Review

Wearable Devices for Supporting Chronic Disease Self-Management: Scoping Review

Marie-Pierre Gagnon[1,2], PhD; Steven Ouellet[1], PhD; Eugène Attisso[1], MSc, MD; Wilfried Supper[1], PhD; Samira Amil[2,3], MSc, MD; Caroline Rhéaume[2,4,5], MD, PhD; Jean-Sébastien Paquette[2,4], MD; Christian Chabot[6]; Marie-Claude Laferrière[7], MSc, MSI; Maxime Sasseville[1,2], RN, PhD

[1]Faculty of Nursing Sciences, Université Laval, Québec, QC, Canada
[2]VITAM Research Center on Sustainable Health, Québec, QC, Canada
[3]School of Nutrition, Université Laval, Québec, QC, Canada
[4]Department of Family Medicine and Emergency Medicine, Faculty of Medicine, Université Laval, Québec, QC, Canada
[5]Research Center of Quebec Heart and Lungs Institute, Québec, QC, Canada
[6]Patient Partner, VITAM Research Center on Sustainable Health, Québec, QC, Canada
[7]Library, Université Laval, Québec, QC, Canada

Corresponding Author:
Marie-Pierre Gagnon, PhD
Faculty of Nursing Sciences
Université Laval
1050 Av. de la Médecine
Québec, QC, G1V 0A6
Canada
Phone: 1 418 656 2131 ext 407576
Email: marie-pierre.gagnon@fsi.ulaval.ca

Abstract

Background: People with chronic diseases can benefit from wearable devices in managing their health and encouraging healthy lifestyle habits. Wearables such as activity trackers or blood glucose monitoring devices can lead to positive health impacts, including improved physical activity adherence or better management of type 2 diabetes. Few literature reviews have focused on the intersection of various chronic diseases, the wearable devices used, and the outcomes evaluated in intervention studies, particularly in the context of primary health care.

Objective: This study aims to identify and describe (1) the chronic diseases represented in intervention studies, (2) the types or combinations of wearables used, and (3) the health or health care outcomes assessed and measured.

Methods: We conducted a scoping review following the Joanna Briggs Institute guidelines, searching the MEDLINE and Web of Science databases for studies published between 2012 and 2022. Pairs of reviewers independently screened titles and abstracts, applied the selection criteria, and performed full-text screening. We included interventions using wearables that automatically collected and transmitted data to adult populations with at least one chronic disease. We excluded studies with participants with only a predisposition to develop a chronic disease, hospitalized patients, patients with acute diseases, patients with active cancer, and cancer survivors. We included randomized controlled trials and cohort, pretest-posttest, observational, mixed methods, and qualitative studies.

Results: After the removal of 1987 duplicates, we screened 4540 titles and abstracts. Of the remaining 304 articles after exclusions, we excluded 215 (70.7%) full texts and included 89 (29.3%). Of these 89 texts, 10 (11%) were related to the same interventions as those in the included studies, resulting in 79 studies being included. We structured the results according to chronic disease clusters: (1) diabetes, (2) heart failure, (3) other cardiovascular conditions, (4) hypertension, (5) multimorbidity and other combinations of chronic conditions, (6) chronic obstructive pulmonary disease, (7) chronic pain, (8) musculoskeletal conditions, and (9) asthma. Diabetes was the most frequent health condition (18/79, 23% of the studies), and wearable activity trackers were the most used (42/79, 53% of the studies). In the 79 included studies, 74 clinical, 73 behavioral, 36 patient technology experience, 28 health care system, and 25 holistic or biopsychosocial outcomes were reported.

Conclusions: This scoping review provides an overview of the wearable devices used in chronic disease self-management intervention studies, revealing disparities in both the range of chronic diseases studied and the variety of wearable devices used.

These findings offer researchers valuable insights to further explore health care outcomes, validate the impact of concomitant device use, and expand their use to other chronic diseases.

Trial Registration: Open Science Framework Registries (OSF) s4wfm; https://osf.io/s4wfm

(Interact J Med Res 2024;13:e55925) doi: 10.2196/55925

KEYWORDS

chronic diseases; self-care; self-management; empowerment; mobile health; mHealth; wearable; devices; scoping; review; mobile phone; PRISMA

Introduction

Background

Noncommunicable diseases, commonly referred to as chronic diseases, are the leading cause of death worldwide, responsible for 41 million deaths annually and accounting for 74% of global mortality [1]. Aging populations, combined with unhealthy lifestyles such as poor diet and sedentary habits, contribute to a significant rise in chronic disease risk factors, including hypertension, hyperglycemia, and hyperlipidemia [1]. These diseases are characterized by their long-term nature, slow progression, and need for continuous care and self-management [2]. Most patients with a chronic disease in primary care have at least one additional chronic condition, making multimorbidity (defined as 2 concomitant chronic diseases) a common challenge that requires integrated, patient-centered care approaches to reduce the treatment burden [3].

Self-management is a key element of the care plan, and capturing meaningful information to empower individuals with chronic diseases is essential. Technological advancements have paved the way for wearable electronic devices and sensors that empower individuals to manage their health conditions more independently [4,5]. These innovations support the adherence to disease-related recommendations, such as medication regimens and symptom monitoring, by facilitating real-time monitoring and data collection. Wearable devices operate as data collection tools, transmitting information to software applications for analysis and delivering actionable health updates or notifications [6]. Key features of these devices include (1) automatic data collection (eg, blood glucose [BG], blood pressure [BP], physical activity, and heart rate); (2) direct transmission of data to the patient and, in some cases, their primary health care providers; and (3) availability of data across multiple platforms (eg, smartwatches, smartphones, and monitors). These systems offer real-time feedback either automatically or via clinician intervention, promoting sustained patient engagement with recommended health behaviors [4-6].

This potential for patient empowerment using wearables is observed in several reviews that report positive effects on clinical outcomes, such as glycemic control, and behavioral outcomes, such as symptom self-management [7-15]. Systematic reviews have explored the efficacy of wearables in managing diabetes, especially in relation to glycemic control [8-15]. BG monitoring devices, a common wearable for diabetes management, exemplify the utility of these technologies in facilitating behavior change and adherence to treatment protocols [8-15]. Numerous literature reviews have explored the use of wearable technologies in chronic disease management focusing on specific devices and health outcomes. Existing literature reviews are focused on specific wearable technologies, such as activity trackers [16-20] or BG monitors [8,9,11], or on self-management within particular chronic disease populations, including patients with diabetes [8-15,21], cardiovascular diseases [22,23], and cancer [7] and cancer survivors [17], as well as populations at risk of chronic diseases [19,24].

Several reviews have emphasized the impact of wearables on specific health outcomes, such as increased physical activity [16,17,19,20]. While these focused reviews offer valuable insights, they often do not capture the broader implications of wearable technology across multiple chronic conditions and diverse health outcomes. Despite the growing body of research, few comprehensive reviews have examined the intersection of various chronic diseases, wearable devices, and the range of health outcomes assessed in intervention studies. A systematic review identified a gap in understanding how wearables influence health outcomes in chronic diseases despite their potential for enhancing self-management [25]. To address this gap, Mattison et al [25] conducted a comprehensive review across multiple chronic diseases and outcome measures, highlighting the importance of such an analysis particularly in the context of primary health care.

Building on this work, our review adopted broad objectives aiming to provide an overview of the role of wearables in chronic disease management considering the clinical realities of the variety of devices used and the high prevalence of multimorbidity. A comprehensive analysis of wearable devices across various chronic diseases and health outcomes is essential for future research and patient-centered interventions in primary care settings that will reduce the treatment burden.

Objectives

The objectives of this scoping review were to identify and describe (1) the chronic diseases represented in intervention studies, (2) the types or combination of wearables used, and (3) the health or health care outcomes assessed and measured. This scoping review uniquely presents a comprehensive overview of the populations of patients with chronic diseases involved, the wearable devices used, and the specific outcomes targeted in intervention studies.

Methods

Overview

We conducted a scoping review informed by the Joanna Briggs Institute guidelines [26] and reported our results based on the

PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist [27]. We registered the review protocol in the Open Science Framework Registries [28]. We followed the population, intervention, comparator, and outcome framework [29] in establishing the study selection criteria (Textbox 1).

Textbox 1. Population, intervention, comparator, outcome, time frame, and study design framework elements [29].

Inclusion criteria

- Population: adult populations (aged ≥18 years) with chronic diseases (diseases characterized by their long-term nature, slow progression, and need for continuous care [2]).
- Intervention: interventions using wearable devices or smart health devices, such as connected weighing scales, that automatically collect and transmit biological or behavioral data to patients
- Comparator: usual care (without a wearable device)
- Outcomes: clinical, behavioral, patient experience with technology, holistic or biopsychosocial, and health care system outcomes
- Time frame and study design: between 2012 and 2022; randomized controlled trials, quasi-randomized controlled trials, prospective cohort studies, pretest-posttest studies, observational studies, mixed methods studies, and qualitative studies; published in English or French

Exclusion criteria

- Population: participants aged <18 years; patients with acute diseases; hospitalized patients; patients with active cancer and cancer survivors; participants with only a predisposition to develop a chronic disease, such as obesity, prediabetes, and prehypertension (without a diagnosis of dyslipidemia or another chronic disease)
- Intervention: hospital inpatient setting; no automatic data collection or transmission by the device, manual device, or survey instrument; data transmission only to caregivers or researchers (not to patients); studies only involving glucose monitoring devices and only measuring glucose levels as an outcome; automated insulin delivery system, also known as “closed loop” control system
- Comparator: not applicable
- Outcomes: Outcomes not related to chronic diseases; studies only addressing development or validation outcomes
- Time frame and study design: reviews, surveys, quantitative descriptive studies, metrology or diagnostic studies, protocols or ongoing studies, and conference papers

We included interventions involving at least one wearable device that automatically collected and transmitted data to adult populations with at least one chronic disease in a primary health care setting. The term “wearables” refers to all devices that collect patient data by directly capturing physiological signals, including connected weighing scales, electronic medication pillboxes, and ingestible sensors. Chronic diseases are defined as health conditions that are likely permanent and can be managed in primary health care settings. We excluded studies involving participants who only had a predisposition to develop chronic diseases, hospitalized patients, individuals with acute diseases, patients with active cancer, and cancer survivors.

Our review included randomized controlled trials (RCTs), cohort studies, pretest-posttest studies, observational studies, mixed methods studies, and qualitative studies published between 2012 and 2022. We excluded reviews, surveys, quantitative descriptive studies, metrology or diagnostic studies, protocols or ongoing studies, and conference papers. Moreover, we modified our published protocol [28] to exclude studies focused solely on the efficacy of connected glucometers that only measure glucose levels as there is already a strong evidence base on this topic [8-15].

Search Strategy

We (MPG and MS) developed search strategies in the MEDLINE (Ovid) and Web of Science (Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index, and Emerging Sources Citation Index) databases with an experienced librarian (MCL) to identify sources published between January 1, 2012, and June 30, 2022. The search strategies can be found in Multimedia Appendix 1.

Data Collection

We imported all references on June 30, 2022, to the web-based collaborative tool Covidence (Veritas Health Innovation) [30] and removed duplicates manually and using the automated function in Covidence before screening. We conducted a calibration exercise with the reviewers (Victoria Bureau Lagarde, EA, WS, SO, Rouwayda Elouni, and SA) and 2 senior researchers (MPG and MS) using a sample of 10 sources to ensure consistency in the application of the inclusion and exclusion criteria before the full screening process. At the first *title and abstract* screening phase, 8 reviewers (Victoria Bureau Lagarde, EA, WS, SO, MPG, MS, Rouwayda Elouni, and SA) independently assessed the titles and abstracts of the sources by applying the inclusion and exclusion criteria. All titles and abstracts underwent dual screening. Discrepancies in decisions were resolved through team consensus. At the *full-text review* stage, we searched and obtained all missing full texts of the selected references and imported them into Covidence. We conducted another calibration exercise with 10 full texts; 7 reviewers (SO, WS, MS, MPG, Victoria Bureau Lagarde, SA, and EA) independently applied the same selection criteria, and all exclusion motives were recorded in Covidence. All full texts underwent dual screening, and any discrepancies were also resolved through team consensus. From the included texts to extract, we tagged those related to the same studies and combined them for extraction. We also performed backward hand searching [31] for relevant articles in the bibliographies of the included studies and added them to Covidence for screening and extraction.

Data Extraction

Following the Joanna Briggs Institute recommendations [32], we developed a grid to extract relevant data from the included studies. We tested this grid in a meeting with reviewers (SO, WS, and EA) and 2 senior researchers (MPG and MS). The data extraction of each included study was performed once by 3 different reviewers (SO, WS, and EA) and validated by at least one senior researcher (MPG or MS). In Covidence, we extracted general information (eg, title of the paper, year of publication, lead author, country, and potential author conflicts of interest), methods (eg, RCT, nonrandomized experimental study, cohort study, pretest-posttest study, mixed methods study, qualitative research, or economic evaluation), intervention data (duration of the intervention and follow-up), setting data (where patients were sourced from), participant data (eg, target population, chronic disease or chronic diseases, inclusion and exclusion criteria, sampling methods, recruitment methods, and methods of allocation to the intervention group), total number of participants included in the analysis sampling (at the end of the study), participant baseline characteristics, process of the intervention (eg, wearable devices, intervention administration, type of blinding, comparator administration, and control group description), all outcomes measured and how they were measured, and intervention effects or results.

