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Wearable Devices to Monitor and Reduce the Risk of Cardiovascular Disease: Evidence and Opportunities

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Keywords

wearable devices, cardiovascular disease, CVD, monitoring, risk reduction, behavioral economics

Abstract

There is a growing interest in using wearable devices to improve cardiovascular risk factors and care. This review evaluates how wearable devices are used for cardiovascular disease monitoring and risk reduction. Wearables have been evaluated for detecting arrhythmias (e.g., atrial fibrillation) as well as monitoring physical activity, sleep, and blood pressure. Thus far, most interventions for risk reduction have focused on increasing physical activity. Interventions have been more successful if the use of wearable devices is combined with an engagement strategy such as incorporating principles from behavioral economics to integrate social or financial incentives. As the technology continues to evolve, wearable devices could be an important part of remote-monitoring interventions but are more likely to be effective at improving cardiovascular care if integrated into programs that use an effective behavior change strategy.

INTRODUCTION

Cardiovascular disease (CVD) is one of the leading causes of death globally (1, 2). The prevalence of CVD such as coronary heart disease, heart failure, stroke, and hypertension in adults is nearly 50%, which accounts for over 100 million people (2). The nature of CVD progression is strongly related to lifestyle behaviors such as physical inactivity. There is a growing interest in the use of devices that can be worn to monitor an individual's activity patterns and biometrics (3). Commercially available devices are now able to track not only physical activity but also specific physiological parameters such as heart rate, heart rhythm, sleep duration, and blood oxygenation (4).

Wearable devices have attracted much attention from industry as well as the academic community (5). These commercial devices may be useful not only for consumers but also for healthcare providers, enabling them to deliver appropriate care by considering interventions that target lifestyle modifications. As of mid-2020, more than 200 clinical trials involving wearables have been completed in the United States.[1] These devices are being leveraged in many ways, with CVD monitoring and risk reduction as two of the most practical and promising applications. This article reviews the current state of the use of wearables to monitor and reduce the risk of CVD.

TECHNOLOGICAL ADVANCES IN CARDIOVASCULAR DISEASE MONITORING

The primary use of wearable devices has been for monitoring activity patterns. Recent technological progress has enabled the monitoring of diverse physiological and behavioral parameters (6–10). For example, advances in light-emitting diodes and the declining cost of sensors have allowed for increased implementation of photoplethysmography (PPG), which can enable continuous pulse rate monitoring (11). Technological improvement has increased not only monitoring capabilities but also the range of product types. In addition to smart shoes and garments, fashionable smart jewelry has been introduced (**Table 1**) (12). Worldwide shipment data reveal that wrist-worn devices are by far the most popular (10). Despite the technological improvements and widely spreading usage of commercial wearable devices, not many clinical studies have evaluated their usefulness in monitoring CVD (**Table 2**). Existing studies focus on detecting arrhythmias (e.g., atrial fibrillation) as well as monitoring physical activity, sleep, and blood pressure (4).

Arrhythmia Detection: Atrial Fibrillation

The detection of arrhythmia, particularly atrial fibrillation, is a promising target for wearable devices (4, 13). Many researchers and clinicians are interested in better using wearable devices to detect atrial fibrillation, which is associated with greater risk of serious embolic complications, such as stroke, that greatly impact quality of life (14). In addition to standard 12-lead electrocardiography (ECG), Holter ECG monitors have long been relied on to diagnose atrial fibrillation (15). However, considering the intermittent nature of atrial fibrillation occurrence and the limited duration of Holter monitors, devices with longer monitoring might be preferable. The mSToPS Trial was a randomized clinical trial and prospective matched observational cohort study evaluating iRhythm Zio, a noncommercial, single-use ambulatory ECG monitor in the form of a skin adhesive patch (16). After 4 months, the incidence of new atrial fibrillation cases was 3.9% in the immediate monitoring group. This was significantly higher than the delayed monitoring group's

[1] Search of ClinicalTrials.gov for "wearable: completed studies—results by topic," Jan. 12, 2020. **https://clinicaltrials.gov/ct2/results/browse?term=wearable&recrs=e&brwse=cond_alpha_all**.

