HHS Public Access
Author manuscript
J Nurse Pract. Author manuscript; available in PMC 2018 January 01.

Published in final edited form as:
J Nurse Pract. 2017 January ; 13(1): 34–40. doi:10.1016/j.nurpra.2016.10.012.

Using Fitness Trackers in Clinical Research: What Nurse Practitioners Need to Know

Lisa Cadmus-Bertram, Ph.D.
Department of Kinesiology, University of Wisconsin – Madison

Abstract

Consumer-based wearable fitness trackers present a new array of opportunities and challenges to nurse practitioners engaged in health promotion research. Key advantages include the ability to provide continuous, objective, remote monitoring of physical activity and the potential to improve the efficacy of physical activity interventions. This paper provides an overview of fitness trackers, including their functions and accuracy, and addresses the following key issues to consider before using trackers in research: (1) when to use a fitness tracker; (2) choosing a brand and model; (3) encouraging good compliance; and (4) extracting and using the data.

Despite the well-documented benefits of physical activity, more than half of US adults self-report not meeting the physical activity guidelines (usually summarized as 150 min/week of moderate-to-vigorous intensity activity).[1,2] Further, when research-grade accelerometers are used to measure population-level physical activity, only 5% of US adults are found to be meeting the guideline.[3] Thus there is a widespread need for clinical research to understand how physical activity relates to chronic disease management, healthy aging, and recovery from major medical procedures, illnesses, and injuries. As the consumer market for fitness trackers continues to grow, so does the interest among researchers and clinicians to leverage these devices to improve healthcare and answer innovative research questions.[4]

Briefly, a fitness tracker is a small electronic device that uses an accelerometer – a tiny instrument that measures acceleration forces – to assess physical activity. By measuring the amount of motion adjusted for time, the tracker is able to determine the timing and patterns of activity as well as some features of movement such as steps and intensity. Thus fitness trackers generate far more detailed and useful information than is provided by traditional step-counting pedometers. Fitness trackers are either clipped to the clothing or worn on the wrist and users connect their tracker through a computer or smartphone. Most trackers provide simple data on the device's display, with more detailed data available online or via the app. It is worth noting that there are also many smartphone apps designed to track users' physical activity level without the need for a fitness tracker. By taking advantage of the

Address: Lisa Cadmus-Bertram, Ph.D., University of Wisconsin – Madison, 2000 Observatory Drive, Madison, WI 53562, lisa.bertram@wisc.edu, Phone: (608) 262-5946.

accelerometer already built in to the smartphone, these essentially function in the same way as a fitness tracker and can be a good choice for patients who keep their phone in a pocket or clipped to their waistband all day.

Dimensions of behavior captured by fitness trackers

Fitness trackers and smartphone apps vary with respect to which components of physical activity are measured. However all will measure the most basic component -- steps. Step tracking remains a mainstay of physical activity promotion because it is simple and easy to understand method for objectively self-monitoring one's activity level. Step counting is particularly important for the most inactive patients (i.e., those who do no exercise at all) because their entire activity level is reliant on basic ambulatory activities such as housework, gardening, and walking for transportation. Steps are also an appealing and approachable behavioral target for patients who may find exercise difficult or intimidating but are amenable to setting modest daily step count goals. Thus step tracking can be an effective way to introduce these individuals to a rewarding, positive habit of setting and achieving goals around physical activity. All fitness trackers and apps will provide daily step count data and most will allow users to track their progress towards a daily or weekly step goal. Many devices, including all Fitbit models, allow users to specify this goal. Other devices (e.g., Garmin vivofit) automatically choose an appropriate daily step count goal based on the user's recent activity level. A default step goal is often 10,000 steps per day, which appears to be sufficient for some health benefits and roughly translates to meeting the physical activity guidelines (e.g., 30 min/day of brisk walking) plus normal daily ambulatory movement.[5] Lower step goals may be appropriate for individuals with poorer physical functioning or chronic conditions while children and adolescents should accumulate 10,000-17,000 steps/day depending on age.[6,7]

Fitness trackers and apps also measure other components of physical activity such as intensity (e.g., min/day spent in a certain intensity category), estimated energy expenditure (calories burned), distance traveled, and elevation climbed. Several models also provide heart rate monitoring and/or global positioning system (GPS) information. There are tradeoffs regarding price and features; most importantly, those devices that provide heart rate monitoring and GPS tend to cost more and may need to be recharged more frequently than models without those features. In addition to measuring physical activity, most trackers are designed to also measure sleep (e.g., total duration of sleep, sleep latency, and sleep quality). Sleep and wake times are automatically detected using the device's algorithms, making data collection effortless for the patient.

In addition to the data collected by the tracker itself, the websites/apps associated with many trackers allow users to manually input data. This can be useful when an exercise session was performed but the person forgot to wear the tracker or could not wear it due to the nature of the activity (e.g., water-based activities). Individuals can also track caloric, macronutrient, and micronutrient intake by logging foods and beverages. Many items are selected from a large database; these tend to include simple whole foods (e.g., fruits and vegetables, milk, cheese, nuts, meats) as well as packaged foods (e.g., yogurt, granola bars, candy) and menu items from chain restaurants. Logging recipes cooked at home is somewhat more complex since these must be either re-created manually or approximated based on a similar item that is already in the database. Frequently consumed food combinations (e.g., a breakfast consisting of oatmeal, skim milk, and a banana) can be stored for quick future entry. In general, although dietary tracking is burdensome, it can provide valuable insights to those patients trying to modify their eating habits or weight.