Quality Assessment

We imported the assessment questions from the Mixed Methods Appraisal Tool (MMAT) [33] into Covidence. According to the MMAT, each study is assigned a score that ranges from 0 to 5 stars, with 5 stars signifying the highest quality and reflecting the rigor of the study's methodology. The quality of each included study was assessed once by 3 different reviewers (SO, WS, and EA), with each study's score validated by at least one senior researcher (MPG or MS). Discrepancies were resolved through consensus among the reviewers and a senior researcher.

Data Synthesis

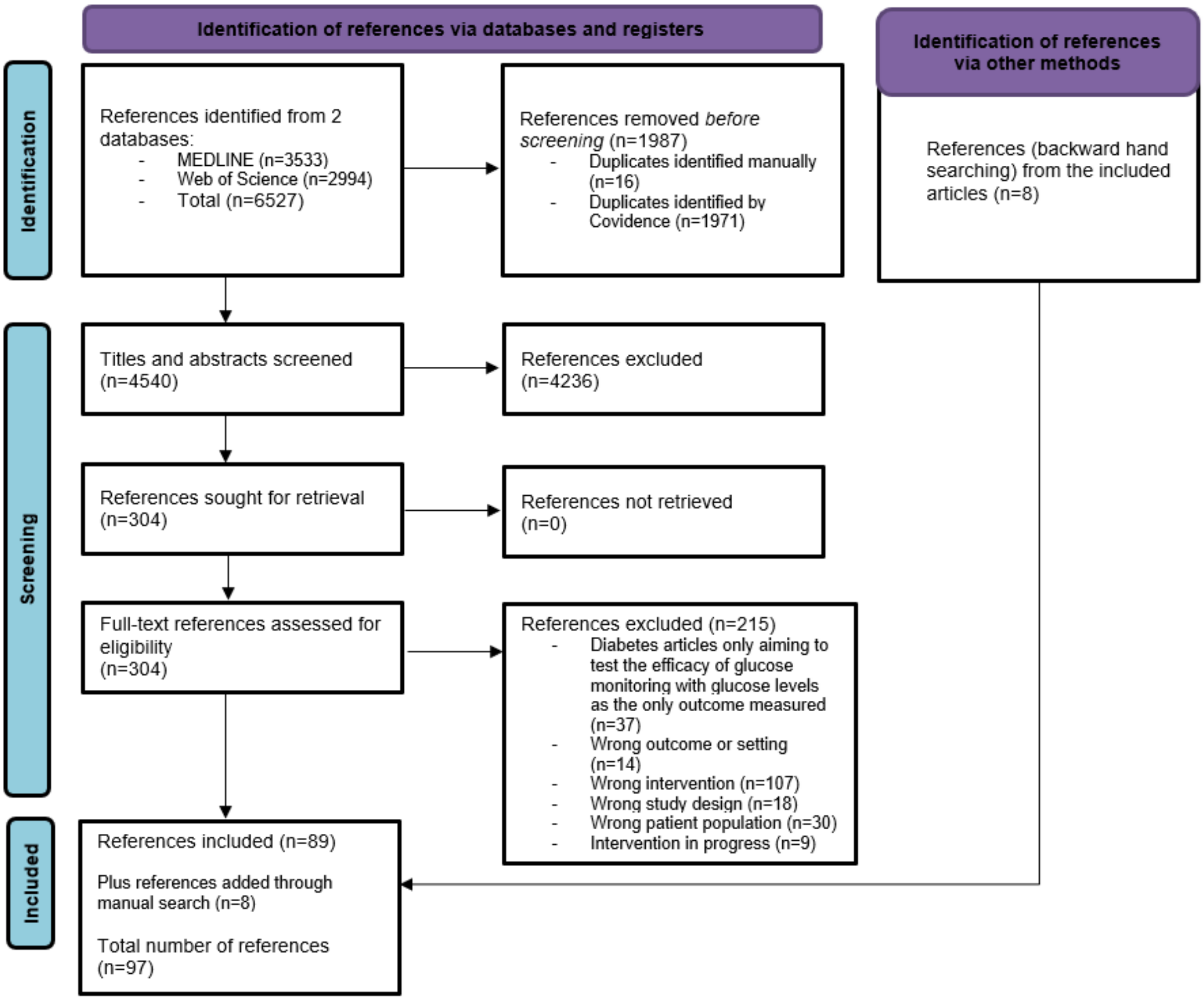
We structured our analysis according to chronic disease clusters; types and combination of wearable devices used; categories of health and health care system outcomes; and reported effects in terms of positive (reported in the studies as statistically significant), neutral, or negative. We synthesized data using tables explained through a narrative approach. We classified the outcomes reported in the intervention studies into 5 categories. The first category involves clinical outcomes, including indicators measured, such as glucose levels (glycated hemoglobin [HbA_{1c}]), BP, heart rate, weight, BMI, sleep time and quality, and pain intensity. The second category includes behavioral outcomes, such as physical activity levels, activation, motivation, self-efficacy, and disease-related knowledge. The third category involves patient technology experience, such as satisfaction, use, adherence, and engagement. The fourth category includes holistic and biopsychosocial outcomes, such as health status, health-related quality of life (QoL), physical well-being, anxiety, and depression. The fifth category involves the health care system, such as effectiveness, cost-effectiveness, admission or readmission to hospital, and emergency department visits.

Results

Overview

After the removal of 1987 duplicates (n=1971, 99.19% through Covidence and n=16, 0.81% manually), we screened 4540 titles and abstracts. Of the remaining 304 references after exclusion, we excluded 215 (70.7%) full texts and included 89 (29.3%). Of these 89 texts, we tagged 10 (11%) [34-43] related to same intervention studies and combined them for extraction, resulting in 79 included studies. We also hand searched and found 8 relevant articles [44-51] related to the included studies, totaling 97 references: 10 (10%) combined articles [34-43], 8 (8%) hand searched articles [44-51], and 79 (81%) main articles of the included studies [52-130]. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 flow diagram [131] of the study inclusion process can be consulted in Figure 1.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.



Characteristics of the Included Studies

Of the 79 studies included, some were published in 2 or even 3 scientific articles. As a result, the number of references (n=97) is higher than the number of studies (n=79). The 97 references [34-130] of the 79 included studies [52-130] can be found in Multimedia Appendix 2. Most studies (45/79, 57%) were conducted in North America (39/45, 87% in the United States and 6/45, 13% in Canada), followed by 9% (7/79) conducted only in the United Kingdom, 5% (4/79) only in the Republic of Korea, 5% (4/79) only in China (one of them was conducted in Hong Kong), 4% (3/79) only in the Netherlands (3/79, and 4% (3/79) only in Spain. 5% (4/79) of the studies were conducted in 2 or more countries, and 11% (9/79) were conducted in other single countries.

We used the MMAT [33] to assess the methodological quality of the included studies. No studies were excluded based on MMAT scores accordingly with the aim of our scoping review to identify and describe existing knowledge [26]. The MMAT scores of the 79 studies [52-130] can be consulted in Multimedia Appendix 3 [34-130]. A total of 58% (46/79) of the studies used an RCT design. Most RCTs (20/46, 43%) obtained a score of 4 stars, 26% (12/46) obtained a score of 3 stars, 24% (11/46) obtained a score of 2 stars, and 7% (3/46) obtained a score of 1 star. Per the study context, an RCT could not have 5 stars due to unfeasible patient blinding.

In Table 1, we structure our results according to 9 chronic disease clusters: diabetes (18/79, 23% of the studies), heart failure (13/79, 16% of the studies), other cardiovascular conditions (10/79, 13% of the studies), hypertension (8/79, 10% of the studies), multimorbidity and other combinations of chronic conditions (8/79, 10% of the studies), chronic obstructive pulmonary disease (COPD; 8/79, 10% of the studies), chronic pain (6/79, 8% of the studies), musculoskeletal conditions (6/79, 8% of the studies), and asthma (2/79, 3% of the studies).

We also structured our results according to the technologies used. The most frequent were wearable activity trackers (WATs; eg, a smartwatch or a device worn at the chest, waist built-in accelerometers, or connected pedometers). We found WATs in 53% (42/79) of the studies, BP monitors in 35% (28/79) of the studies, weighing scales in 25% (20/79) of the studies, BG monitors in 20% (16/79) of the studies, and electrocardiogram (ECG) monitors/devices in 10% (8/79) of the included studies. A total of 61% (48/79) of the intervention studies used a single wearable (or smart health) device, whereas 39% (31/79) of the studies used ≥2 devices.

In Table 2, we structure our results based on the types or combinations of wearables used. Table 2 provides an overview of the outcomes measured for each wearable or combination of wearables along with the reported effects. There are 2 points that require clarification. First, the study designs and sample sizes are not presented, but this information is available in Multimedia Appendix 3 [52-130]. Second, confounding factors such as multicomponent behavioral interventions are not considered. Full details of the sources used for Table 2 can also be found in Multimedia Appendix 3.

Table 1. Wearable devices per chronic disease category (N=79).

	WATs[a] (n=42), n (%)	BP[b] monitors (n=28), n (%)	WSs[c] (n=20), n (%)	BG[d] monitors (n=16), n (%)	ECG[e] monitors (n=8), n (%)	Electronic medication tray or pillbox (n=4), n (%)	SpO_2[f] devices (n=4), n (%)	Photoplethysmography signal (n=2), n (%)	Inhaler adapter, indoor air quality monitor, portable spirometer, and a small device attached to inhalers (n=2), n (%)	Other (an ingestible sensor and a wearable patch with an accelerometer; n=1), n (%)
Diabetes (n=18)	12 (67)	2 (11)	2 (11)	10 (56)	0 (0)	1 (6)	0 (0)	1 (6)	0 (0)	0 (0)
Heart failure (n=13)	3 (23)	11 (85)	12 (92)	2 (15)	2 (15)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other cardiovascular conditions (n=10)	5 (50)	5 (50)	3 (30)	0 (0)	6 (60)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hypertension (n=8)	2 (25)	5 (62)	0 (0)	0 (0)	0 (0)	3 (38)	0 (0)	0 (0)	0 (0)	1 (12)
Multimorbidity and other combinations of chronic conditions (n=8)	3 (38)	4 (50)	2 (25)	4 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
COPD[g] (n=8)	5 (62)	1 (12)	1 (12)	0 (0)	0 (0)	0 (0)	4 (50)	0 (0)	0 (0)	0 (0)
Chronic pain (n=6)	6 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Musculoskeletal conditions (n=6)	5 (83)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)
Asthma (n=2)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)
Total studies	42 (53)	28 (35)	20 (25)	16 (20)	8 (10)	4 (5)	4 (5)	2 (3)	2 (3)	1 (1)

[a]WAT: wearable activity tracker.
[b]BP: blood pressure.
[c]WS: weighing scale.
[d]BG: blood glucose.
[e]ECG: electrocardiogram.
[f]SpO_2: oxygen saturation.
[g]COPD: chronic obstructive pulmonary disease.

Table 2. Summary of wearables used, outcomes, and reported effects[a].

Wearables	Clinical outcomes (eg, HbA_{1c}[b] or glucose levels, BP[c], HR[d], weight, BMI, sleep time or quality, and pain)	Behavioral outcomes (eg, PA[e] levels, activation, motivation, self-efficacy, and knowledge)	Patient technology experience outcomes (eg, use or adherence, satisfaction, and engagement)	Holistic or biopsychosocial outcomes (eg, HRQoL[f] and physical well-being)	Health care system outcomes (eg, use, effectiveness, and cost-effectiveness)
WATs[g] only [52-82]	• 19 outcomes[h] (BP [56], sleep time and quality [56], disability and pain [58]; BP [62], weight [62], waist circumference [62], BMI [62], BP [63], frailty [65], weight [65], BMI [65], disability at 6 months [67], pain [70], cardiorespiratory endurance [71], BMI [71], functional status [78], weight [79], insomnia severity [82], and acceptance of sleep difficulties [82]) • 3 outcomes[i] (Pain [55], disability at 12 months [67], and KOOS[j], pain and symptoms [69]) • 11 outcomes[k] (severe COPD[l] exacerbations [53], glucose level [62,66,71,80], weight [66], BMI [66], waist circumference [66], muscle strength [71,80], and cholesterol level [71])	• 13 outcomes[h] (self-reported walking and PA goals [52], decreased depressive symptoms [56], PA [66], perceived walking habits [70], MVPA[m] [70], daily step count [72,75,76], work productivity at 3 months [74], fatigue [76], heart failure knowledge [78], motivation to engage in behaviors [78], and minutes of daily PA [81]) • 9 outcomes[i] (PA levels [53], engagement levels [55], work productivity [55], PA [58], adherence to exercise guidelines [61], session attendance of a behavioral lifestyle intervention [65], mean MVPA time [69], mean daily steps and sedentary time [69], and KOOS, activities, sport, and recreation function [69]) • 8 outcomes[k] (self-management [52], functional activity capacity [53], self-efficacy [57], improvement in functioning and walking [64], work productivity at 6 and 12 months [74], self-efficacy to maintain PA [75], PA [79], and general self-efficacy [81]) • 1 outcome[n] (step count [57])	• 13 outcomes[i] (patient experience or satisfaction with WATs [54,55,64-66,68,78,81], satisfaction with wearable motion sensors with straps [55], acceptability and usability [60], and acceptance of forms of recommendations [55,64,77]) • 2 outcomes[n] (some technical or dexterity-related difficulties [64], acceptability, and responses to [waist-worn] wearable vibration prompts [73])	• 5 outcomes[h] (intervention group pretest-posttest health status [59,60], QoL[o] [78], HRQoL [79], QoL and mental health score [81]) • 1 outcome[i] (KOOS and HRQoL [69]) • 5 outcomes[k] (HRQoL [53,72], health status changes between intervention and control groups [59,60], and QoL [65])	• 2 outcomes[h] [60,78] (unplanned hospital visits [60] and heart failure–related hospitalization [78]) • 6 outcomes[i] (unplanned hospital visits and admissions during a 6-month follow-up period [59], hospital admissions during follow-up [60], continuity of care [60], incremental cost-effectiveness ratio [59,60], and person-centeredness [60])
Only BG[p] monitoring devices (but with more outcomes measured than only glycemic control) [83-86]	• 4 outcomes[h] (glucose level [83,84,86] and cholesterol control [84]) • 2 outcomes[i] (weight [83] and glucose level [85]) • 5 outcomes[k] (weight [84,86], BP [83,84], and cardiovascular risk [84])	• 2 outcomes[h] (medication management [84] and knowledge about diabetes and BG testing [84]) • 2 outcomes[k] (skill and technique acquisition [85], depressive symptoms and lifestyle changes [85])	• 2 outcomes[h] [84] (overall treatment satisfaction [84], willingness to recommend treatment to others [84])	• 1 outcome[k] (HRQoL [85])	• 2 outcomes[h] (initiating web messages to providers, mostly nurse care managers [84], health service navigation self-management [85]) • 1 outcome[k] (health care use [84])
WATs and BG monitoring devices [87,88]	• 1 outcome[h] (glucose level [88])	• 1 outcome[h] (self-care activity scores [88]) • 1 outcome[i] (self-regulation behaviors [87])	—[q]	—	—