Table 1 Characteristics of wearable devices

Part of the body	Type of device	Product name examples	Parameters monitored
Head	Headbands Eyewear	Muse Instabeat	Pulse[a] Sleep
Finger	Ring[b]	Oura Ring Motiv Ring	Pulse Blood pressure Physical activity Sleep
Wrist	Watch Wristband Bracelet[b]	Apple Watch Fitbit Moov Now	Pulse Blood pressure Physical activity Single-lead ECG (with other-hand finger) Sleep
Chest	Patch Garment (e.g., T-shirt, vest) Necklace[b] Chest strap	Lief Heartin Fit T-shirt Leaf Zephyr	Any type of ECG (single-lead or multichannel) Heart rate Sleep Respiratory rate
Waist	Belt	WELT	Physical activity
Leg	Leg garments, pants Socks Shoe insole	Athos SENSORIA Mettis Trainer	Physical activity

Abbreviation: ECG, electrocardiogram.

[a]Pulse can be used for monitoring heart rate, blood pressure, and blood oxygenation.

[b]Necklaces, bracelets, and rings are also sometimes called "smart jewelry."

incidence of 0.9%. These findings support the potential utility of continuous monitoring to diagnose atrial fibrillation.

As discussed above, PPG-derived pulse monitoring is increasing in popularity, especially by means of wrist-worn devices. The Health eHeart Study was a multinational clinical cohort study that used the Apple Watch to remotely monitor data to develop and validate a deep neural network algorithm predicting atrial fibrillation (17). This algorithm was validated in 51 patients undergoing cardioversion (sensitivity of 98.0% and specificity of 90.2%). However, in a second validation cohort of 1,617 ambulatory participants, which simulated a real clinical screening scenario, sensitivity and specificity were 67.7% and 67.6%, respectively.

The Apple Heart Study is the largest prospective cohort study evaluating PPG from a commercially available smartwatch to screen for atrial fibrillation in a broad population (18). Of the 419,297 participants, 2,161 (0.52%) received irregular pulse notifications and were then given ECG patches to wear for up to 7 days; 450 participants returned the patch, and ultimately 153 (34%) were diagnosed with atrial fibrillation. In this study, 84% of all notifications were concordant with atrial fibrillation.

Some other commercial ECG monitoring wearables, like the Apple Watch series 4 or later, and other noncommercial ECG monitoring devices, like AliveCor, enable us to obtain approximately 30 s of continuous Lead I monitoring (single-lead ECG) from the wrist. REHEARSE-AF was a randomized controlled trial using an AliveCor Kardia monitor (intermittent single-lead ECG) in ambulatory high-risk patients (≥65 years of age with a CHADS-VASc score ≥2 and free from atrial fibrillation) (19). In REHEARSE-AF, 1,001 patients were randomized to either the monitoring arm (twice per week and additional submissions if symptomatic) or routine care (no screening). Over the 12-month study period, 19 patients in the monitoring group were diagnosed with atrial

Table 2 Examples of studies that use wearables to monitor cardiovascular disease

Disease/target for monitoring	Trial name or author (reference)	Year	Device	Description
Atrial fibrillation	Apple Heart Study (18)	2019	Apple Watch	This large clinical feasibility study about PPG monitoring included 419,297 participants. Among the 2,161 participants with irregular pulse notification, only 34% of incidents were confirmed as atrial fibrillation by a subsequent ECG patch. According to this subsequent ECG analysis, 84% of all notifications were concordant with AF, which is lower than reported in the previous validation study based on PPG analysis
	Health eHeart Study (17)	2017	Apple Watch	Smartwatch PPG with deep neural network algorithm detected AF in 51 patients undergoing cardioversion with a sensitivity of 98.0% and specificity of 90.2%. In self-report of persistent AF in ambulatory participants [64/1,617 (4%) participants reported persistent AF], the C statistic was 0.72 (95% CI 0.64–0.78); sensitivity was 67.7% and specificity was 67.6%
Physical activity	Cook et al. (30)	2013	Fitbit wireless accelerometers	Fitbit wireless accelerometers in 149 postoperative cardiac surgical patients showed that in-hospital recovery could be objectively demonstrated as step counts. Thus, wearable monitoring after cardiac surgery could be considered feasible and practical
	Alharbi et al. (31)	2016	Fitbit-Flex	Among 48 cardiac patients and their families, Fitbit-Flex was highly sensitive (100%) to participants achieving guideline recommended activity. Its specificity was suboptimal: 83% for participants with ≥10,000 steps/day, and 67% for those with ≥150 min MVPA/week. Compared with Actigraph, Fitbit-Flex overestimated step counts by 1,038 steps/day and minutes of MVPA by 10 min/day. Wearable devices were reliable to classify participants who achieved the recommended physical activity guidelines
Sleep	Teo et al. (39)	2019	Fitbit Charge HR	Total sleep time and sleep efficiency were associated with cardiovascular risk markers such as body mass index and waist circumference
Blood pressure	van Helmond et al. (47)	2019	Everlast watch, BodiMetrics	The average differences between the Everlast smartwatch and reference were systolic BP of 16.9 ± 13.5 mm Hg and diastolic BP of 8.3 ± 6.1 mm Hg. The average difference between the BodiMetrics performance monitor and reference was systolic BP of 5.3 ± 4.7 mm Hg. The Everlast smartwatch and the BodiMetrics performance monitor are not accurate enough to be used as BP measurement devices
	AHA (48)	2019	No specific device mentioned	"Although current noninvasive techniques for cuffless BP monitoring have demonstrated substantial advances, the lack of accuracy and calibration issues limit their current utility" (48, p. e50)