Fitness trackers and apps will also allow the user to track body weight, either through manual entry, or by using a wi-fi enabled scale such as the Fitbit Aria or the Withings scale. Wireless scales are identical in appearance to a standard digital bathroom scale but will upload the user's weight and estimated body composition (percent body fat) to the app. Given evidence suggesting the benefit of daily weighing, these scales may have promise for assisting in weight management efforts.[8]

Viewing physical activity data collected by activity trackers

Fitness trackers vary with respect the amount and type of information provided on the device display. The Jawbone UP series, for example, consists of a colorful silicone wristband or clip-on device with no display at all. A vibration function can be used for some activity-related alerts but the user must access the accompanying smartphone app to actually view their data. Most other trackers display steps along with some selection of other information (e.g., calories burned, distance walked). The information on the display is a running total of activity accrued on that day only. At midnight, the display resets to zero (although the data will be retained until the device is synced). Therefore, in order to view the most useful information about progress towards weekly goals and trends over time, individuals must access the website or app. There, the user will have a page or “dashboard” showing a summary of data, typically both from the current day as well as information about activity over time. Data are presented using simple charts, graphs, and progress bars. Often, users can select what type of information they wish to see, or how they would like to see the information presented.

Are fitness trackers accurate?

A number of research teams have conducted validation studies to determine the accuracy of fitness trackers. This endeavor is complicated by three factors: (1) The algorithms used by the manufacturer to aggregate the raw accelerometer data into usable variables (e.g., minutes/day spent in activity) are often not available; (2) New fitness tracker models are released frequently, making it difficult to maintain an up-to-date body of literature on current models; and (3) the wide variety of features (e.g., steps, intensity, energy expenditure, sleep) renders it impractical to evaluate all dimensions of a tracker's accuracy. Nevertheless, several studies have demonstrated that fitness trackers and smartphones are sufficiently accurate for measurement of steps.[9-11] Hip-worn trackers appear to be the most consistently accurate for assessment of steps because the placement facilitates the detection of ambulatory movement. Wrist-worn trackers have more measurement error but are still sufficient for health promotion purposes. The added convenience of a wrist-worn device makes this a favorable tradeoff for many individuals. Smartphone apps can be just as precise as hip-worn trackers but their accuracy relies on being worn on the body (e.g., in a hip pocket) for the entire day, even while exercising. Thus apps are not optimal for many individuals.

Several studies have also tested the accuracy of trackers for the assessment of activity intensity, energy expenditure, and sleep. While much more data is needed in this area, the literature currently suggests that trackers are perhaps less accurate for energy expenditure and sleep than for steps. An excellent summary of the specifications for and validity of Fitbit and Jawbone models was provided by Evenson and colleagues in 2015, although due to the rapid evolution of the fitness tracker industry, some newer models are now available as well.[10] Overall, validity data for wearables are fairly encouraging. Evenson, et al. reported strong validity for steps at typical walking speeds, although accuracy declines somewhat at very slow walking speeds as well as during running. The authors also reported high inter-device reliability for some of the most common tracker models. Very little information as yet is available regarding important dimensions of activity other than steps – only a few studies have examined physical activity intensity and only one tested accuracy for distance. Some newer models use pattern recognition algorithms that allow the device to categorize bouts of activity by type (e.g., running, cycling). No validity data are as yet available for that feature.

Clearly, a single sensor cannot capture movement of all parts of the body, therefore no fitness tracker will provide a perfectly accurate measurement of activity. Current models are, however, sufficiently accurate to provide patients with the feedback they need to set goals and monitor progress. Thus nurse practitioners can play two important roles in communicating with patients. First, they can encourage patients to use fitness trackers in conjunction with goal-setting and frequent review of progress. Second, they can educate patients by explaining that tracker data does not need to be 100% accurate in order to be quite helpful for behavior change purposes.

Types of fitness trackers

There are a wide and growing array of fitness trackers on the market and leading manufacturers continuously update and expand their product lines. Major manufacturers include Fitbit, Garmin, and Jawbone. Trackers vary with respect to style (wrist-worn *vs.* clip-on), battery type (rechargeable vs. coin cell), price (most are between $50-300), and features (heart rate monitoring, GPS, activity recognition). Other factors that may be important to some consumers include system requirements (e.g., Jawbone trackers require a smartphone or table whereas most other brands can be used with a computer) and water resistance.

Using fitness trackers in research

Due to their user-friendliness and ability to provide objective continuous monitoring, fitness trackers are an appealing option to many researchers interested in promoting or measuring physical activity. They are not, of course, appropriate for all contexts. Four important considerations are described here: (1) When to use a fitness tracker; (2) Choosing a brand and model; (3) Encouraging good compliance; and (4) Extracting and using the data. A detailed list of considerations is presented in Table 1.

When to use a fitness tracker

Fitness trackers serve two basic research functions – to measure activity and to promote activity.[12,13] Before using a fitness tracker in research, it is important to have a clear understanding of which of these functions (or both) the investigator is seeking. While research-grade accelerometers like the ActiGraph (Penscacola, FL) are still the gold standard for physical activity measurement, fitness trackers are an acceptable alternative in some contexts. They are most appropriate for use studies in which the key outcome is either steps or is activity that occurs during ambulatory movement. Researchers may also choose to use a fitness tracker in situations where the use of ActiGraphs is prohibitive due to cost or lack of training in accelerometer processing and analysis. Finally, fitness trackers are an excellent – and essentially the only – choice for studies that involve continuous monitoring of patients over periods of time longer than a week or two.

With respect to their use as an intervention tool fitness trackers can be a good choice for health promotion studies, assuming the patient population has a high level of broadband and/or smartphone penetrance and will be able to use the technology. Patients who are less technologically savvy may still have good results with a fitness tracker as long as they receive sufficient initial training and have access to ongoing support from the clinical or research team. