



Using behavioral economic interventions with remote-monitoring technologies to increase physical activity

Sujatha Changolkar, Kevin G. Volpp, & Mitesh S. Patel

abstract

Many workplaces and insurers sponsor programs to increase employees' physical activity, but these programs often fail to create healthy behaviors or else work only temporarily. They typically offer financial incentives without considering cognitive biases that influence whether people will join the programs and remain committed to exercising. We argue that interventions should leverage both insights from behavioral economics and the availability of remote-monitoring technologies, such as automatic step trackers, to be more effective. In this article, we summarize relevant insights from behavioral economics, highlight research findings that show the value of combining behaviorally informed program design with remote monitoring, and suggest strategies for selecting interventions and remote-monitoring devices.

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Core Findings

What is the issue?

Organizations continue to implement programs aimed at improving employee health outcomes. But these workplace wellness programs often fail to (a) address underlying cognitive biases, (b) capitalize on behavioral insights, and (c) use emerging remote-monitoring technologies that would lead to sustained improvements in employee health.

How can you act?

Selected recommendations include:

- 1) Designing social incentives that give rewards to individuals only if the group as a whole meets predetermined health targets
- 2) Embedding remote-monitoring technologies within some form of a feedback loop to help people develop a habit of regular wear and use

Who should take the lead?

Researchers, employees, managers, and organizations

Employees who exercise regularly reduce their risks for heart disease and other serious disorders,¹⁻⁴ and their efforts are also good for their employers' bottom line: the employees use fewer health care dollars, show up to work more often, and are more productive.⁴ Yet most Americans are not active enough to reap these benefits for themselves or their employers. Only 53% of adults do the recommended amount of aerobic exercise identified in the Physical Activity Guidelines from the U.S. Department of Health and Human Services,⁵ and only 23% achieve the recommended amounts of both aerobic and muscle-strengthening activities. Consistent with the Centers for Disease Control and Prevention's recommendations,⁶ over 85% of large employers offer financial incentives for health promotion through workplace wellness programs.⁷ Recent evidence indicates, however, that the programs may not be effective at sustaining the behavior change needed for better health.⁸

We believe that workplace programs intended to increase physical activity can be improved by applying insights from behavioral economics research and incorporating remote-monitoring technologies, such as smartphone apps, wearable activity trackers (like Fitbits), and smart watches. This combination addresses two major limitations of typical programs. For one, the designs of workplace wellness programs are often based on standard economic thinking, which assumes that people act rationally and make decisions that align perfectly with their long-term goals.⁹ Yet, as behavioral economics research has revealed, people commonly make decisions that belie these assumptions. For example, individuals tend to be more motivated by the prospect of losing a given amount than by the prospect of gaining the same amount.¹⁰ People also tend to choose to receive smaller awards immediately rather than larger rewards later.¹¹ They are strongly motivated to avoid regret over choices they make.¹² Interventions that take people's "predictably irrational"¹³⁻¹⁶ tendencies into account should help to improve motivation and outcomes in several phases of exercise programs, including initial engagement with a fitness program, participation in the early

stages, and long-term maintenance of the exercise habit.

The other major limitation of most workplace wellness programs is a reliance on self-reported data: participants have to log in to a website and manually input step counts, gym attendance, or other information. This requirement creates extra work for participants and also creates the possibility of inaccuracies, either because of a desire to be seen favorably by others or because of recall errors.¹⁷ Activity trackers, smart watches, and smartphones^{18,19} provide an easier, more accurate way of tracking exercise. In the 2018 Physical Activity Guidelines for Americans, the U.S. Department of Health and Human Services recommends using such technologies to monitor physical activity levels.²⁰ However, evidence indicates that remote-monitoring tools are not by themselves enough to motivate sustained behavior change.^{18,19,21} The immediate feedback (which is more motivating than delayed feedback) facilitated by such technologies can add to the motivational prods provided by interventions based on behavioral economics.

In this article, we review a number of the behavioral biases that influence human decisionmaking and discuss how employers and insurers can leverage these factors to improve the design of physical activity interventions in the workplace. Table 1 summarizes many of these ideas. In the course of that discussion, we provide examples from clinical trials that used behaviorally designed interventions in combination with remote-monitoring technologies, and we highlight current gaps in evidence that warrant further investigation. We also provide strategies for selecting interventions and describe options for remote-monitoring technologies.