Abbreviations: AF, atrial fibrillation; AHA, American Heart Association; BP, blood pressure; ECG, electrocardiogram; MVPA, moderate to vigorous physical activity; PPG, photoplethysmography.

fibrillation, compared to 5 in the control arm (hazard ratio 3.9; 95% CI 1.4–10.4; $p = 0.007$). While the REHEARSE-AF study demonstrated the usefulness of single-lead ECG to detect atrial fibrillation, future research can compare whether intermittent single-lead ECG monitoring or PPG monitoring is a better tool for evaluating atrial fibrillation.

The iHEART study is an ongoing single-center prospective randomized controlled trial to evaluate the usefulness, relative to routine cardiac care, of an intermittent single-lead ECG by AliveCor to detect atrial fibrillation. This study also aims to use motivational text messaging as a part of the mobile health intervention (20). Results will provide further insights on the usefulness of wearable devices in real-world clinical settings.

Physical Activity

Increasing physical activity is a significant opportunity to prevent atherosclerotic CVD and promote a healthy lifestyle (21). Among the various physical activity monitoring measures, step counts are most often used (22, 23). Several systematic reviews and meta-analyses have supported the feasibility of physical activity trackers, including accelerometers and pedometers, to monitor physical activity levels across ages (24, 25). The accuracy of both wearable devices and smartphone applications to track physical activity has also been demonstrated. A study by Case et al. (26) found that, relative to direct observation, the mean difference in step count ranged from −22.7% to −1.5% for wearable devices and −6.7% to 6.2% for smartphone applications. Other studies have also demonstrated reliable accuracy (27–29).

Cook et al. (30) demonstrated that Fitbit wireless accelerometers could be clinically feasible to monitor steps in 149 postoperative cardiac surgical patients during hospitalization. In a study of 48 cardiac patients and their families, Alharbi et al. (31) reported that the Fitbit-Flex was highly sensitive (100%) in identifying participants who achieved guideline recommended activity. Specificity was lower at 83% for identifying participants with at least 10,000 steps/day and 67% for those with at least 150 min/week of moderate to vigorous physical activity (MVPA).

While these findings highlight the utility of wearable devices for monitoring cardiovascular patients' physical activity, initial activation of these devices is reported to be only 0.2–1.0% in the general population. Once activated, monitoring continues for 80.0% of that population at 6 months (32). A recent study identified differences in monitoring sustainability between smartphone users and wearable device users; 61.2% of those in the smartphone group continued to transmit data at 180 days compared to 46.5% in the wearable group (33).

Sleep

The associations of CVD with sleep duration and quality have long been described. Sleep deficiency could lead to increases in blood pressure and early endothelial dysfunction, which contributes to CVD (34). Many commercial wearable devices, such as Jawbone UP, Fitbit Charge HR, and Oura Ring, have been validated to monitor sleep in healthy individuals (35–37). Most research shows >90% sensitivity to detect sleep but low specificity for periods of wakefulness. Thus far, only a few studies have evaluated the relationship between sleep monitoring and CVD. Kroll et al. (38) reported that Fitbit Charge HR device–derived sleep duration was moderately correlated with questionnaire-derived sleep quality among intensive care unit patients, including those with CVD. Teo et al. (39) demonstrated that total sleep time and sleep efficiency (measured by Fitbit Charge HR) are associated with cardiovascular risk markers such as body mass index and waist circumferences. Future work can explore the detection of other conditions strongly related with CVD.