Wearables	Clinical outcomes (eg, HbA_{1c}[b] or glucose levels, BP[c], HR[d], weight, BMI, sleep time or quality, and pain)	Behavioral outcomes (eg, PA[e] levels, activation, motivation, self-efficacy, and knowledge)	Patient technology experience outcomes (eg, use or adherence, satisfaction, and engagement)	Holistic or biopsychosocial outcomes (eg, HRQoL[f] and physical well-being)	Health care system outcomes (eg, use, effectiveness, and cost-effectiveness)
WATs, BG monitoring devices, and connected WSs[r] [89,90]	• 1 outcome[i] (weight [90])	• 1 outcome[i] (reduction of dose of oral hypoglycemic agents or insulin [90]) • 2 outcomes[n] (changes in caloric intake over time [90], mean daily step count [90])	• 1 outcome[i] (patient experience and satisfaction [89])	—	—
BP monitoring devices only [91-94]	—	• 1 outcome[h] (self-efficacy [93]) • 1 outcome[i] (self-efficacy [92]) • 1 outcome[k] (hypertension knowledge and participants' perspectives on an mHealth[s]-based care model [91])	—	—	• 1 outcome[i] (all-cause 30-day readmissions [93]) • 1 outcome[k] (ED[t] visits [93])
WATs and BG and BP monitoring devices [95]	• 1 outcome[h] (VO_2max[u] [95]) • 2 outcomes[i] (weight [95], waist circumference [95])	• 2 outcomes[i] (PA [95] and adherence rates for self-monitoring [95])	• 1 outcome[i] (patient experience and satisfaction [95])	—	—
BG and BP monitoring devices and medication tray or pillbox devices [96]; BP monitoring devices and medication pillbox or tray devices [97-99]	• 4 outcomes[h] (glucose level [96], BP control [97,99], and resting BP [99]) • 1 outcome[i] (ambulatory BP [99])	• 2 outcomes[i] (medication adherence [97,99])	• 1 outcome[i] (patient experience and satisfaction [96])	—	—
BG and BP monitoring devices [100,101], WSs [102,103], and ECG[v] devices [104]	• 1 outcome[h] (BG and BP control [101]) • 2 outcomes[i] (weight, BP, BG, and symptoms reported by patients [102], BG, BP, and weight [103]) • 1 outcome[k] (body fat, BP, and BG [100])	• 1 outcome[h] (changes in medication adherence, general adherence to treatment, adherence to disease-specific activities, and diabetes and hypertension knowledge [101]) • 1 outcome[i] (health self-management [104])	• 1 outcome[i] (patient experience and satisfaction [102]) • 1 outcome[k] (patient experience and satisfaction [100])	—	• 1 outcome[k] (health care resource use [104])
Connected WSs only [105]	• 2 outcomes[i] (weight change [105], waist circumference, BP, and BG [105])	—	—	—	—

Wearables	Clinical outcomes (eg, HbA_{1c}[b] or glucose levels, BP[c], HR[d], weight, BMI, sleep time or quality, and pain)	Behavioral outcomes (eg, PA[e] levels, activation, motivation, self-efficacy, and knowledge)	Patient technology experience outcomes (eg, use or adherence, satisfaction, and engagement)	Holistic or biopsychosocial outcomes (eg, HRQoL[f] and physical well-being)	Health care system outcomes (eg, use, effectiveness, and cost-effectiveness)
BP monitoring devices and WSs [106-113]	• 1 outcome[i] (BNP[w] values [112])	• 1 outcome[h] (self-efficacy and self-care management [112]) • 4 outcomes[i] (self-efficacy and self-care management [107,108,113], daily monitoring after the intervention [108]) • 1 outcome[k] (the use of guideline-recommended medical therapy [110])	• 5 outcomes[i] (usability and adherence to devices [106,108,111], end-user experience [107], contribution to a sense of safety and security after hospital discharge [107]) • 1 outcome[m] (use of the devices [109])	• 1 outcome[h] (QoL [112]) • 2 outcomes[i] (QoL [107,113]) • 1 outcome[k] (physical well-being of participants [110])	• 2 outcomes[h] (30-day all-cause readmission after discharge [109], health service use [112]) • 3 outcomes[i] (unscheduled ED revisits, readmission to hospital, and overall length of hospitalization [107], health system cost-effectiveness, including cost reduction and hospital bed capacity [107], proximity and communication with health care team or physicians [113]) • 1 outcome[k] (hospital resource use [113]) • 1 outcome[n] (traditional communication and engagement with providers prevailed, delaying access to care [108])
ECG devices only [114,115]	• 2 outcomes[h] (detection of AF[x], flutter recurrence [114], and detection of AF or other atrial arrhythmias [115])	• 1 outcome[h] (two scales of the PCS[y]: Physical Functioning and Role Physical, and two scales of the MCS[z]: Vitality and Social Functioning [115])	• 1 outcome[i] [114] (monitor usage among patients with AF [114])	• 1 outcome[h] (two scales of the MCS: Role-Emotional and Mental Health [115]) • 1 outcome[k] (HRQoL in patients with AF [114])	—
WATs and ECG devices (a chest strap) [116]; WATs, ECG devices, and sleep trackers [117]	• 1 outcome[h] (the eGFR[aa] [117]) • 1 outcome[k] (body weight and BMI [117])	• 2 outcomes[h] (self-care management and confidence [116], self-efficacy and self-management [117]) • 2 outcomes[i] (medication adherence [116], number of steps [117])	—	• 1 outcome[i] [117] (QoL [117]) • 1 outcome[n] [116] (QoL [116])	—

Wearables	Clinical outcomes (eg, HbA_{1c}[b] or glucose levels, BP[c], HR[d], weight, BMI, sleep time or quality, and pain)	Behavioral outcomes (eg, PA[e] levels, activation, motivation, self-efficacy, and knowledge)	Patient technology experience outcomes (eg, use or adherence, satisfaction, and engagement)	Holistic or biopsychosocial outcomes (eg, HRQoL[f] and physical well-being)	Health care system outcomes (eg, use, effectiveness, and cost-effectiveness)
ECG devices, BP monitoring devices, and WSs (a small sensor worn on the patient's chest wall) [118]; ECG devices, BP monitoring devices, and WSs with [119,120] or without [121] WATs and sleep trackers	—	• 1 outcome[h] (lifestyle behavior [120]) • 1 outcome[i] (self-care management and confidence [118])	• 2 outcomes[i] (patient experience and satisfaction [118], adherence to mHealth program [121]) • 1 outcome[k] (patient experience and satisfaction [119])	• 1 outcome[k] (QoL [120])	• 1 outcome[i] (rehospitalization rates [118])
An ingestible sensor and a wearable patch that incorporates an accelerometer [122]	• 1 outcome[i] (BP [122])	—	• 1 outcome[i] (experiences with a digital health feedback system [122])	—	• 1 outcome[i] (patients' experiences with pharmacists [122])
COPD multicomponent systems (monitoring of SpO_2[ab]) [123-126]; SpO_2 device only [123]; inhaler adherence monitoring device+BG monitoring device [124]; SpO_2 device+BP device+WS [125]; SpO_2 device+WAT [126]	• 1 outcome[k] (symptom scores [125])	• 3 outcomes[h] (awareness level [123], self-efficacy [123], behavioral intention [123]) • 1 outcome[i] (self-management skills [125])	• 1 outcome[i] (continuous wearing of a vest may be stressful [124])	• 1 outcome[h] (between-group generic health status differences [126])	• 1 outcome[h] (median number of visits to practice nurses [126]) • 1 outcome[i] (median number of visits to general practitioners [126]) • 2 outcomes[k] (hospitalizations, ED visits, or clinic visits [125,126])
Asthma devices (an inhaler adapter, an indoor air quality monitor, a portable spirometer, and a fraction exhaled nitric oxide device [127]; a small electronic medication monitor attached to inhalers [128])	• 2 outcomes[h] (asthma control [127], exacerbations [127])	• 1 outcome[h] (inhaler use [ICS[ac] and SABAs[ad]] [128])	• 1 outcome[h] (technology acceptance [127])	• 1 outcome[h] (QoL [127])	—
Photoplethysmography signal devices [129,130]	• 3 outcomes[h] (difference in the ASDAS[ae] [130], total pain [130], VO_2max [130]) • 3 outcomes[i] (glucose level [129], weight [129], and BP [129])	• 1 outcome[h] (between-group frequency of difficulty feeling high motivation [130])	• 1 outcome[i] [129] (patient experience and satisfaction [129])	—	—

[a]The results presented in this table can be interpreted as follows. Can we significantly improve clinical, behavioral, technology experience, psychosocial, and health care system effects or results by using a specific wearable or a combination of wearables? Taking the first row as an example, we identified 31 intervention studies in which only wearable activity trackers were used. In these 31 interventions, we identified 19 clinical, 13 behavioral, 5 holistic or biopsychosocial, and 2 health system outcomes showing positive effects or results (reported as statistically significant in the studies).

[b]HbA_{1c}: glycated hemoglobin.

[c]BP: blood pressure.

[d]HR: heart rate.

[e]PA: physical activity.

[f]HRQoL: health-related quality of life.

[g]WAT: wearable activity tracker.

[h]Positive effect (identified as statistically significant).

[i]Neutral effect (positive effect but not identified as statistically significant).

[j]KOOS: Knee injury and Osteoarthritis Outcome Score.

[k]Neutral effect.

[l]COPD: chronic obstructive pulmonary disease.

[m]MVPA: moderate to vigorous PA.

[n]Negative effect.

[o]QoL: quality of life.

[p]BG: blood glucose.

[q]Not applicable.

[r]WS: weighing scale.

[s]mHealth: mobile health.

[t]ED: emergency department.

[u]VO_2max: volume of oxygen maximum.

[v]ECG: electrocardiogram.

[w]BNP: B-type natriuretic peptide.

[x]AF: atrial fibrillation.

[y]PCS: physical component summary.

[z]MCS: mental component summary.

[aa]eGFR: estimated glomerular filtration rate.

[ab]SpO_2: peripheral capillary oxygen saturation.

[ac]ICS: inhaled corticosteroids.

[ad]SABA: short-acting beta-agonist.

[ae]ASDAS: Ankylosing Spondylitis Disease Activity Score.

The most frequently reported clinical outcomes were BP control-related, in 23% (18/79) of studies [56,62,63,83,92, 93,95,97-101,103-105,112,122,129]. The other clinical outcomes most reported were weight or BMI changes in 13% (10/79) of studies. The most frequently reported behavioral outcomes were PA or lifestyle changes, including the number of steps and self-reported walking, in 27% (21/79) of studies [52,53,57,58,61,63-66,69,70,72,75, 76,78-81,90,95,117]. Other behavioral outcomes, such as self-efficacy (9/79, 11%) [53,57,75,81,92,93,107,117,123], and self-care management (6/79, 8%) [88,107,112,113,116,118], also appeared in a substantial number of studies. Adherence to treatment or recommendations (12/79, 15%) [61,65,78,94,95,97,99,101,106, 111,116,121] and engagement (6/79, 8%) [55,78,89, 108,113,115] are also frequently reported. Other commonly reported outcomes include satisfaction with technology (12/79, 15%) [55,64,66,68,75,78,81,84,96,100,102,118], and technology usability (6/79, 8%) [60,78,96,106,108,111]. QoL or health-related QoL are assessed in 19% (15/79) of studies [53,65,72,79,81,85,94,102,107,114-117,120,127], reflecting a broad focus on clinical, behavioral, technological experience, holistic, and biopsychosocial aspects.

In terms of positive results, BP control-related outcomes were reported as statistically significant in 8% (6/79) of studies [56,62,63, 93,97,98], and PA or lifestyle behavior changes in 10% (8/79) of studies [52,66,70,72,75,76,81,120]. Other behavioral outcomes, such as self-efficacy and self-care management enhancement, were reported as statistically significant in 5% (4/79) [112,116,117,123] of studies. Positive changes in weight or BMI were reported as statistically significant in 4% (3/79,) of studies [62,65,79] but demonstrated neutral or non-significant results in 9% (7/79) of studies [83,86,88,103,105,117,129]. Other outcomes, such as QoL or health-related QoL (8/79, 10%) [65,72,102,107,113,114, 117,120], technology usability (5/79, 6%) [60,96,106,108,111], and adherence to devices (4/79, 5%) [65,95,101,111], also demonstrated non-significant or neutral findings in those studies.