Behavioral Biases That Can Affect Responses to Exercise Incentives

Status Quo Bias

People tend to stick with the current state (or status quo)—that is, the path of least resistance.²² When offered a default option, most

Table 1. Factors influencing behavior & their potential design implications

Influence	Design implication
Status quo bias	Make participation the default option.
Present-based preferences	Provide multiple stepwise goals and immediate rewards; use precommitment pledges.
Probability inflation	Use lottery-based rewards.
Regret aversion	Inform individuals of what they would have received had they met their goal.
Loss aversion	Put rewards at risk of being lost if a goal is not achieved.
Sensitivity to social forces	Set up competitions; require participants to collaborate in groups; enlist participants' friends and family to provide support; contribute to charitable causes on behalf of participants.

people choose it because doing so requires less effort than opting out does. Studies have shown that health care decisions related to prescribing medications, ordering imaging tests, and setting goals for end-of-life care are significantly affected by the choice that is presented as the default.^{23–29}

Most physical activity interventions are presented as opt-in choices, requiring participants to actively enroll, which is a barrier to high participation rates. For example, in a study of health insurance beneficiaries across the United States, only 1.2% signed up for a wellness program that offered rewards for connecting to an activity tracker and achieving physical activity goals.¹⁹ Several studies of medical interventions have demonstrated that presenting participation as the default, with an opportunity to opt out, leads to higher participation. In a randomized trial among people with uncontrolled type 2 diabetes, making a remote-monitoring diabetes management program an opt-out default resulted in 38% enrollment, compared with 13% enrollment in the opt-in arm.³⁰ In a randomized trial among patients who had recently had heart attacks, framing a remote-monitoring medication management program as an opt-out plan led to 39% enrollment, compared with 16% enrollment in the opt-in arm.³¹ In the same way, in a randomized trial of patients due for colorectal cancer screening, presenting the screening tool known as fecal immunochemical testing as an opt-out default led to 29% of patients being screened; in the opt-in arm,

10% were screened.³² Similarly, physical activity programs could well attain higher engagement if enrollment were framed as the default, with people being given the choice to opt out.

Present-Based Preferences

Evidence shows that people tend to place more value on the present than on the future, preferring immediate rather than delayed gratification. This preference holds true even when the delayed reward is larger.^{11,33} A present-biased person, therefore, would rather receive \$10 today than wait for \$20 at a later time. Although many wellness programs ask participants to change their present behavior in anticipation of a future reward, it may be more effective to offer more immediate rewards and more frequent communications about progress toward earning more rewards. For example, individuals could be given a daily target for steps and notified each day as to whether they achieved their goal and earned a reward. The reward itself can be delivered at a later time (such as weekly or monthly), but daily communication about fitness achievements and the rewards those achievements have unlocked is a powerful motivator. This type of daily communication (combined with automatic recording of measurements) has been tested in several clinical trials and found to lead to significant improvements in diabetes monitoring,³⁴ physical activity,^{35,36} and weight loss.^{37,38}

Present bias may also help to explain some other phenomena that could be useful in designing interventions. One is that people tend to work

“people work harder as the finish line becomes part of the present rather than the future”

harder as they get closer to a goal, or, to frame it in terms of present bias, people work harder as the finish line becomes part of the present rather than the future. Studies have shown that working toward multiple stepwise goals (or *goal gradients*) sustains motivation better than does one big far-off goal.^{39,40}

Conversely, temptations are harder to resist in the present than in the future. It is easy to decide to skip dessert tomorrow night but difficult to resist a dessert on the table in the present moment. Written and signed precommitment pledges can help to keep commitments top of mind and thereby help people stick with long-term plans, including exercise goals.

Probability Inflation

Individuals tend to overestimate the likelihood that low-probability events will occur.^{41,42} That is why so many people buy lottery tickets, and it is also why lottery-based incentives can motivate people to exercise. Programs can, for instance, incentivize participants by entering them in lotteries when they meet program requirements, such as attending an exercise class twice a week.

In a randomized trial of overweight and obese adults, physical activity levels were measured automatically via a smartphone app for participants in three experimental groups (each offered a different lottery incentive) and in a control group that did not receive lottery tickets.⁴³ Two of the incentives were single-tiered: one provided a high probability of winning a small reward, and one provided a lower probability of a much larger reward (a jackpot). The third incentive was two-tiered and included a high-frequency small reward along with a low-frequency large reward. People in the jackpot lottery condition, a setup commonly used in health promotion efforts, had worse outcomes over time than those in the control

condition did, perhaps because the lottery participants realized they were unlikely to win. The two-tiered lottery, which likely balanced both immediate rewards (owing to frequent wins) and probability inflation, was the most effective in increasing participants' physical activity.