Blood Pressure

Blood pressure monitoring devices have been in routine use in clinical settings (40). Ambulatory monitoring, which requires blood pressure measurements every 15–30 min during the day and every 15–60 min overnight, can be uncomfortable and disruptive to daily life and sleep (41, 42). However, recent cuffless blood pressure monitoring devices estimate blood pressure using ECG signals or PPG signals without causing major inconveniences (43). These devices measure not only blood pressure but also variability, which can be useful for hypertension prognosis prediction and management (44). Additionally, small skin patches with ultrasound technology have been suggested as future wearable devices to monitor blood pressure (45). From the perspective of a strict universal standard for validating blood pressure monitoring devices, these are still regarded as less accurate for clinical application (44, 46). For example, van Helmond et al. (47) reported that the average differences between the Everlast watch and reference (using a hospital-grade automated sphygmomanometer) were systolic blood pressure of 16.9 ± 13.5 mm Hg and diastolic pressure of 8.3 ± 6.1 mm Hg, implying that this tool is not accurate enough to be used as a clinical measurement device. The American Heart Association (AHA) also recently released a statement which reads, "Although current noninvasive techniques for cuffless BP monitoring have demonstrated substantial advances, the lack of accuracy and calibration issues limit their current utility" (48, p. e50). Further improvement and refinement will be needed to use commercial devices for the purpose of monitoring blood pressure.

RISK REDUCTION STRATEGIES USING WEARABLE DEVICES

Wearable devices are increasingly being used in interventions focused on changing behavior (49). Systematic reviews suggest that simply using wearable devices is associated with little benefit for changing health behaviors, but they can be more effective if combined with behavior change strategies (50–52). Although few prospective intervention studies have examined the direct impact of wearable device usage on cardiovascular mortality and morbidities, there is evidence on using wearable devices to increase physical activity (53).

Simple monitoring-based interventions have shown limited promise. The mActive study showed that among 48 randomized patients at an academic CVD prevention center, tracking physical activity with a Fitbug Orb did not increase step counts significantly [1,024 steps/day (95% CI −580–2,628; $p = 0.21$)]. However, participants who also received texts increased their daily steps by 2,534 steps (95% CI 1,318–3,750; $p < 0.001$), a significant increase relative to those who did not receive texts. Furthermore, compared to non-feedback controls who wore the Fitbug Orb but were blinded to the numeric physical activity feedback information provided by the tracker, the text message arm had 3,376 more steps (95% CI 1,951–4,801; $p < 0.001$) (54). This result demonstrated that only feedback on physical activity might not lead to substantial changes in steps.

Ramadi & Haennel (55) also reported that cardiac rehabilitation with SenseWear Mini Armband monitoring did not reduce sedentary behavior. The percentage of waking time spent in MVPA increased initially (baseline: 6.9 ± 5.4% versus 12 weeks: 9.1 ± 6.8%; $p < 0.05$) but returned to the baseline level at the 6-month follow-up ($p = 0.813$) (55). This is similar to the phenomenon of weight regain after loss in weight reduction trials (56). Internal perceived barriers, such as stress and time, and external barriers, including lack of social support, can be discouraging (57). Although this is quite common across populations, some differences exist among those with CVD. The HONOR Trial was a randomized clinical trial conducted at three US medical centers for patients with peripheral artery disease (58). A home-based exercise intervention with wearable physical activity monitoring and telephone coaching in peripheral

Table 3 Behavioral economics approaches for cardiovascular disease risk reduction

Risk reduction strategy examples	Trial name (reference)	Year	Device	Description
Make rewards tangible and in a familiar context	TRIPPA trial (64)	2016	Fitbit Zip wireless activity tracker	800 participants were randomly assigned to the control, Fitbit, charity, or cash group. At 6 months and at 12 months, compared with control, the cash group logged an additional 29 MVPA bout min per week (95% CI 10 to 47; $p = 0.0024$). At 12 months, the Fitbit group logged an additional 37 MVPA bout min per week (95% CI 19–56; $p = 0.0001$) and the charity group an additional 32 MVPA bout min per week (95% CI 12–51; $p = 0.0013$) compared with control. Unfortunately, there were no improvements in any health outcomes (weight, blood pressure, etc.)
Social incentive–based gamification	BE FIT randomized clinical trial (65)	2017	Smartphone application (Moves or Fitbit) or Fitbit-Flex	Gamification arm had a significantly greater increase in mean daily steps compared with baseline (1,661 versus 636; adjusted difference 953; 95% CI 505–1,401; $p < 0.001$) than the control arm. During the follow-up period, physical activity in the gamification arm declined but remained significant (1,385 versus 798; adjusted difference 494; 95% CI 170–818; $p < 0.01$)
Loss-framed financial incentives	ACTIVE REWARD randomized trial (65)	2018	Misfit Shine	Loss-framed financial incentives with personalized goal setting and wearable devices increased adjusted daily steps by 1,368 (95% CI 571–2,164); effect persisted after 8 weeks
Gamification with several approaches	STEP UP randomized clinical trial (66)	2019	Withings Activité Steel	Gamification with support, collaboration, and competition showed adjusted difference improvement of 710 (95% CI 316–1,104), 645 (95% CI 262–1,027), and 936 (95% CI 516–1,356) steps, respectively, compared with control