As shown in Table 3, we then counted the number of outcomes measured for each chronic disease cluster according to our 5 outcome categories. The results showed that clinical and behavioral outcomes were the most assessed and measured. Full details of the sources used for Table 3 are available in Multimedia Appendix 4 [52-130].

Table 3. Effects of outcomes measured for each chronic disease cluster across 5 outcome categories (N=79)[a].

Effect	Diabetes (n=18), n	Heart failure (n=13), n	Other cardiovascular conditions (n=10), n	Hypertension (n=8), n	Multimorbidity and other combinations of chronic conditions (n=8), n	COPD[b] (n=8), n	Chronic pain (n=6), n	Musculoskeletal conditions (n=6), n	Asthma (n=2), n	Total, n
Clinical (eg, HbA_{1c}[c]or glucose levels, BP[d], HR[e], weight, BMI, sleep time or quality, and pain)										
Positive effect (identified as statistically significant)	16	0	3	5	2	0	4	5	2	37
Neutral (positive effect but not identified as statistically significant)	8	2	0	2	3	0	2	1	0	18
Neutral	15	0	1	0	1	2	0	0	0	19
Negative	0	0	0	0	0	0	0	0	0	0
Behavioral (eg, physical activity levels, activation, motivation, self-efficacy, and knowledge)										
Positive effect (identified as statistically significant)	4	4	7	1	1	4	1	4	1	27
Neutral (positive effect but not identified as statistically significant)	5	7	2	2	1	2	3	4	0	32
Neutral	2	1	1	1	2	2	2	1	0	12
Negative	2	0	0	0	0	0	0	0	0	2
Patient technology experience (eg, use or adherence, satisfaction, and engagement)										
Positive effect (identified as statistically significant)	2	0	0	0	0	0	0	0	1	3
Neutral (positive effect but not identified as statistically significant)	8	8	3	1	2	0	5	0	0	27
Neutral	0	0	1	0	1	0	0	0	0	2
Negative	0	1	0	0	0	2	1	0	0	4
Holistic and biopsychosocial (eg, health-related quality of life or physical well-being)										
Positive effect (identified as statistically significant)	0	2	1	0	3	1	0	1	1	9
Neutral (positive effect but not identified as statistically significant)	0	2	1	0	0	0	1	1	0	5
Neutral	2	1	2	0	1	3	0	1	0	10
Negative	0	1	0	0	0	0	0	0	0	1
Health care system (eg, use, effectiveness, and cost-effectiveness)										

Effect	Diabetes (n=18), n	Heart failure (n=13), n	Other cardiovascular conditions (n=10), n	Hypertension (n=8), n	Multimorbidity and other combinations of chronic conditions (n=8), n	COPD[b] (n=8), n	Chronic pain (n=6), n	Musculoskeletal conditions (n=6), n	Asthma (n=2), n	Total, n
Positive effect (identified as statistically significant)	2	3	0	0	1	1	0	0	0	7
Neutral (positive effect but not identified as statistically significant)	0	4	1	1	4	1	0	2	0	13
Neutral	1	1	1	0	1	2	1	0	0	7
Negative	0	1	0	0	0	0	0	0	0	1
Total										
Positive effect (identified as statistically significant)	24	9	11	6	7	6	5	10	5	—[f]
Neutral (positive effect but not identified as statistically significant)	22	23	7	6	12	3	11	8	0	—
Neutral	20	3	6	1	6	9	3	2	0	—
Negative	2	3	0	0	0	2	1	0	0	—

[a]The results presented in this table can be interpreted as follows. Can we significantly improve clinical, behavioral, technology experience, psychosocial, and health care system effects or results by using one or more wearables? Taking the diabetes column as an example, 16 clinical, 4 behavioral, 2 patient experience, and 2 health care system outcomes showed positive results (reported as statistically significant in the included studies). There are 2 points that need to be clarified. First, the number of participants and the duration of the studies were not considered. Second, confounding factors such as multicomponent behavioral interventions were not considered either.

[b]COPD: chronic obstructive pulmonary disease.

[c]HbA_{1c}: glycated hemoglobin.

[d]BP: blood pressure.

[e]HR: heart rate.

[f]Not applicable.

The following sections present the outcomes assessed and measured, as well as the effects reported for each wearable or combination of wearables within each chronic disease cluster.

Diabetes

We identified 23% (18/79) of the studies in which participants with diabetes were recruited [54,62,65,66,68,71,80,83-90,95,96,129]. The complete table with details is available in Multimedia Appendix 4.

Participants with diabetes used a WAT in 67% (12/18) of the studies. We identified 22% (4/18) of the studies that included only a connected glucometer but measuring more outcomes than only glycemic or HbA_{1c} levels [83-86]. A total of 75% (3/4) of these studies reported statistically significant positive effects between groups on HbA_{1c} or glycemic control at 6 [83,86] and 12 months [84]. In the remaining study, HbA_{1c} levels decreased in all groups but did not differ between groups [85]. WATs were used in 67% (12/18) of all diabetes studies and in 86% (12/14) of diabetes studies that did not use a connected glucometer. With only using WAT without BG monitoring, no effects were found on glucose or HbA_{1c} levels [62,66,71,80].

Across all 23% (18/79) of the diabetes studies included, positive effects reported as statistically significant were found for 16 clinical (glucose or HbA_{1c} levels [83,84,86], cholesterol control [84], maximal oxygen consumption [95], frailty [65], weight [62,65], BMI [62,65,71], cardiorespiratory endurance [71], waist-to-hip ratio circumference [71], and BP [62]), 4 behavioral (physical activity [66], self-care activity scores [88], medication management [84], and knowledge about diabetes [84]), 2 patient technology experience (overall treatment satisfaction [84] and willingness to recommend to others [84]), and 2 health care system (initiating web-based messages to providers [84] and health service navigation self-management [85]) outcomes. No holistic or biopsychosocial outcomes showed effects. In total, 2 weak negative behavioral effects were found on a small single-group study of 9 participants in which changes in caloric intake and mean daily step count declined over the 12-week intervention [90].

Heart Failure

We identified 16% (13/79) of the studies in which participants with heart failure were recruited [61,78,102,106-113,116,118]. The complete table with details is available in Multimedia Appendix 4.

Most heart failure studies used connected weighing scales (12/13, 92%) and BP monitoring devices (11/13, 85%). WATs were used in 23% (3/13) of the studies [61,78,116]. Clinical outcomes were measured in 15% (2/13) of the studies [102,112], and both studies showed no effects. Positive effects reported as statistically significant were found for 4 behavioral (self-efficacy or self-care management [112,116], heart failure knowledge [78], and motivation to engage in behaviors [78]), 2 holistic or biopsychosocial (QoL [78,112]), and 3 health system (30-day all-cause readmission after discharge [109], health service use [112], and heart failure–related hospitalization [78]) outcomes. A total of 3 outcomes showed weak negative effects related to technology experience (ie, use of the devices [109]), holistic or biopsychosocial (ie, QoL related to wearing a chest strap [116]), and health care system (ie, delaying accessibility to care as traditional communication with providers prevailed [108]) outcomes.

Other Cardiovascular Conditions

We grouped 13% (10/79) of the studies in which participants with cardiovascular diseases such as chronic heart disease, coronary artery disease, atrial fibrillation or atrial flutter, poststroke control or cardiac rehabilitation, acute myocardial infarction, and any combination of heart failure and hypertension were recruited [75,76,92,93,114,115,117,119-121]. The complete table with details is available in Multimedia Appendix 4.

ECG devices were used in 60% (6/10) of the studies, WATs and BP monitors were used in 50% (5/10) of the studies, and connected weighing scales were used in 30% (3/10) of the studies. Positive effects reported as statistically significant were found for 3 clinical (detection of atrial fibrillation or atrial flutter recurrence [114], detection of other atrial arrhythmias [115], and slower decline in the estimated glomerular filtration rate [117]) outcomes in which ECG devices were involved. Positive effects reported as statistically significant were found for 6 behavioral (daily step count or walking time [75,76], fatigue [76], self-efficacy or self-management [93,117], physical functioning [115], and lifestyle behavior [120]) outcomes. Positive effects were found for 1 holistic or biopsychosocial outcome (mental health domain scores [115]). All other outcomes had weak positive or neutral effects.

Hypertension

We identified 10% (8/79) of the studies in which participants with hypertension were recruited [56,63,91,94,97-99,122]. The complete table with details is available in Multimedia Appendix 4.

A total of 62% (5/8) of the hypertension studies used BP monitors, 38% (3/8) used a connected medication tray or pillbox, and 25% (2/8) used WATs. Positive effects reported as statistically significant were found for 5 clinical (BP measures or control [56,63,97,99] and sleep time or quality [5]) and 1 behavioral (decreased depressive symptoms [56]) outcomes. No other patient technology experience, holistic and biopsychosocial, or health care system outcomes showed positive effects.

Multimorbidity and Other Combinations of Chronic Conditions

We identified 10% (8/79) of the studies that recruited participants with ≥2 chronic conditions [60,79,81,100,101,103-105]. The complete table with details is available in Multimedia Appendix 4.

A total of 50% (4/8) of the studies used BG and BP monitoring devices [100,101,103,104], 38% (3/8) used only WATs [60,79,81], 25% (2/8) used connected weighing scales [103,105], and 12% (1/8) used ECG devices [104]. Positive effects reported as statistically significant in the studies were found for 2 clinical (weight [79] and BG and BP [101]), 2 behavioral (minutes of daily physical activity [81] and hypertension knowledge [101]), 3 holistic or biopsychosocial (health status [60], health-related QoL [79], and QoL and mental health score [81]), and 1 health care system (unplanned hospital visits [60]) outcomes. The wearable devices used had only weak positive or neutral effects on patient technology experience outcomes.

Studies on COPD

We identified 10% (8/79) of the studies in which participants with COPD were recruited [53,57,72,73,123-126]. The complete table with details is available in Multimedia Appendix 4.

We identified a first group of 50% (4/8) of the studies comprising multicomponent systems in which oxygen saturation or inhaler adherence was monitored [123-126] and a second group of 50% (4/8) of the studies that used only WATs [53,57,72,73].

In the first group of 50% (4/8) of the studies, 1 clinical effect was measured and found out to be neutral (symptom scores [125]). However, positive effects reported as statistically significant were found for 3 behavioral (awareness level, self-efficacy, and behavioral intention [123]), 1 holistic or psychosocial (generic health status [126]), and 1 health care system (reduction of median number of visits to practice nurses [126]) outcomes. Negative effects were found for 1 patient technology experience outcome (stress related to continuously wearing a monitoring vest [126]).

In the second group of 50% (4/8) of the studies, which used only WATs, 1 clinical effect was measured and found out to be neutral (severe COPD exacerbations [53]). Positive effects reported as statistically significant were found for 1 behavioral outcome (daily step count [72]), whereas step count decreased over time in another study [57]. Another negative effect was reported for 1 patient technology experience outcome (low acceptability and responses to the waist-worn wearable vibration prompts [73]).

Chronic Pain

We identified 8% (6/79) of the studies in which participants with chronic pain were recruited [52,55,58,64,67,77]. The complete table with details is available in Multimedia Appendix 4.

Only WATs were used in the identified studies on chronic pain. Positive effects reported as statistically significant were found for 4 clinical outcomes (symptom score [58], disability [58], pain [58], and chronic back pain–related disability at 6 months [67]). Another positive effect was found for 1 behavioral outcome (self-reported walking and physical activity goals [52]). All other outcomes had neutral or weak and nonsignificant positive effects, and negative effects were found on 1 patient technology experience outcome (technical or dexterity-related difficulties [64]).

Musculoskeletal Conditions

We identified 8% (6/79) of the studies in which participants with osteoporosis, rheumatoid arthritis, systemic lupus erythematosus, or ankylosing spondylitis were recruited [59,69,70,74,82,130]. The complete table with details is available in Multimedia Appendix 4.

We identified 83% (5/6) of the studies on osteoporosis, rheumatoid arthritis, or systemic lupus erythematosus that all used WATs [59,69,70,74,82]. The remaining study recruited participants with ankylosing spondylitis, and their intervention used photoplethysmography signal technology [130]. Positive effects reported as statistically significant in this study were found for 3 clinical (Ankylosing Spondylitis Disease Activity Score [130]; total pain, fatigue, spinal pain, and morning stiffness intensity [130]; and maximal oxygen consumption back extensor endurance test and range of motion of cervical lateral flexion [130]) and 1 behavioral (frequency of difficulty with high motivation [130]) outcomes. Concerning the other 83% (5/6) of the studies, positive effects reported as statistically significant were found for 2 clinical (pain reduction [70] and Insomnia Severity Index score and acceptance of sleep difficulties [82]) and 3 behavioral (perceived walking habits [70], moderate to vigorous physical activity for participants with rheumatoid arthritis [70], and work productivity at the 3-month follow-up [74]) outcomes. Regarding the latter work productivity behavioral outcome, we noticed that the effects were no longer significant at the 6- and 12-month follow-ups [74].