Regret Aversion

People anticipate and strongly fear the regret they feel after making a wrong choice; having such aversion to regret, they will often take action to avoid it. The Dutch Postcode Lottery has been highlighted as an example of a program that capitalizes on regret aversion.¹² In this lottery, a postal code is randomly selected, and prizes are distributed only to people who entered the lottery and reside in the selected area. Residents living in a winning postal code who did not buy a lottery ticket see neighbors being rewarded and, wanting to avoid future regret over missing out on the winnings, become more likely to purchase a lottery ticket the next time tickets are available.

Physical activity interventions could use a similar technique by randomly selecting a different group of program participants each day and rewarding those in the group who met their goals. Group members who see their friends being rewarded would be motivated to hop back on the wagon to prevent that feeling of regret the next time the group was selected. In the absence of multiple groups, program designers could capitalize on regret aversion by informing participants of what they would have won that day had they met their goals, as a way of encouraging them to try again tomorrow.

Loss Aversion

Prospect theory, a core concept in behavioral economics, holds that people are loss averse: they tend to be motivated more by avoiding losses than by obtaining equivalent gains.¹⁰ This principle has been implemented in health promotion efforts through deposit contracts, which ask participants to forfeit money (that is, lose all or part of their deposit) if a goal is not achieved. However, many people do not like to participate in programs that could involve losing money. For example, in a randomized

trial focused on smoking cessation, only 14% of those assigned to a deposit contract incentive chose to accept it, compared with 90% of those assigned to a reward-based incentive.⁴⁴

Several studies have tested the value of leveraging loss aversion by framing reward-based incentives as losses. In a randomized trial of overweight and obese adults, participants in an exercise program were randomly assigned to receive one of three daily financial incentives each valued at \$1.40 per day for three months or to a control group.³⁶ All participants used a smartphone to track step counts and were asked to achieve at least 7,000 steps a day. The three incentives were framed as either a gain (receive \$1.40 for each day the goal is met), a lottery (similar to the two-tiered lottery incentive previously discussed), or a loss (lose \$1.40 from a virtual account of \$42 for each day that the goal is missed). Participants in the control group, who received daily feedback but no financial incentives, achieved step goals 30% of the time. Participants in the gain-framed incentive and lottery incentive arms achieved goals 35% and 36% of the time, respectively, but neither result was statistically different from the result for the control group. The most effective design used the loss framing: its participants achieved the goal 45% of the time.

Loss-framed financial incentives were also used in a clinical trial aiming to increase physical activity among patients with heart disease.³⁵ Patients were asked to use a waterproof wrist-worn activity tracker that could go over six months without needing its battery charged, and they were randomly assigned either to a control group that used the wearable activity trackers alone or to an intervention group that used the activity trackers, had personalized step targets, and received loss-framed financial incentives. Step targets increased gradually from baseline for the first eight weeks and then remained constant for another eight weeks. During the 16 weeks, \$14 was allotted to a virtual account weekly and \$2 was taken away each day the participant did not achieve the step goal. Over the course of the trial, patients in the intervention group increased their daily activity from baseline by 1,368 more steps than the control

“participants in the intervention group took 1,154 more steps daily”

group did. During an eight-week follow-up, the participants in the intervention group took 1,154 more steps daily than those in the control group did, sustaining a significant difference even after the incentives ended.

Several insurers have launched programs that use loss-framed incentives to motivate their members. These programs often include a wearable activity-tracking device provided to the user at no or very low cost, as long as the user meets a monthly activity goal. Each month that users do not meet their goal, they pay back a portion of the cost of the device through their health insurance premium. By offering an expensive wearable activity-tracking device at little or no cost, these programs engage a larger proportion of the population than a typical wellness program otherwise might. The insurers also stand to reap a financial benefit: they recoup the cost of the device from people who do not meet activity goals and foot the bill only when people engage in the desired healthy behavior, which can yield lower costs in the future by mitigating health problems that often arise from inactivity. A recent study by the RAND Corporation found that a program of this sort offered by Vitality resulted in increased physical activity among members who opted to receive an Apple Watch.⁴⁵

