to encouraged participants to decrease their SB in daily live activities, through some key tips such as walking instead of driving, using the stairs instead of waiting for the elevator, and getting up to move. These findings can be considered as positive results, as the increase in daily PA tends to contribute to a better BP control, which can be explained by simple but substantial lifestyle changes[32].

Another prospective study adds that 60% of individuals with prehypertension developed hypertension within four years when there were no healthy habits. Healthy habits include any activities or behaviors that can benefit the individual's well-being, such as good nutrition, stress control, and regular PA practice (Debon et al., 2015). This evidence indicates that changes in the lifestyle of the women evaluated in the study might have contributed to their health outcomes so that they have less chance of developing AH in the future.

In individuals diagnosed with AH, being physically active is also important to BP reduction. Aerobic exercises (90 to 150 minutes per week) of moderate-intensity (65% to 75% of the reserve heart rate), such as walking, can result in a reduction in SBP between -5 to -8 mmHg (Bakris et al., 2019; Perrier-Melo et al., 2020). Furthermore, there are reductions after resistance training about -4mmHg and -2mmHg in hypertensive and normotensive individuals, respectively (Bakris et al., 2019). In vigorous aerobic exercise (80% to 85% of the reserve heart rate) the reductions in BP values in hypertensive patients might reach -10.1mmHg for SBP and -12.3mmHg for DBP, following 24h of monitoring (Dos Santos et el., 2015).

Cho et al. (2020) also did not observe any BP changes. The application was composed by a functionality were the patient entered exercise duration and intensity, which allow the calculation of calories expended in each activity. Participants received guidance through personalized coaching messages three times a week. Conversely, similar studies with telemonitored guidance (Lv et al., 2017; Petrella et al., 2014; Kim et al., 2016; Douough et al., 2014; Mainsbridge et al., 2018; Liu et al., 2020; Jahan et al., 2020) with free access to interact with health professionals showed improvement in BP rates.

Interventions with mobile health applications designed to improve lifestyle of patients diagnosed with chronic diseases, such as AH, suggest that lifestyle changes are promotes improvements in patient's clinical outcomes when users are monitored by health professionals with a multidisciplinary team. This monitoring and follow-up guarantee better data reliability and greater adherence to treatment during the m-Health intervention[16]. Furthermore, the active support of the professional team is essential when using m-Health technology to ensure better outcomes for patients with AH.

This systematic review has some limitations. The applications used in the studies have different m-Health functionalities, with large variety and range of combinations, which can make it difficult to attribute the positive effects to a specific functionalities. The different duration of interventions may also be a limiting factor. Furthermore, few studies that included the assessment of SB were found.

The findings of this review show that systematic self-management can motivate individuals to be more engaged and committed to their health and well-being, as long as they have the support of health professionals. Currently, this topic has been little explored for this population. Therefore, SB must also be thoroughly investigated to control possible cardiometabolic events, stimulating the reduction of these behaviors with the support of m-Health.

5. Conclusion

Based on the results presented in this systematic review, most studies showed favorable results with the use of m-Health as a motivator to increase PA level and to reduce SB. In addition, this review identified that the increase in PA and decrease in SB might be an important factor to decrease BP in hypertensive subjects.

Individuals who practiced the minimum regular PA recommended by current PA and exercise guidelines had benefits in lowering blood pressure values, reducing health risks. However, few studies investigate the relationship between SB and m-

Health. Therefore, more studies are needed to assess SB, since the literature shows that m-Health applications are a feasible strategy to encourage and promote increase in PA and SB reduction, such as recommended by the PA guidelines to improve several cardiometabolic outcomes.

Furthermore, healthcare professionals should not only focus on adopting and initiating innovative risk reduction strategies but also on providing long-term maintenance of a healthy lifestyle, as the studies included in this systematic review showed a promising trend in BP reduction that can be achieved with the use of technology.

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