Asthma

We identified 3% (2/79) of the studies in which participants with asthma were recruited [127,128]. The complete table with details is available in Multimedia Appendix 4. Positive effects reported as statistically significant were found for 2 clinical (asthma control [127] and asthma exacerbations [127]), 1 behavioral (inhaler use [128]), 1 patient technology experience (technology acceptance [127]), and 1 holistic or biopsychosocial (QoL [127]) outcomes. Health care system outcomes were not investigated.

Discussion

Principal Findings

This scoping review aimed to achieve 3 main objectives related to health intervention studies involving wearable devices. The primary strength of this review lies in our broad portrayal of interventions across multiple chronic diseases, various wearable devices, and distinct categories of health and health care outcomes, along with their reported effects (positive, neutral, or negative). We selected these broad objectives because, as other reviews have highlighted [24,25], providing a comprehensive overview of this topic is relevant for informing and shaping future research directions.

First, we identified and described clusters of chronic diseases that have been studied. We observed significant disparities—diabetes and heart failure have been extensively researched, whereas musculoskeletal conditions and asthma have been studied much less frequently despite showing promising results. We intentionally excluded studies that solely involved BG monitoring devices measuring BG levels as the only outcome given the existing evidence [8-15]. Nevertheless, diabetes emerged as the most represented chronic disease, appearing in 23% (18/79) of the studies, whereas only 3% (2/79) of the studies included participants with asthma.

Second, we identified and described the technologies used. WATs were commonly used either alone or in conjunction with other devices tailored to specific chronic conditions, such as BG monitors, BP devices, ECG devices, and connected weighing scales. There was notable variation in technology use—while WATs were widely used, other devices such as oxygen saturation monitors, photoplethysmography sensors, inhaler adapters, indoor air quality monitors, portable spirometers, small devices attached to inhalers, ingestible sensors, and wearable patches with accelerometers were less common.

Third, we identified and described the outcomes measured in 5 distinct categories. Clinical and behavioral outcomes were the most frequently assessed, whereas patient technology experience, health care system (such as use or efficiency), and holistic or biopsychosocial (such as QoL) outcomes were reported less frequently.

Limitations

This scoping review has several limitations. We did not integrate the individual interventions into our analysis. Although we report the measured outcomes, these results must be interpreted with caution as effect sizes were not considered. However, informed readers can consult the appended files that contain all the relevant information, including study design, sample size, intervention and participant characteristics, outcomes measured, and effects. We only conducted searches in the MEDLINE (Ovid) and Web of Science (Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index, and Emerging Sources Citation Index) databases, which may have led to missing sources. Confounding factors such as multicomponent behavioral strategy interventions were also not considered. Nevertheless, these confounding factors were similarly not addressed in a previous systematic review and meta-analysis on the effectiveness of WATs due to the heterogeneity of study designs and interventions [18]. In total, 3 reviewers extracted and assessed the quality of all the studies only once, although this was mitigated by data validation from an experienced researcher.

Comparison With Other Reviews

Our findings revealed significant disparities in the chronic diseases studied. Type 2 diabetes and heart failure were extensively researched, whereas conditions such as musculoskeletal disorders, chronic pain, and asthma were less represented. This both complements and contrasts with the findings of another review, which noted type 2 diabetes, Parkinson disease, and chronic lower back pain as among the most studied conditions [25]. Many other reviews have focused on diabetes [8-15,21] and cardiovascular diseases [22,23]. One reason for this emphasis on cardiovascular disease and type 2 diabetes may be the inherent capabilities of wearables to monitor and manage these conditions [4], along with their availability and affordability. For instance, regarding asthma, we found promising effects on health outcomes but identified only a limited number of studies [127,128].

In terms of the technologies used, we observed that the most common devices used were WATs. This aligns with the number of reviews focusing on the effects of WATs for different diseases [16-20], often in combination with disease-specific devices. This observation is also consistent with those of other reviews as wearable technologies have emerged as promising tools for managing chronic diseases, offering continuous monitoring of vital signs, physical activity, and disease-specific markers [132,133]. Similarly to our findings, these devices have shown potential across various conditions, including BP and ECG monitors for cardiovascular diseases [22,23] and BG monitoring devices for diabetes [8,9,11], by enabling early detection of complications and promoting patient engagement [25,132-134].

Regarding outcomes, we identified 5 distinct categories in our review, with clinical and behavioral outcomes being the most frequently reported. This aligns with the growing body of research highlighting the role of wearables in monitoring physiological parameters and behaviors [134]. Similarly to our findings, other reviews have reported clinical outcomes such as glycemic control [8-15] as well as behavioral outcomes, including physical activity levels [16-20], medication adherence, and self-management [5,18].

Future Directions

Despite the promising health outcomes reported, other reviews have highlighted that the quality of evidence varies considerably, with many studies limited by small sample sizes or short durations [25]. Researchers emphasize the need for more long-term studies and systematic reviews that incorporate RCTs with larger sample sizes to measure the effectiveness of wearables across a wider variety of chronic diseases [18,24,25]. There is a need for rigorous, long-term studies to establish the clinical effectiveness and cost-efficiency of wearables in chronic disease self-management [25,132].

Our findings indicate that patient technology experience, holistic and biopsychosocial, and health care system outcomes have been covered less and could benefit from more robust studies. As the integration of wearable technology into health research and clinical practice continues to expand, establishing comprehensive guidelines to ensure effective use across diverse chronic conditions and applications will be important, ranging from chronic disease management to real-time health monitoring for specific or underrepresented populations [134].

In line with our findings, which show that health care system outcomes are reported less frequently than clinical and behavioral outcomes and often have inconclusive effects, a significant challenge will be integrating wearable data into existing health care systems and clinical workflows [135].

Conclusions

This review provides a comprehensive overview of wearable devices used in chronic disease self-management intervention studies, revealing disparities in both the range of chronic diseases studied and the variety of wearable devices used. We described the clinical and behavioral benefits of wearable devices, particularly for activity trackers, BG and BP monitors, and ECG wearable devices. These findings lay a foundation for future research, offering researchers valuable insights to further explore health care system outcomes, validate the impact of concomitant device use, and expand their use to other chronic diseases.

Acknowledgments

The authors would like to thank Manon Mouric for her valuable work during her internship. They also extend their gratitude to Rouwayda Elouni for her participation in abstract screening, Victoria Bureau Lagarde for her involvement in both abstract and full text screening, and Florian Naye for his contributions in reviewing this manuscript. Artificial intelligence (DALL-E) was used to generate the feature image for this manuscript.

Data Availability

The PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist [27] was included in the manuscript submission and can be consulted in Multimedia Appendix 5. The data sets generated and analyzed during this study are available from the corresponding author (MPG) on reasonable request.

Authors' Contributions

MPG is the corresponding author and guarantor of this review. MPG and MS conceptualized the study. MCL developed the search strategy. SO, WS, MS, MPG, EA, and SA performed independent screening of abstracts and full-text papers. SO performed data extraction and drafted the manuscript with significant input from MPG and MS. JSP, CR, SA, and CC (a patient as partner in health research) reviewed the manuscript and submitted comments and suggestions. All authors have read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Database search strategies.
[PDF File (Adobe PDF File), 124 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Characteristics of the sources of evidence.
[PDF File (Adobe PDF File), 305 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Characteristics of the studies with Mixed Methods Appraisal Tool scores.
[PDF File (Adobe PDF File), 516 KB-Multimedia Appendix 3]

Multimedia Appendix 4

Connected wearable devices used, outcomes measured, and effects per chronic disease cluster.
[PDF File (Adobe PDF File), 409 KB-Multimedia Appendix 4]

Multimedia Appendix 5

The PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist.
[PDF File (Adobe PDF File), 127 KB-Multimedia Appendix 5]

References

1. Non-communicable diseases. World Health Organization. Sep 16, 2023. URL: https://www.who.int/fr/news-room/fact-sheets/detail/noncommunicable-diseases [accessed 2024-04-01]
2. Chronic disease. National Institutes of Health National Cancer Institute. URL: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/chronic-disease [accessed 2024-04-01]
3. Skou ST, Mair FS, Fortin M, Guthrie B, Nunes BP, Miranda JJ, et al. Multimorbidity. Nat Rev Dis Primers. Jul 14, 2022;8(1):48. [FREE Full text] [doi: 10.1038/s41572-022-00376-4] [Medline: 35835758]
4. Dadkhah M, Mehraeen M, Rahimnia F, Kimiafar K. Use of internet of things for chronic disease management: an overview. J Med Signals Sens. May 24, 2021;11(2):138-157. [FREE Full text] [doi: 10.4103/jmss.JMSS_13_20] [Medline: 34268102]
5. Peyroteo M, Ferreira IA, Elvas LB, Ferreira JC, Lapão LV. Remote monitoring systems for patients with chronic diseases in primary health care: systematic review. JMIR Mhealth Uhealth. Dec 21, 2021;9(12):e28285. [FREE Full text] [doi: 10.2196/28285] [Medline: 34932000]
6. Giusto D, Iera A, Morabito G, Atzori L. The Internet of Things: 20th Tyrrhenian Workshop on Digital Communications. New York, NY. Springer; 2010.
7. Albino de Queiroz D, André da Costa C, Aparecida Isquierdo Fonseca de Queiroz E, Folchini da Silveira E, da Rosa Righi R. Internet of things in active cancer treatment: a systematic review. J Biomed Inform. Jun 2021;118:103814. [FREE Full text] [doi: 10.1016/j.jbi.2021.103814] [Medline: 34015540]
8. Luo J, Zhang K, Xu Y, Tao Y, Zhang Q. Effectiveness of wearable device-based intervention on glycemic control in patients with type 2 diabetes: a system review and meta-analysis. J Med Syst. Dec 24, 2021;46(1):11. [doi: 10.1007/s10916-021-01797-6] [Medline: 34951684]
9. Rodriguez-León C, Villalonga C, Munoz-Torres M, Ruiz JR, Banos O. Mobile and wearable technology for the monitoring of diabetes-related parameters: systematic review. JMIR Mhealth Uhealth. Jun 03, 2021;9(6):e25138. [FREE Full text] [doi: 10.2196/25138] [Medline: 34081010]

10. American Diabetes Association. 7. Diabetes technology: standards of medical care in diabetes-2020. Diabetes Care. Jan 2020;43(Suppl 1):S77-S88. [doi: 10.2337/dc20-S007] [Medline: 31862750]
11. Smith MB, Albanese-O'Neill A, Macieira TG, Yao Y, Abbatematteo JM, Lyon D, et al. Human factors associated with continuous glucose monitor use in patients with diabetes: a systematic review. Diabetes Technol Ther. Oct 2019;21(10):589-601. [FREE Full text] [doi: 10.1089/dia.2019.0136] [Medline: 31335196]
12. Ahmed A, Aziz S, Abd-Alrazaq A, Farooq F, Sheikh J. Overview of artificial intelligence-driven wearable devices for diabetes: scoping review. J Med Internet Res. Aug 09, 2022;24(8):e36010. [FREE Full text] [doi: 10.2196/36010] [Medline: 35943772]
13. Fleming GA, Petrie JR, Bergenstal RM, Holl RW, Peters AL, Heinemann L. Diabetes digital app technology: benefits, challenges, and recommendations. A consensus report by the European association for the study of diabetes (EASD) and the American diabetes association (ADA) diabetes technology working group. Diabetologia. Feb 2020;63(2):229-241. [doi: 10.1007/s00125-019-05034-1] [Medline: 31802144]
14. Makroum MA, Adda M, Bouzouane A, Ibrahim H. Machine learning and smart devices for diabetes management: systematic review. Sensors (Basel). Feb 25, 2022;22(5):1843. [FREE Full text] [doi: 10.3390/s22051843] [Medline: 35270989]
15. Mutunhu B, Chipangura B, Twinomurinzi H. A systematized literature review: internet of things (IoT) in the remote monitoring of diabetes. In: Proceedings of 7th International Congress on Information and Communication Technology. 2022. Presented at: ICICT 2022; February 21-24, 2022; Virtual Event. URL: https://doi.org/10.1007/978-981-19-1610-6_57 [doi: 10.1007/978-981-19-1610-6_57]
16. Kirk MA, Amiri M, Pirbaglou M, Ritvo P. Wearable technology and physical activity behavior change in adults with chronic cardiometabolic disease: a systematic review and meta-analysis. Am J Health Promot. Jun 2019;33(5):778-791. [doi: 10.1177/0890117118816278] [Medline: 30586996]
17. Coughlin SS, Caplan LS, Stone R. Use of consumer wearable devices to promote physical activity among breast, prostate, and colorectal cancer survivors: a review of health intervention studies. J Cancer Surviv. Jun 2020;14(3):386-392. [FREE Full text] [doi: 10.1007/s11764-020-00855-1] [Medline: 31933148]
18. Franssen WM, Franssen GH, Spaas J, Solmi F, Eijnde BO. Can consumer wearable activity tracker-based interventions improve physical activity and cardiometabolic health in patients with chronic diseases? A systematic review and meta-analysis of randomised controlled trials. Int J Behav Nutr Phys Act. May 11, 2020;17(1):57. [FREE Full text] [doi: 10.1186/s12966-020-00955-2] [Medline: 32393357]
19. Wang W, Cheng J, Song W, Shen Y. The effectiveness of wearable devices as physical activity interventions for preventing and treating obesity in children and adolescents: systematic review and meta-analysis. JMIR Mhealth Uhealth. Apr 08, 2022;10(4):e32435. [FREE Full text] [doi: 10.2196/32435] [Medline: 35394447]
20. Yu S, Chen Z, Wu X. The impact of wearable devices on physical activity for chronic disease patients: findings from the 2019 health information national trends survey. Int J Environ Res Public Health. Jan 03, 2023;20(1):887. [FREE Full text] [doi: 10.3390/ijerph20010887] [Medline: 36613207]
21. Greenwood DA, Gee PM, Fatkin KJ, Peeples M. A systematic review of reviews evaluating technology-enabled diabetes self-management education and support. J Diabetes Sci Technol. Sep 2017;11(5):1015-1027. [FREE Full text] [doi: 10.1177/1932296817713506] [Medline: 28560898]
22. Moses JC, Adibi S, Angelova M, Islam SM. Smart home technology solutions for cardiovascular diseases: a systematic review. Appl Syst Innov. May 27, 2022;5(3):51. [FREE Full text] [doi: 10.3390/asi5030051]
23. Bayoumy K, Gaber M, Elshafeey A, Mhaimeed O, Dineen EH, Marvel FA, et al. Smart wearable devices in cardiovascular care: where we are and how to move forward. Nat Rev Cardiol. Aug 2021;18(8):581-599. [FREE Full text] [doi: 10.1038/s41569-021-00522-7] [Medline: 33664502]
24. Kang HS, Exworthy M. Wearing the future-wearables to empower users to take greater responsibility for their health and care: scoping review. JMIR Mhealth Uhealth. Jul 13, 2022;10(7):e35684. [FREE Full text] [doi: 10.2196/35684] [Medline: 35830222]
25. Mattison G, Canfell O, Forrester D, Dobbins C, Smith D, Töyräs J, et al. The influence of wearables on health care outcomes in chronic disease: systematic review. J Med Internet Res. Jul 01, 2022;24(7):e36690. [FREE Full text] [doi: 10.2196/36690] [Medline: 35776492]
26. Peters MD, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Synth. Oct 2020;18(10):2119-2126. [doi: 10.11124/JBIES-20-00167] [Medline: 33038124]
27. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med. Oct 02, 2018;169(7):467-473. [FREE Full text] [doi: 10.7326/M18-0850] [Medline: 30178033]
28. Sasseville M, Attisso E, Lagarde VB, Ouellet S, Amil S, Wilfried Supper JM, et al. Rapid review of internet of things for chronic disease self-management. OSF Home. Sep 5, 2022. URL: https://osf.io/s4wfm/ [accessed 2024-11-19]
29. Thomas J, Kneale D, McKenzie JE, Brennan SE, Bhaumik S. Determining the scope of the review and the questions it will address. In: Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al, editors. Cochrane Handbook for Systematic Reviews of Interventions. Hoboken, NJ. John Wiley & Sons; Sep 20, 2019.
30. Covidence homepage. Covidence. URL: https://www.covidence.org/ [accessed 2023-12-21]