Incentive Options

So far, our examples of interventions have illustrated ways that insights from behavioral economics can inform the design of financial incentives, such as lotteries and deposit contracts. See Table 2 for descriptions of study designs that use financial incentives informed by behavioral research. But anything that motivates a behavior can be an incentive. Behavioral economics research has generated evidence that various nonmonetary incentives can also influence behavior—such as by tugging on

Table 2. How financial incentives can leverage behavioral principles

Incentive	Design example	Description	Sample communication to an individual	Behavioral economic principle applied
Conditional payment (reward tied to meeting a goal)	Reward framed as a gain and given immediately	Reward allocated once a goal is completed	Each day you achieve your step goal, you will receive \$2.	Present-based preferences (immediate gratification)
	Reward framed as a loss	Reward allocated up front and taken away if the goal is not met	\$14 has been allocated to your account this week. Each day you do not achieve your step goal, \$2 will be removed.	Loss aversion
Deposit contract	Individual's money is put at risk	Individuals allocate their own money and, if the behavior is not completed, it is not returned	You put down \$100 of your own money for the 50-day program. If you achieve your average step goal, this will be returned with a 1:1 match. Otherwise, you will lose your contribution.	Loss aversion
Lottery	Single tier	Tickets earned for a lottery with <i>either</i> a high probability of winning and low incentive amount <i>or</i> a low probability of winning and high incentive amount	Each day you achieve your step goal, you are eligible for a lottery with a 1% chance of winning \$200.	Probability inflation
	Multiple tiers	Tickets earned for a combination of two or more single-tier lotteries	Each day you achieve your step goal, you are eligible for a lottery with a 10% chance of winning \$10 and a 1% chance of winning \$100.	Probability inflation and present-based preferences

people's social sensitivities or evoking their desire to win at games. Socially based incentives, as discussed next, can be applied alone or embedded in interventions that use financial incentives, and the effects of both financial and social incentives can be enhanced through a gamified design.

Social Incentives

The social sensitivities that influence motivation can take many forms.⁴⁶⁻⁴⁸ For instance, people can be motivated by the support of another person, the desire to help others, the desire to win a competition against other people, or even the enjoyment of bonding with others in the pursuit of shared goals. In Table 3, we present some benefits and risks of using social incentives.

In one type of social incentive, a program makes a donation to charity when a participant meets a goal. Kristin Harkins and her colleagues conducted a physical activity trial assessing the impact of weekly feedback plus incentives consisting of either money given to the individual, money given to a charity, or money

split between the individual and the charity.⁴⁹ (All participants, including those in the control group, wore digital pedometers.) People in all three incentive arms increased physical activity more than participants in the control group did. The researchers did not find significant differences between the intervention arms.

Eric Finkelstein and his colleagues conducted a randomized trial of individuals in Singapore to test whether waist-worn activity trackers could increase physical activity either alone or in combination with a cash payment given (if set goals were met) to the participant or to a charitable cause.⁵⁰ The participants in the cash and charity incentive groups (who could earn up to \$30 per week) increased their physical activity most during the six-month intervention. The participants in the charity incentive group performed significantly more exercise than did the control group participants, who received neither trackers nor incentives. However, the differences between the cash incentive and control groups quickly dissipated during the six-month follow-up period. Two groups continued to engage in significantly more

Table 3. Opportunities & challenges posed by social incentives

Incentive type	Potential opportunity	Potential challenge
Support	Participants are motivated by the support of others in their social networks.	This requires effort from others, who may not be as engaged in the behavior.
	Participants are motivated to help others by earning rewards that are donated to charity.	The participant may not feel directly tied to an external organization, so the reward feels distant.
Competition	Participants are motivated to improve behaviors after seeing others' behavior.	Lower performers may become discouraged and drop out.
Collaboration	Participants are motivated to work together in groups to accomplish a collective goal.	Lower performers may prevent the group from reaching its goal.

physical activity than the control group did, though: those who had received a tracker with no incentives during the study and those who had received the charity incentive. This study, like that of Harkins and her colleagues, demonstrates that charitable financial incentives can bring about behavior change. However, the results of the study conducted by Finkelstein and his colleagues suggest that extrinsic rewards, such as financial incentives given directly to the individual, work only while they are being offered, as activity tracker use dropped rapidly after the individual incentives ended.