Abbreviation: MVPA, moderate to vigorous physical activity.

artery disease patients did not improve walking performance at 9 months; the between-group difference was −8.9 m (95% CI −26.0–8.2 m; $p = 0.31$). In accordance with these findings, an AHA statement noted that home-based exercise and rehabilitation may not achieve similar levels of safety and efficacy among ischemic heart disease patients (59).

Interventions that use behavior change theories along with monitoring devices could be effective. Huffman et al. (60) performed a randomized clinical trial testing a positive psychology approach (motivational interviewing) and a noncommercial Actigraph G3TX+ accelerometer. It was a 12-week, phone-delivered intervention among 47 postacute coronary syndrome patients with low baseline health behavior adherence as assessed by the Medical Outcomes Study Specific Adherence Scale. The intervention was associated with more daily steps at 12 weeks (estimated mean difference of 1,842.1 ± 849.8 steps/day; $p = 0.030$) and MVPA at 24 weeks (estimated mean difference of 15.1 ± 6.8 min/day; $p = 0.026$) compared to the control group.

Insights from behavioral economics could be used to improve the design of interventions (**Table 3**). Behavioral economics combines principles from economics and psychology to understand how individuals behave and make decisions. Interventions leveraging behavioral economics have shown promise in helping people achieve their longer-term goals (61). Several common decision errors and biases, such as status quo bias and loss aversion, have been shown to be effective

in changing behavior when combined with wearable devices (62). In the ACTIVE REWARD randomized trial, $14 was allocated to a virtual account each week; $2 could be lost per day for not achieving step goals. The investigators found that among ischemic heart disease patients, a wearable device and loss-framed financial incentives with personalized goal setting increased physical activity by 1,368 steps/day (95% CI 571–2,164) and persisted for 8 weeks after the intervention completed (63). TRIPPA was a randomized trial to evaluate making the rewards tangible and orienting them in a familiar context. In total, 800 participants were randomly assigned to four groups: control (wearing no device and receiving a weekly participation payment), only wearable (wearing Fitbit and receiving a weekly participation payment), charity (wearing Fitbit and receiving a monetary incentive to donate to charity), and cash (wearing Fitbit and receiving a monetary incentive to keep). The participation payment, which was given regardless of whether goals were reached, was smaller than the incentives in the charity and the cash groups. The monetary incentives were determined by the participants' weekly step counts. The study outcome was "MVPA bouts" in minutes (a bout was counted if at least 8 of 10 consecutive minutes of MVPA were reached). At 6 months, compared with control, the cash group and the charity group logged an additional 29 weekly MVPA bouts (95% CI 10–47; $p = 0.0024$) and 21 bouts (95% CI 2–39; $p = 0.0310$), respectively. At 12 months, the Fitbit group and charity group logged an additional 37 weekly MVPA bouts (95% CI 19–56; $p = 0.0001$) and 32 weekly MVPA bouts (95% CI 12–51; $p = 0.0013$), respectively. The difference between cash and control was not significant. In addition, there were no improvements in any health outcomes (weight, blood pressure, etc.) (64). This study suggests that cash incentives can have a big initial impact on behavior, but sustaining these effects can be challenging.