31. Handsearching. Cochrane Training. URL: https://training.cochrane.org/resource/tsc-induction-mentoring-training-guide/5-handsearching [accessed 2024-04-01]
32. Pollock D, Peters MD, Khalil H, McInerney P, Alexander L, Tricco AC, et al. Recommendations for the extraction, analysis, and presentation of results in scoping reviews. JBI Evid Synth. Mar 01, 2023;21(3):520-532. [doi: 10.11124/JBIES-22-00123] [Medline: 36081365]
33. Hong Q, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M, et al. Mixed Methods Appraisal Tool (MMAT) version 2018: user guide. McGill University. 2018. URL: http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/fetch/127916259/MMAT_2018_criteria-manual_2018-08-01_ENG.pdf [accessed 2024-04-01]
34. de Batlle J, Massip M, Vargiu E, Nadal N, Fuentes A, Ortega Bravo M, et al. Implementing mobile health-enabled integrated care for complex chronic patients: patients and professionals' acceptability study. JMIR Mhealth Uhealth. Nov 20, 2020;8(11):e22136. [FREE Full text] [doi: 10.2196/22136] [Medline: 33216004]
35. Östlind E, Sant'Anna A, Eek F, Stigmar K, Ekvall Hansson E. Physical activity patterns, adherence to using a wearable activity tracker during a 12-week period and correlation between self-reported function and physical activity in working age individuals with hip and/or knee osteoarthritis. BMC Musculoskelet Disord. May 15, 2021;22(1):450. [FREE Full text] [doi: 10.1186/s12891-021-04338-x] [Medline: 33992121]
36. Verwey R, van der Weegen S, Tange H, Spreeuwenberg M, van der Weijden T, de Witte L. Get moving: the practice nurse is watching you! A case study of the user-centred design process and testing of a web-based coaching system to stimulate the physical activity of chronically ill patients in primary care. Inform Prim Care. 2012;20(4):289-298. [FREE Full text] [doi: 10.14236/jhi.v20i4.19] [Medline: 23890341]
37. Torbjørnsen A, Jenum AK, Småstuen MC, Arsand E, Holmen H, Wahl AK, et al. A low-intensity mobile health intervention with and without health counseling for persons with type 2 diabetes, part 1: baseline and short-term results from a randomized controlled trial in the Norwegian Part of RENEWING HEALTH. JMIR Mhealth Uhealth. Dec 11, 2014;2(4):e52. [FREE Full text] [doi: 10.2196/mhealth.3535] [Medline: 25499592]
38. Kim JY, Wineinger NE, Steinhubl SR. The influence of wireless self-monitoring program on the relationship between patient activation and health behaviors, medication adherence, and blood pressure levels in hypertensive patients: a substudy of a randomized controlled trial. J Med Internet Res. Jun 22, 2016;18(6):e116. [FREE Full text] [doi: 10.2196/jmir.5429] [Medline: 27334418]
39. Rahimi K, Velardo C, Triantafyllidis A, Conrad N, Shah SA, Chantler T, SUPPORT-HF Investigators, et al. A user-centred home monitoring and self-management system for patients with heart failure: a multicentre cohort study. Eur Heart J Qual Care Clin Outcomes. Nov 01, 2015;1(2):66-71. [FREE Full text] [doi: 10.1093/ehjqcco/qcv013] [Medline: 29474596]
40. Chantler T, Paton C, Velardo C, Triantafyllidis A, Shah SA, Stoppani E, et al. Creating connections - the development of a mobile-health monitoring system for heart failure: qualitative findings from a usability cohort study. Digit Health. Oct 10, 2016;2:2055207616671461. [FREE Full text] [doi: 10.1177/2055207616671461] [Medline: 29942568]
41. Goldenthal IL, Sciacca RR, Riga T, Bakken S, Baumeister M, Biviano AB, et al. Recurrent atrial fibrillation/flutter detection after ablation or cardioversion using the AliveCor KardiaMobile device: iHEART results. J Cardiovasc Electrophysiol. Nov 2019;30(11):2220-2228. [FREE Full text] [doi: 10.1111/jce.14160] [Medline: 31507001]
42. Caceres BA, Hickey KT, Bakken SB, Biviano AB, Garan H, Goldenthal IL, et al. Mobile electrocardiogram monitoring and health-related quality of life in patients with atrial fibrillation: findings from the iPhone helping evaluate atrial fibrillation rhythm through technology (iHEART) study. J Cardiovasc Nurs. 2020;35(4):327-336. [FREE Full text] [doi: 10.1097/JCN.0000000000000646] [Medline: 32015256]
43. Reading M, Baik D, Beauchemin M, Hickey KT, Merrill JA. Factors influencing sustained engagement with ECG self-monitoring: perspectives from patients and health care providers. Appl Clin Inform. Oct 2018;9(4):772-781. [FREE Full text] [doi: 10.1055/s-0038-1672138] [Medline: 30304745]
44. Arbillaga-Etxarri A, Gimeno-Santos E, Barberan-Garcia A, Balcells E, Benet M, Borrell E, et al. Long-term efficacy and effectiveness of a behavioural and community-based exercise intervention (Urban Training) to increase physical activity in patients with COPD: a randomised controlled trial. Eur Respir J. Oct 18, 2018;52(4):1800063. [FREE Full text] [doi: 10.1183/13993003.00063-2018] [Medline: 30166322]
45. Elnaggar A, von Oppenfeld J, Whooley MA, Merek S, Park LG. Applying mobile technology to sustain physical activity after completion of cardiac rehabilitation: acceptability study. JMIR Hum Factors. Sep 02, 2021;8(3):e25356. [FREE Full text] [doi: 10.2196/25356] [Medline: 34473064]
46. Radhakrishnan K, Julien C, O'Hair M, Baranowski T, Lee G, Allen C, et al. Usability testing of a sensor-controlled digital game to engage older adults with heart failure in physical activity and weight monitoring. Appl Clin Inform. Oct 2020;11(5):873-881. [FREE Full text] [doi: 10.1055/s-0040-1721399] [Medline: 33378780]
47. Verwey R, van der Weegen S, Spreeuwenberg M, Tange H, van der Weijden T, de Witte L. Process evaluation of physical activity counselling with and without the use of mobile technology: a mixed methods study. Int J Nurs Stud. Jan 2016;53:3-16. [doi: 10.1016/j.ijnurstu.2015.10.008] [Medline: 26518108]
48. Holmen H, Wahl A, Torbjørnsen A, Jenum AK, Småstuen MC, Ribu L. Stages of change for physical activity and dietary habits in persons with type 2 diabetes included in a mobile health intervention: the Norwegian study in RENEWING

HEALTH. BMJ Open Diabetes Res Care. May 12, 2016;4(1):e000193. [FREE Full text] [doi: 10.1136/bmjdrc-2016-000193] [Medline: 27239317]
49. Lewinski AA, Vaughn J, Diane A, Barnes A, Crowley MJ, Steinberg D, et al. Perceptions of using multiple mobile health devices to support self-management among adults with type 2 diabetes: a qualitative descriptive study. J Nurs Scholarsh. Sep 2021;53(5):643-652. [FREE Full text] [doi: 10.1111/jnu.12667] [Medline: 33928755]
50. van Lieshout F, Yang R, Stamenova V, Agarwal P, Cornejo Palma D, Sidhu A, et al. Evaluating the implementation of a remote-monitoring program for chronic obstructive pulmonary disease: qualitative methods from a service design perspective. J Med Internet Res. Oct 09, 2020;22(10):e18148. [FREE Full text] [doi: 10.2196/18148] [Medline: 33034565]
51. Whelan M, Biggs C, Areia C, King E, Lawson B, Newhouse N, et al. Recruiting patients to a digital self-management study whilst in hospital for a chronic obstructive pulmonary disease exacerbation: a feasibility analysis. Digit Health. May 27, 2021;7:20552076211020876. [FREE Full text] [doi: 10.1177/20552076211020876] [Medline: 34104470]
52. Amorim AB, Pappas E, Simic M, Ferreira ML, Jennings M, Tiedemann A, et al. Integrating mobile-health, health coaching, and physical activity to reduce the burden of chronic low back pain trial (IMPACT): a pilot randomised controlled trial. BMC Musculoskelet Disord. Feb 11, 2019;20(1):71. [doi: 10.1186/s12891-019-2454-y] [Medline: 30744606]
53. Koreny M, Demeyer H, Arbillaga-Etxarri A, Gimeno-Santos E, Barberan-Garcia A, Benet M, et al. Determinants of study completion and response to a 12-month behavioral physical activity intervention in chronic obstructive pulmonary disease: a cohort study. PLoS One. May 20, 2019;14(5):e0217157. [FREE Full text] [doi: 10.1371/journal.pone.0217157] [Medline: 31107900]
54. Årsand E, Muzny M, Bradway M, Muzik J, Hartvigsen G. Performance of the first combined smartwatch and smartphone diabetes diary application study. J Diabetes Sci Technol. May 2015;9(3):556-563. [FREE Full text] [doi: 10.1177/1932296814567708] [Medline: 25591859]
55. Bailey JF, Agarwal V, Zheng P, Smuck M, Fredericson M, Kennedy DJ, et al. Digital care for chronic musculoskeletal pain: 10,000 participant longitudinal cohort study. J Med Internet Res. May 11, 2020;22(5):e18250. [FREE Full text] [doi: 10.2196/18250] [Medline: 32208358]
56. Baron KG, Duffecy J, Richardson D, Avery E, Rothschild S, Lane J. Technology assisted behavior intervention to extend sleep among adults with short sleep duration and prehypertension/stage 1 hypertension: a randomized pilot feasibility study. J Clin Sleep Med. Nov 15, 2019;15(11):1587-1597. [FREE Full text] [doi: 10.5664/jcsm.8018] [Medline: 31739848]
57. Bentley CL, Powell L, Potter S, Parker J, Mountain GA, Bartlett YK, et al. The use of a smartphone app and an activity tracker to promote physical activity in the management of chronic obstructive pulmonary disease: randomized controlled feasibility study. JMIR Mhealth Uhealth. Jun 03, 2020;8(6):e16203. [FREE Full text] [doi: 10.2196/16203] [Medline: 32490838]
58. Chhabra HS, Sharma S, Verma S. Smartphone app in self-management of chronic low back pain: a randomized controlled trial. Eur Spine J. Nov 15, 2018;27(11):2862-2874. [doi: 10.1007/s00586-018-5788-5] [Medline: 30324496]
59. Colomina J, Drudis R, Torra M, Pallisó F, Massip M, Vargiu E, et al. Implementing mHealth-enabled integrated care for complex chronic patients with osteoarthritis undergoing primary hip or knee arthroplasty: prospective, two-arm, parallel trial. J Med Internet Res. Sep 02, 2021;23(9):e28320. [FREE Full text] [doi: 10.2196/28320] [Medline: 34473068]
60. de Batlle J, Massip M, Vargiu E, Nadal N, Fuentes A, Ortega Bravo M, et al. Implementing mobile health-enabled integrated care for complex chronic patients: intervention effectiveness and cost-effectiveness study. JMIR Mhealth Uhealth. Jan 14, 2021;9(1):e22135. [FREE Full text] [doi: 10.2196/22135] [Medline: 33443486]
61. Deka P, Pozehl B, Williams MA, Norman JF, Khazanchi D, Pathak D. MOVE-HF: an internet-based pilot study to improve adherence to exercise in patients with heart failure. Eur J Cardiovasc Nurs. Feb 2019;18(2):122-131. [doi: 10.1177/1474515118796613] [Medline: 30129790]
62. Fukuoka Y, Gay CL, Joiner KL, Vittinghoff E. A novel diabetes prevention intervention using a mobile app: a randomized controlled trial with overweight adults at risk. Am J Prev Med. Aug 2015;49(2):223-237. [FREE Full text] [doi: 10.1016/j.amepre.2015.01.003] [Medline: 26033349]
63. Ito S, Morimoto T, Kitakaze M. Daily self-monitoring of blood pressure decreases systolic and diastolic blood pressure in hypertensive participants. Heart Vessels. Jul 2022;37(7):1265-1270. [FREE Full text] [doi: 10.1007/s00380-021-02013-8] [Medline: 35091786]
64. Janevic MR, Shute V, Murphy SL, Piette JD. Acceptability and effects of commercially available activity trackers for chronic pain management among older African American adults. Pain Med. Feb 01, 2020;21(2):e68-e78. [FREE Full text] [doi: 10.1093/pm/pnz215] [Medline: 31509196]
65. Jiwani R, Wang J, Li C, Dennis B, Patel D, Gelfond J, et al. A behavioral lifestyle intervention to improve frailty in overweight or obese older adults with type 2 diabetes: a feasibility study. J Frailty Aging. 2022;11(1):74-82. [FREE Full text] [doi: 10.14283/jfa.2021.17] [Medline: 35122094]
66. Kooiman TJ, de Groot M, Hoogenberg K, Krijnen WP, van der Schans CP, Kooy A. Self-tracking of physical activity in people with type 2 diabetes: a randomized controlled trial. Comput Inform Nurs. Jul 2018;36(7):340-349. [doi: 10.1097/CIN.0000000000000443] [Medline: 29742550]