Another type of social incentive involves giving rewards to individuals only if the group as a whole meets its targets. Members of our research group conducted two trials using social and financial incentives in tandem, along with remote-monitoring technology, to increase physical activity.⁵¹ In the first trial, they examined the impact of financial incentives valued at \$1.40 per day at two levels—the individual and the team—and found that a combination of both was the most effective. People who received only individual or only team incentives did no more exercise than did participants in the control group, who received no incentive. This result suggests that incentives are likely to be most effective if they both reinforce the actions of individuals and appeal to their desire to contribute to their team's success.

In the second trial, our research group evaluated the impact of letting teams know how their performance compared with that of other teams.⁵² In some teams, participants received

lottery-based financial incentives for taking 7,000 steps a day, whereas the others received no financial incentives. All teams received weekly feedback on how their step counts compared with the steps achieved by teams who were in either the 50th percentile (that is, the average teams) or the 75th percentile. This trial revealed that the combination of monetary reward with normative feedback (50th percentile) was the most effective at increasing physical activity. These findings are directly relevant to many programs that display leaderboards of the top performers, because highlighting superior performance may inadvertently discourage those participants who need motivation the most. Programs could be improved by delivering normative information in the feedback rather than putting so much focus on the top performers.

Evidence from other research suggests that providing peer comparisons without incentives can have an unintended consequence of pulling down individuals' performance to match the levels of the lowest performing participants; it is possible that in our trial, the lowest-common-denominator effect was mitigated in the 50th percentile comparison group through the use of team-based collaboration along with peer comparison.⁵³ It may be that one type of comparative feedback works better for those who already exercise at a level close to the goal, whereas a different type works better for those for whom there is a large gap between current activity and the goal; this is a question for future research to explore.

85%

Large employers offering financial incentives in workplace wellness programs

53%

U.S. adults who do the amount of aerobic exercise recommended by the DHHS

23%

U.S. adults who do the amount of both aerobic exercise and muscle-strengthening activities recommended by the DHHS

Several other clinical trials have also shown that competition in combination with incentives—at either the individual or the team level—can be effective for increasing adherence to exercise goals.⁵⁴ Jingwen Zhang and coauthors compared four groups of participants who were rewarded for attending exercise classes (this study did not use remote-monitoring devices). In one group, participants competed as individuals. In another group, teams of participants competed against other teams. In a third group, participants received incentives as a team but did not compete against other teams. In the control group, participants simply received individual incentives for attending the classes. The researchers found that participants in the two groups involving competition attended significantly more exercise classes than did participants in the other groups.

The use of social incentives has not been restricted to research; many workplace programs have been leveraging both social and financial incentives to promote physical activity. In 2015, Target launched its Fall Fitbit Challenge, using a corporate wellness platform from Fitbit. More than 300,000 Target employees were eligible for one free or discounted Fitbit, and they competed in teams for the highest daily step counts. Target, which did not publish a formal analysis of its employees' physical activity, donated \$1 million to a charity selected by the winners.

Gamification

Gamification is the use of game elements such as points and levels in nongame contexts; the fun of amassing points and reaching new levels can be motivating, even in the absence of monetary rewards. Insurers and smartphone applications often use gamification to try to spur people to be more physically active.^{18,55} However, a recent review of the top health and fitness applications found that although two-thirds used elements of gamification, few, if any, used key insights from behavioral economics to optimize their design.⁵⁵

Members of our research group conducted one of the first clinical trials using behaviorally designed gamification to increase physical

activity among families (this was, by the way, the first intervention study ever done with participants in the famous Framingham Heart Study, which has been investigating the risk factors for heart disease since 1948).⁵⁶ The game incorporated many elements of behavioral economics. Participants signed a pledge to strive to reach their goal (precommitment). Points were endowed up front and could be lost if goals were not met (loss aversion). Participants, whose steps were tracked by a wearable device, progressed through levels (goal gradients) and were informed of progress daily via text message or email. Further, they were teamed up with family members (collaboration). Each day, one person from each group was selected at random to represent the family, and the entire family lost points if that person had not achieved the prior day's goal. Family members in the three-month intervention achieved their step goals about twice as often as did participants in the control group (who only received daily feedback on step goal attainment and no other intervention). They also walked nearly 1,000 more steps per day. Differences were smaller but sustained during the three-month follow-up period.