Gamification is another approach that has been combined with wearables to increase physical activity. Gamification is the use of game design elements such as points and levels in nongame contexts. The BE FIT randomized clinical trial was a gamification intervention among a Framingham Heart Study cohort. In this study, participants were endowed with 70 points every Monday (10 for each day of the upcoming week). Each day they did not meet their step goal, they lost 10 points. Daily steps were tracked using a smartphone application (Moves or Fitbit) or Fitbit-Flex. The gamification arm had a significantly greater increase in mean daily steps from baseline relative to the control arm (1,661 versus 636; adjusted difference 953; 95% CI 505–1,401; $p < 0.001$). During the follow-up period, change in daily steps in the gamification arm declined, but the difference from the control group remained significant (1,385 versus 798; adjusted difference 494; 95% CI 170–818; $p < 0.01$) (65). The STEP UP randomized clinical trial was another gamification study that found a significant improvement of daily steps in the intervention arm compared to the control arm (66). The adjusted difference improvement was 710 steps (95% CI 316–1,104) in the "gamification with support" arm; 645 steps (95% CI 262–1,027) for "gamification with collaboration"; and 936 steps (95% CI 516–1,356) for "gamification with competition." During follow-up, an effect remained only in the competition group. These studies reveal the potential of using behavioral economics with wearable devices for sustained impact, and their findings can be applied in clinical practice to improve physical activity (67).

CURRENT CHALLENGES AND FUTURE OPPORTUNITIES

For wearables to have a larger impact, several challenges must still be addressed. First, the accuracy of measurement varies among monitoring targets and devices (**Table 4**). Although some measurements, including step count, are considered fairly accurate, others, including blood pressure, need further improvement and evaluation. These devices must accurately measure data to be trusted by clinicians and patients to inform medical decision making. Second, data privacy should

Table 4 Opportunities and challenges of using wearable devices for cardiovascular disease management

Disease/target for monitoring	Parameters monitored	Challenges
Atrial fibrillation	Pulse (usually by PPG)	Pulse irregularity does not always mean atrial fibrillation Body movement could result in artifacts which might affect the measurement The clinical impact of early detection of asymptomatic atrial fibrillation is still under discussion
	ECG	Many watch-type devices and small patches can monitor only single-lead ECG, but wearable vests could offer multichannel ECG monitoring Compared with multichannel ECG monitoring like Holter ECG, the performance of detecting arrhythmias by single-lead devices is limited The clinical impact of early detection of asymptomatic atrial fibrillation is still under discussion
Hypertension	Blood pressure	Cuffless blood pressure monitoring (e.g., PPG-based or tonometry-based blood pressure monitoring) needs further validation for clinical use Pulse pressure, variability, and other indices could also be calculated but still need validation
Physical inactivity	Step counts	Accuracy of measuring step counts could differ among many devices and measuring points Overestimates and underestimates of step counts cannot be ruled out
Sleep abnormalities	Raw activity scores (usually by using actigraphy)	Definitions of sleep duration and quality vary among many devices Optimal sleep quality and duration are still being debated For the purpose of risk reduction for cardiovascular disease, the intervention strategy to improve sleep duration and quality has not been established

Abbreviations: ECG, electrocardiogram; PPG, photoplethysmography.

be taken into account in the design of remote-monitoring programs (68, 69). Wearable device data are sometimes collected by the device manufacturer, which may impinge on patient privacy goals, thereby reducing uptake (70). Third, it is important to consider whom to target with interventions that use wearables. As revealed in the Apple Heart Study, over-diagnosis of atrial fibrillation could increase the potential burden for not only primary and cardiology clinics but also patients (71). Finally, as mentioned above, monitoring by wearable devices in itself might not improve outcomes. Monitoring should be delivered with effective behavior change intervention strategies, such as those that incorporate principles from behavioral economics.

Although some barriers exist, there are promising opportunities with wearable devices. For example, some devices have implemented blood oxygenation monitoring, which can offer new management strategies for heart failure and many CVDs. Further technological improvements to wearable devices, such as longer battery duration, waterproof properties, and greater monitoring accuracy, will not only enhance our knowledge about CVD but also contribute to improvements in patient care.

CONCLUSION

There is an increasing interest in using wearable devices to monitor and reduce the risk of CVD. As the technological capabilities advance, these devices will be a key part of remote-monitoring programs that passively track health behaviors and biometrics. Most interventions to reduce the risk of CVD have been focused on increasing physical activity, and there is an opportunity to use these devices to change other health behaviors and potentially cardiovascular outcomes. However,

it will be important to design programs that combine the use of wearables with behavior change strategies and to rigorously evaluate their impact over longer-term periods.

DISCLOSURE STATEMENT

M.S.P. is the founder of the consulting firm Catalyst Health LLC, and is on the advisory boards of Life.io, Healthmine Services, and Holistic Industries.

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