67. Krein SL, Kadri R, Hughes M, Kerr EA, Piette JD, Holleman R, et al. Pedometer-based internet-mediated intervention for adults with chronic low back pain: randomized controlled trial. J Med Internet Res. Aug 19, 2013;15(8):e181. [FREE Full text] [doi: 10.2196/jmir.2605] [Medline: 23969029]
68. Lee JH, Park JC, Kim SB. Therapeutic exercise platform for type-2 diabetic mellitus. Electronics. Jul 29, 2021;10(15):1820. [FREE Full text] [doi: 10.3390/electronics10151820]
69. Li LC, Sayre EC, Xie H, Falck RS, Best JR, Liu-Ambrose T, et al. Efficacy of a community-based technology-enabled physical activity counseling program for people with knee osteoarthritis: proof-of-concept study. J Med Internet Res. Apr 30, 2018;20(4):e159. [FREE Full text] [doi: 10.2196/jmir.8514] [Medline: 29712630]
70. Li LC, Feehan LM, Xie H, Lu N, Shaw C, Gromala D, et al. Efficacy of a physical activity counseling program with use of a wearable tracker in people with inflammatory arthritis: a randomized controlled trial. Arthritis Care Res (Hoboken). Dec 27, 2020;72(12):1755-1765. [doi: 10.1002/acr.24199] [Medline: 32248626]
71. Li J, Wei D, Liu S, Li M, Chen X, Chen L, et al. Efficiency of an mHealth app and chest-wearable remote exercise monitoring intervention in patients with type 2 diabetes: a prospective, multicenter randomized controlled trial. JMIR Mhealth Uhealth. Feb 09, 2021;9(2):e23338. [FREE Full text] [doi: 10.2196/23338] [Medline: 33560244]
72. Moy ML, Collins RJ, Martinez CH, Kadri R, Roman P, Holleman RG, et al. An internet-mediated pedometer-based program improves health-related quality-of-life domains and daily step counts in COPD: a randomized controlled trial. Chest. Jul 2015;148(1):128-137. [FREE Full text] [doi: 10.1378/chest.14-1466] [Medline: 25811395]
73. Orme MW, Weedon AE, Saukko PM, Esliger DW, Morgan MD, Steiner MC, et al. Findings of the chronic obstructive pulmonary disease-sitting and exacerbations trial (COPD-SEAT) in reducing sedentary time using wearable and mobile technologies with educational support: randomized controlled feasibility trial. JMIR Mhealth Uhealth. Apr 11, 2018;6(4):e84. [FREE Full text] [doi: 10.2196/mhealth.9398] [Medline: 29643055]
74. Östlind E, Eek F, Stigmar K, Sant'Anna A, Hansson EE. Promoting work ability with a wearable activity tracker in working age individuals with hip and/or knee osteoarthritis: a randomized controlled trial. BMC Musculoskelet Disord. Feb 03, 2022;23(1):112. [FREE Full text] [doi: 10.1186/s12891-022-05041-1] [Medline: 35114983]
75. Park LG, Elnaggar A, Lee SJ, Merek S, Hoffmann TJ, Von Oppenfeld J, et al. Mobile health intervention promoting physical activity in adults post cardiac rehabilitation: pilot randomized controlled trial. JMIR Form Res. Apr 16, 2021;5(4):e20468. [FREE Full text] [doi: 10.2196/20468] [Medline: 33861204]
76. Paul L, Wyke S, Brewster S, Sattar N, Gill JM, Alexander G, et al. Increasing physical activity in stroke survivors using STARFISH, an interactive mobile phone application: a pilot study. Top Stroke Rehabil. Jun 2016;23(3):170-177. [FREE Full text] [doi: 10.1080/10749357.2015.1122266] [Medline: 27077973]
77. Rabbi M, Aung MS, Gay G, Reid MC, Choudhury T. Feasibility and acceptability of mobile phone-based auto-personalized physical activity recommendations for chronic pain self-management: pilot study on adults. J Med Internet Res. Oct 26, 2018;20(10):e10147. [FREE Full text] [doi: 10.2196/10147] [Medline: 30368433]
78. Radhakrishnan K, Julien C, Baranowski T, O'Hair M, Lee G, Sagna De Main A, et al. Feasibility of a sensor-controlled digital game for heart failure self-management: randomized controlled trial. JMIR Serious Games. Nov 08, 2021;9(4):e29044. [FREE Full text] [doi: 10.2196/29044] [Medline: 34747701]
79. Richardson CR, Goodrich DE, Larkin AR, Ronis DL, Holleman RG, Damschroder LJ, et al. A comparative effectiveness trial of three walking self-monitoring strategies. Transl J ACSM. 2016;1(15):133-142. [doi: 10.1249/tjx.0000000000000017]
80. Timurtas E, Inceer M, Mayo N, Karabacak N, Sertbas Y, Polat MG. Technology-based and supervised exercise interventions for individuals with type 2 diabetes: randomized controlled trial. Prim Care Diabetes. Feb 2022;16(1):49-56. [doi: 10.1016/j.pcd.2021.12.005] [Medline: 34924318]
81. van der Weegen S, Verwey R, Spreeuwenberg M, Tange H, van der Weijden T, de Witte L. It's LiFe! Mobile and web-based monitoring and feedback tool embedded in primary care increases physical activity: a cluster randomized controlled trial. J Med Internet Res. Jul 24, 2015;17(7):e184. [FREE Full text] [doi: 10.2196/jmir.4579] [Medline: 26209025]
82. Zaslavsky O, Thompson HJ, McCurry SM, Landis CA, Kitsiou S, Ward TM, et al. Use of a wearable technology and motivational interviews to improve sleep in older adults with osteoarthritis and sleep disturbance: a pilot study. Res Gerontol Nurs. Jul 01, 2019;12(4):167-173. [FREE Full text] [doi: 10.3928/19404921-20190319-02] [Medline: 30901479]
83. Kim EK, Kwak SH, Jung HS, Koo BK, Moon MK, Lim S, et al. The effect of a smartphone-based, patient-centered diabetes care system in patients with type 2 diabetes: a randomized, controlled trial for 24 weeks. Diabetes Care. Jan 30, 2019;42(1):3-9. [doi: 10.2337/dc17-2197] [Medline: 30377185]
84. Tang PC, Overhage JM, Chan AS, Brown NL, Aghighi B, Entwistle MP, et al. Online disease management of diabetes: engaging and motivating patients online with enhanced resources-diabetes (EMPOWER-D), a randomized controlled trial. J Am Med Inform Assoc. May 01, 2013;20(3):526-534. [FREE Full text] [doi: 10.1136/amiajnl-2012-001263] [Medline: 23171659]
85. Holmen H, Torbjørnsen A, Wahl AK, Jenum AK, Småstuen MC, Arsand E, et al. A mobile health intervention for self-management and lifestyle change for persons with type 2 diabetes, part 2: one-year results from the Norwegian randomized controlled trial renewing health. JMIR Mhealth Uhealth. Dec 11, 2014;2(4):e57. [FREE Full text] [doi: 10.2196/mhealth.3882] [Medline: 25499872]

86. Wang J, Cai C, Padhye N, Orlander P, Zare M. A behavioral lifestyle intervention enhanced with multiple-behavior self-monitoring using mobile and connected tools for underserved individuals with type 2 diabetes and comorbid overweight or obesity: pilot comparative effectiveness trial. JMIR Mhealth Uhealth. Apr 10, 2018;6(4):e92. [FREE Full text] [doi: 10.2196/mhealth.4478] [Medline: 29636320]
87. Fritschi C, Kim MJ, Srimoragot M, Jun J, Sanchez LE, Sharp LK. "Something tells me I can't do that no more": experiences with real-time glucose and activity monitoring among underserved Black women with type 2 diabetes. Sci Diabetes Self Manag Care. Apr 04, 2022;48(2):78-86. [doi: 10.1177/26350106221076042] [Medline: 35118920]
88. Kim EK, Kwak SH, Baek S, Lee SL, Jang HC, Park KS, et al. Feasibility of a patient-centered, smartphone-based, diabetes care system: a pilot study. Diabetes Metab J. Jun 2016;40(3):192-201. [FREE Full text] [doi: 10.4093/dmj.2016.40.3.192] [Medline: 27098508]
89. Shaw RJ, Yang Q, Barnes A, Hatch D, Crowley MJ, Vorderstrasse A, et al. Self-monitoring diabetes with multiple mobile health devices. J Am Med Inform Assoc. May 01, 2020;27(5):667-676. [FREE Full text] [doi: 10.1093/jamia/ocaa007] [Medline: 32134447]
90. Zheng Y, Weinger K, Greenberg J, Burke LE, Sereika SM, Patience N, et al. Actual use of multiple health monitors among older adults with diabetes: pilot study. JMIR Aging. Mar 23, 2020;3(1):e15995. [FREE Full text] [doi: 10.2196/15995] [Medline: 32202506]
91. Culhane-Pera KA, Vang KB, Ortega LM, Xiong T, Northuis CA, de la Parra P, et al. Mobile health technology for hypertension management with Hmong and Latino adults: mixed-methods community-based participatory research. Ethn Health. Apr 06, 2023;28(3):413-430. [FREE Full text] [doi: 10.1080/13557858.2022.2059451] [Medline: 35387531]
92. Lakshminarayan K, Westberg S, Northuis C, Fuller CC, Ikramuddin F, Ezzeddine M, et al. A mHealth-based care model for improving hypertension control in stroke survivors: pilot RCT. Contemp Clin Trials. Jul 2018;70:24-34. [FREE Full text] [doi: 10.1016/j.cct.2018.05.005] [Medline: 29763657]
93. Marvel FA, Spaulding EM, Lee MA, Yang WE, Demo R, Ding J, et al. Digital health intervention in acute myocardial infarction. Circ Cardiovasc Qual Outcomes. Jul 2021;14(7):e007741. [FREE Full text] [doi: 10.1161/CIRCOUTCOMES.121.007741] [Medline: 34261332]
94. Zhang Y, Fang Y, Xu Y, Xiong P, Zhang J, Yang J, et al. Adherence with blood pressure monitoring wearable device among the elderly with hypertension: the case of rural China. Brain Behav. Jun 09, 2020;10(6):e01599. [FREE Full text] [doi: 10.1002/brb3.1599] [Medline: 32385965]
95. Read E. Feasibility of the Diabetes and Technology for Increased Activity (DaTA) Study: a pilot intervention in high-risk rural adults. J Phys Act Health. Jan 2014;11(1):118-126. [doi: 10.1123/jpah.2011-0381] [Medline: 23249608]
96. Welch G, Balder A, Zagarins S. Telehealth program for type 2 diabetes: usability, satisfaction, and clinical usefulness in an urban community health center. Telemed J E Health. May 2015;21(5):395-403. [doi: 10.1089/tmj.2014.0069] [Medline: 25748544]
97. Chandler J, Sox L, Kellam K, Feder L, Nemeth L, Treiber F. Impact of a culturally tailored mHealth medication regimen self-management program upon blood pressure among hypertensive Hispanic adults. Int J Environ Res Public Health. Apr 06, 2019;16(7):1226. [FREE Full text] [doi: 10.3390/ijerph16071226] [Medline: 30959858]
98. Davidson TM, McGillicuddy J, Mueller M, Brunner-Jackson B, Favella A, Anderson A, et al. Evaluation of an mHealth medication regimen self-management program for African American and Hispanic uncontrolled hypertensives. J Pers Med. Nov 17, 2015;5(4):389-405. [FREE Full text] [doi: 10.3390/jpm5040389] [Medline: 26593951]
99. Sieverdes JC, Gregoski M, Patel S, Williamson D, Brunner-Jackson B, Rundbaken J, et al. mHealth medication and blood pressure self-management program in Hispanic hypertensives: a proof of concept trial. Smart Homecare Technol Telehealth. Oct 2013;1:1-10. [doi: 10.2147/SHTT.S49633]
100. Oh SW, Kim KK, Kim SS, Park SK, Park S. Effect of an integrative mobile health intervention in patients with hypertension and diabetes: crossover study. JMIR Mhealth Uhealth. Jan 11, 2022;10(1):e27192. [FREE Full text] [doi: 10.2196/27192] [Medline: 35014961]
101. Or CK, Liu K, So MK, Cheung B, Yam LY, Tiwari A, et al. Improving self-care in patients with coexisting type 2 diabetes and hypertension by technological surrogate nursing: randomized controlled trial. J Med Internet Res. Mar 27, 2020;22(3):e16769. [FREE Full text] [doi: 10.2196/16769] [Medline: 32217498]
102. Alnosayan N, Chatterjee S, Alluhaidan A, Lee E, Houston Feenstra L. Design and usability of a heart failure mHealth system: a pilot study. JMIR Hum Factors. Mar 24, 2017;4(1):e9. [FREE Full text] [doi: 10.2196/humanfactors.6481] [Medline: 28341615]
103. Mallow JA, Theeke LA, Theeke E, Mallow BK. The effectiveness of mI SMART: a nurse practitioner led technology intervention for multiple chronic conditions in primary care. Int J Nurs Sci. Apr 2018;5(2):131-137. [doi: 10.1016/j.ijnss.2018.03.009]
104. Bloss CS, Wineinger NE, Peters M, Boeldt DL, Ariniello L, Kim JY, et al. A prospective randomized trial examining health care utilization in individuals using multiple smartphone-enabled biosensors. PeerJ. 2016;4:e1554. [FREE Full text] [doi: 10.7717/peerj.1554] [Medline: 26788432]
105. Bennett GG, Steinberg D, Askew S, Levine E, Foley P, Batch BC, et al. Effectiveness of an app and provider counseling for obesity treatment in primary care. Am J Prevent Med. Dec 2018;55(6):777-786. [doi: 10.1016/J.AMEPRE.2018.07.005]