In a later clinical trial, we conducted a similar behaviorally designed gamification intervention for overweight and obese employees from 40 U.S. states and compared three social incentives: collaboration (the team was rewarded if a randomly chosen team member achieved a daily step goal), competition (participants competed against teammates for first place), and support (a friend or family member received performance reports and offered support).⁵⁷ During the six-month intervention, all three intervention groups increased their physical activity at statistically significant levels relative to the control group's activity. The competition group performed the best, with its participants increasing their physical activity by 920 more steps per day than participants in the control group did. The people assigned to the collaboration and support arms had daily step increases of 637 and 689, respectively. During the three-month follow-up after the game's end, the physical activity of participants in the collaboration and support arms looked no different from

the activity of those in the control condition, but participants in the competition arm maintained increases of 569 steps more per day than the control group participants did. It is possible that a competitive social incentive compounds the benefit of a gamified design, as there are two rewards for participants to win: points in the game and first place on a team. This possibility could be explored further in future research.

Selecting the Right Behavioral Economic Approach

The collected findings suggest that combining remote-monitoring technologies with behavioral economic approaches holds great promise for spurring people to exercise more. However, different behaviorally designed interventions have not been tested head-to-head or for long durations. More evidence is therefore needed before comprehensive guidelines for designing programs meant to increase physical activity can be constructed. Nevertheless, on the basis of existing research, we can offer some ideas for selecting behavior-change strategies and technologies.

First, the easier it is to use a remote-monitoring technology, the more likely it is that people will use it consistently. Syncing, charging, and recording are all barriers to use, as is having to remove a wearable device before showering or swimming. Many new wearable devices have long-lasting batteries and are waterproof; these features help circumvent barriers that contribute to disengagement over time. In accordance with the status quo bias (and common sense), the less participants have to do to maintain the technology, the more likely it is they will continue engaging in the program.

Second, several low-cost and easily applied interventions have been shown to motivate exercise-related behavior change—notably, precommitment contracts, in which participants pledge to do their best to increase physical activity, and goal setting by the participants themselves.^{56,57} These approaches can be useful when a program lacks the resources needed to provide frequent interactions with participants.

“Syncing, charging, and recording are all barriers to use”

Third, social incentives should be considered when people already have strong ties with one another, as is the case at work or when multiple members of a household need to increase their activity. Gamification often pairs readily with interventions that include social incentives and can help to make challenging endeavors more fun. Social interventions and ones that leverage features of gaming are particularly suitable for helping people sustain new habits when providing ongoing financial incentives is not feasible.

Fourth, financial incentives—which can be easily distributed through mechanisms that already exist, such as insurance plans or workplace wellness programs—can help accelerate the adoption of new behaviors. However, deciding when they are worth the cost can be difficult. Monetary incentives can be worth it when enticing people to join a program is challenging or if the incentives can offset other costs, for example, by decreasing hospitalizations or the recurrence of health problems (such as second heart attacks). Although most physical fitness programs still frame incentives in terms of gains,⁵⁸ evidence suggests that they could be more effective if framed as losses or delivered in the form of lotteries.

Selecting the Right Remote-Monitoring Technology

Table 4 outlines differences among traditional pedometers, wearable activity trackers, and smartphone apps. Pedometers are meant to be carried or clipped to clothing and serve no major function outside of tracking step counts. Smartphones can passively track physical activity data and transmit information to remote servers; however, a person’s activity is monitored only while the phone is being carried.

Wearable devices, such as Fitbits and other activity trackers, are more fashionable and are designed to be worn visibly, typically on the

Table 4. Characteristics of devices & tools to monitor physical activity

Characteristic	Pedometer	Wearable activity tracker	Smartphone application
Remote-monitoring capability	No	Yes	Yes
Location commonly worn	Waist or pocket	Wrist	Pocket
Behavior for physical activity tracking	Carry or clip on	Wear	Download app, carry phone
Managing physical activity data	User manually logs in to website	User regularly syncs to another device and charges battery	Phone passively transmits to cloud servers
Cost	\$10+	\$100+	Free
Population-level adoption in United States	Very low (<1%)	Low but increasing (~5%–10%)	Very high ^a (81%)

^aThis figure refers to smartphone ownership (as reported by Pew Research Center: <https://www.pewresearch.org/internet/fact-sheet/mobile/2019/>); use for tracking activity can be assumed to be lower.

wrist. They tend to serve multiple functions, with capabilities ranging from displaying time to providing directions in addition to tracking steps and heart rate. Table 5 presents features of various activity trackers and advice for how to choose among the options.

A common challenge posed by wearable devices is that people stop using them over

time.^{18,19,59} Therefore, to help people develop a habit of regular wear and use, it is critical to embed these technologies within some form of a feedback loop. Figure 1 depicts a strategy known as *automated hovering*, in which constant monitoring and feedback promote a desired activity.⁶⁰ Data from the sensor are transmitted regularly to remote cloud servers that process and compare it with criteria for

Table 5. Characteristics of wearable activity trackers

Characteristic	Description	Selecting a device
Price	Ranges from about \$30 to over \$200	Almost all wearables track steps, distance, minutes, and calories. Fancier and often more expensive models collect additional information related to sleep or other biometrics such as heart rate. Smart wearables can run applications that provide holistic insights into other physical activity, such as swimming and biking.
Typical features	Displays counts of steps taken, distance traveled, active minutes, estimated calories burned	
Other features	Sleep quality tracking, heart rate readings, waterproof or water resistant, training recommendations, GPS and navigation, music storage, Bluetooth connection	
Where worn	Strapped on wrist, hanging around neck, or clipped to clothing	The wristband is most popular. The wearable should be minimally intrusive for the user if it is to get regular use.
Sync compatibility	Usually compatible with iOS and Android applications (with some exceptions; for example, Apple Watch uses only iOS)	If the targeted population has a variety of phone operating systems, select a wearable that is compatible with all.
Battery types	Rechargeable battery or coin-cell battery (which can last from a few months to a year)	Program duration is important to keep in mind when selecting battery types. For shorter programs, a coin-cell battery may be suitable, as the participant would not need to recharge it regularly. For longer programs, battery replacement can be a barrier, so rechargeable wearables may be preferable.
Battery life (if rechargeable)	Ranges from about five to 10 days per charge	Long-duration batteries are best because participants will not have the hassle of frequent charging. Short-duration batteries can be used, though, especially for a proactive group.

the specific individual. After determining the person's goal and whether it was achieved, the system can automatically deliver feedback that includes both a reward (or penalty) and a trigger that reminds the user to hit that day's target.

Because pedometers do not allow remote monitoring, they are not well suited for behavioral interventions that focus on using frequent feedback to build new habits. Smartphone apps are useful for programs that lack the money for sophisticated wearable devices. Programs that need to record metrics that go beyond steps, such as heart rate or sleep patterns, may require wearable trackers. As tracking technologies evolve and battery life lengthens, the user experience and program designers' ability to apply behavioral economic approaches will also improve.

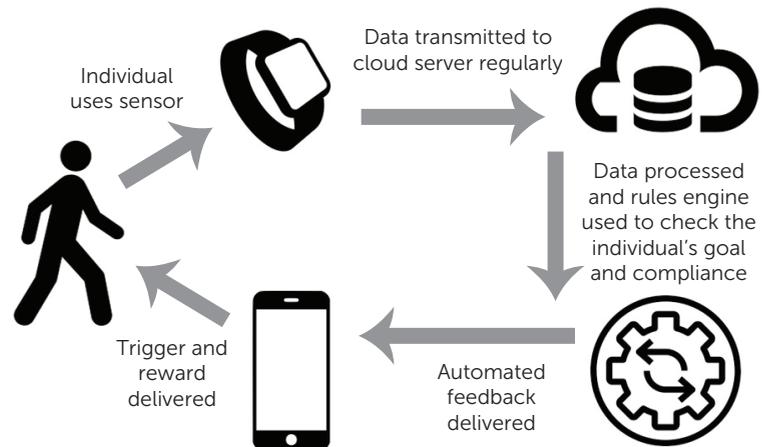
Conclusion

Smartphone apps and wearable activity trackers can help monitor activity levels, but unless they are combined with a well-designed behavior change strategy, they are unlikely to be effective. Applying evidence-based insights from behavioral economics to interventions aimed at increasing physical activity should help people reach their exercise goals and improve their health.

author affiliation

Changolkar: University of Pennsylvania; now at the University of Michigan. Volpp and Patel: University of Pennsylvania and Crescenz Veterans Affairs Medical Center. Corresponding author's e-mail: mpatel@pennmedicine.upenn.edu.

Figure 1. Remote-monitoring technology can provide continuous monitoring & feedback (automated hovering) to promote physical activity



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