106. Evans J, Papadopoulos A, Silvers CT, Charness N, Boot WR, Schlachta-Fairchild L, et al. Remote health monitoring for older adults and those with heart failure: adherence and system usability. Telemed J E Health. Jun 2016;22(6):480-488. [FREE Full text] [doi: 10.1089/tmj.2015.0140] [Medline: 26540369]
107. Ho K, Novak Lauscher H, Cordeiro J, Hawkins N, Scheuermeyer F, Mitton C, et al. Testing the feasibility of sensor-based home health monitoring (TEC4Home) to support the convalescence of patients with heart failure: pre-post study. JMIR Form Res. Jun 03, 2021;5(6):e24509. [FREE Full text] [doi: 10.2196/24509] [Medline: 34081015]
108. Lefler LL, Rhoads SJ, Harris M, Funderburg AE, Lubin SA, Martel ID, et al. Evaluating the use of mobile health technology in older adults with heart failure: mixed-methods study. JMIR Aging. Dec 04, 2018;1(2):e12178. [FREE Full text] [doi: 10.2196/12178] [Medline: 31518257]
109. Park C, Otobo E, Ullman J, Rogers J, Fasihuddin F, Garg S, et al. Impact on readmission reduction among heart failure patients using digital health monitoring: feasibility and adoptability study. JMIR Med Inform. Nov 15, 2019;7(4):e13353. [FREE Full text] [doi: 10.2196/13353] [Medline: 31730039]
110. Rahimi K, Nazarzadeh M, Pinho-Gomes AC, Woodward M, Salimi-Khorshidi G, Ohkuma T, et al. Home monitoring with technology-supported management in chronic heart failure: a randomised trial. Heart. Oct 24, 2020;106(20):1573-1578. [FREE Full text] [doi: 10.1136/heartjnl-2020-316773] [Medline: 32580977]
111. Triantafyllidis A, Velardo C, Chantler T, Shah SA, Paton C, Khorshidi R, et al. A personalised mobile-based home monitoring system for heart failure: the SUPPORT-HF study. Int J Med Informatics. Oct 2015;84(10):743-753. [doi: 10.1016/j.ijmedinf.2015.05.003]
112. Ware P, Ross HJ, Cafazzo JA, Boodoo C, Munnery M, Seto E. Outcomes of a heart failure telemonitoring program implemented as the standard of care in an outpatient heart function clinic: pretest-posttest pragmatic study. J Med Internet Res. Feb 08, 2020;22(2):e16538. [doi: 10.2196/16538] [Medline: 32027309]
113. Zan S, Agboola S, Moore SA, Parks KA, Kvedar JC, Jethwani K. Patient engagement with a mobile web-based telemonitoring system for heart failure self-management: a pilot study. JMIR Mhealth Uhealth. Apr 01, 2015;3(2):e33. [FREE Full text] [doi: 10.2196/mhealth.3789] [Medline: 25842282]
114. Masterson Creber RM, Reading Turchioe M, Biviano A, Caceres B, Garan H, Goldenthal I, et al. Cardiac symptom burden and arrhythmia recurrence drives digital health use: results from the iHEART randomized controlled trial. Eur J Cardiovasc Nurs. Mar 03, 2022;21(2):107-115. [FREE Full text] [doi: 10.1093/eurjcn/zvab009] [Medline: 34009326]
115. T Hickey K, B Biviano A, Garan H, Sciacca RR, Riga T, Warren K, et al. Evaluating the utility of mHealth ECG heart monitoring for the detection and management of atrial fibrillation in clinical practice. J Atr Fibrillation. 2017;9(5):1546. [FREE Full text] [doi: 10.4022/jafib.1546] [Medline: 29250277]
116. Athilingam P, Jenkins B, Johansson M, Labrador M. A mobile health intervention to improve self-care in patients with heart failure: pilot randomized control trial. JMIR Cardio. Aug 11, 2017;1(2):e3. [FREE Full text] [doi: 10.2196/cardio.7848] [Medline: 31758759]
117. Li WY, Chiu FC, Zeng JK, Li YW, Huang SH, Yeh HC, et al. Mobile health app with social media to support self-management for patients with chronic kidney disease: prospective randomized controlled study. J Med Internet Res. Dec 15, 2020;22(12):e19452. [FREE Full text] [doi: 10.2196/19452] [Medline: 33320101]
118. Dadosky A, Overbeck H, Barbetta L, Bertke K, Corl M, Daly K, et al. Telemanagement of heart failure patients across the post-acute care continuum. Telemed J E Health. May 2018;24(5):360-366. [doi: 10.1089/tmj.2017.0058] [Medline: 28910238]
119. Andersen TO, Langstrup H, Lomborg S. Experiences with wearable activity data during self-care by chronic heart patients: qualitative study. J Med Internet Res. Jul 20, 2020;22(7):e15873. [FREE Full text] [doi: 10.2196/15873] [Medline: 32706663]
120. Broers ER, Widdershoven J, Denollet J, Lodder P, Kop WJ, Wetzels M, et al. Personalized eHealth program for life-style change: results from the “do cardiac health advanced new generated ecosystem (Do CHANGE 2)” randomized controlled trial. Psychosom Med. Mar 17, 2020;82(4):409-419. [doi: 10.1097/psy.0000000000000802]
121. Koole MA, Kauw D, Winter MM, Dohmen DA, Tulevski II, de Haan R, et al. First real-world experience with mobile health telemonitoring in adult patients with congenital heart disease. Neth Heart J. Jan 28, 2019;27(1):30-37. [FREE Full text] [doi: 10.1007/s12471-018-1201-6] [Medline: 30488380]
122. Noble K, Brown K, Medina M, Alvarez F, Young J, Leadley S, et al. Medication adherence and activity patterns underlying uncontrolled hypertension: assessment and recommendations by practicing pharmacists using digital health care. J Am Pharm Assoc (2003). May 2016;56(3):310-315. [FREE Full text] [doi: 10.1016/j.japh.2016.01.005] [Medline: 27053077]
123. Alharbey R, Chatterjee S. An mHealth assistive system "MyLung" to empower patients with chronic obstructive pulmonary disease: design science research. JMIR Form Res. Mar 19, 2019;3(1):e12489. [FREE Full text] [doi: 10.2196/12489] [Medline: 30888329]
124. Kayyali R, Savickas V, Spruit MA, Kaimakamis E, Siva R, Costello RW, et al. Qualitative investigation into a wearable system for chronic obstructive pulmonary disease: the stakeholders' perspective. BMJ Open. Aug 31, 2016;6(8):e011657. [FREE Full text] [doi: 10.1136/bmjopen-2016-011657] [Medline: 27580831]
125. Stamenova V, Liang K, Yang R, Engel K, van Lieshout F, Lalingo E, et al. Technology-enabled self-management of chronic obstructive pulmonary disease with or without asynchronous remote monitoring: randomized controlled trial. J Med Internet Res. Jul 30, 2020;22(7):e18598. [FREE Full text] [doi: 10.2196/18598] [Medline: 32729843]

126. Farmer A, Williams V, Velardo C, Shah SA, Yu LM, Rutter H, et al. Self-management support using a digital health system compared with usual care for chronic obstructive pulmonary disease: randomized controlled trial. J Med Internet Res. May 03, 2017;19(5):e144. [FREE Full text] [doi: 10.2196/jmir.7116] [Medline: 28468749]
127. Khusial RJ, Honkoop PJ, Usmani O, Soares M, Simpson A, Biddiscombe M, et al. Effectiveness of myAirCoach: a mHealth self-management system in asthma. J Allergy Clin Immunol Pract. Jun 2020;8(6):1972-9.e8. [FREE Full text] [doi: 10.1016/j.jaip.2020.02.018] [Medline: 32142961]
128. Mosnaim GS, Stempel DA, Gonzalez C, Adams B, BenIsrael-Olive N, Gondalia R, et al. The impact of patient self-monitoring via electronic medication monitor and mobile app plus remote clinician feedback on adherence to inhaled corticosteroids: a randomized controlled trial. J Allergy Clin Immunol Pract. Apr 2021;9(4):1586-1594. [doi: 10.1016/j.jaip.2020.10.064] [Medline: 33212239]
129. Munster-Segev M, Fuerst O, Kaplan SA, Cahn A. Incorporation of a stress reducing mobile app in the care of patients with type 2 diabetes: a prospective study. JMIR Mhealth Uhealth. May 29, 2017;5(5):e75. [FREE Full text] [doi: 10.2196/mhealth.7408] [Medline: 28554881]
130. Wang Y, Liu X, Wang W, Shi Y, Ji X, Hu L, et al. Adherence, efficacy, and safety of wearable technology-assisted combined home-based exercise in Chinese patients with ankylosing spondylitis: randomized pilot controlled clinical trial. J Med Internet Res. Jan 18, 2022;24(1):e29703. [FREE Full text] [doi: 10.2196/29703] [Medline: 35040798]
131. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. Mar 29, 2021;372:n71. [FREE Full text] [doi: 10.1136/bmj.n71] [Medline: 33782057]
132. Lu L, Zhang J, Xie Y, Gao F, Xu S, Wu X, et al. Wearable health devices in health care: narrative systematic review. JMIR Mhealth Uhealth. Nov 09, 2020;8(11):e18907. [FREE Full text] [doi: 10.2196/18907] [Medline: 33164904]
133. Guo Y, Liu X, Peng S, Jiang X, Xu K, Chen C, et al. A review of wearable and unobtrusive sensing technologies for chronic disease management. Comput Biol Med. Feb 2021;129:104163. [FREE Full text] [doi: 10.1016/j.compbiomed.2020.104163] [Medline: 33348217]
134. Huhn S, Axt M, Gunga HC, Maggioni MA, Munga S, Obor D, et al. The impact of wearable technologies in health research: scoping review. JMIR Mhealth Uhealth. Jan 25, 2022;10(1):e34384. [FREE Full text] [doi: 10.2196/34384] [Medline: 35076409]
135. Hughes A, Shandhi MM, Master H, Dunn J, Brittain E. Wearable devices in cardiovascular medicine. Circ Res. Mar 03, 2023;132(5):652-670. [doi: 10.1161/circresaha.122.322389]

Abbreviations

BG: blood glucose
BP: blood pressure
COPD: chronic obstructive pulmonary disease
ECG: electrocardiogram
HbA1c: glycated hemoglobin
MMAT: Mixed Methods Appraisal Tool
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
QoL: quality of life
RCT: randomized controlled trial
WAT: wearable activity tracker

Edited by T de Azevedo Cardoso; submitted 29.12.23; peer-reviewed by J Ruokolainen, W Wang; comments to author 05.03.24; revised version received 10.05.24; accepted 22.10.24; published 09.12.24

Please cite as:
Gagnon M-P, Ouellet S, Attisso E, Supper W, Amil S, Rhéaume C, Paquette J-S, Chabot C, Laferrière M-C, Sasseville M
Wearable Devices for Supporting Chronic Disease Self-Management: Scoping Review
Interact J Med Res 2024;13:e55925
URL: https://www.i-jmr.org/2024/1/e55925
doi: 10.2196/55925
PMID: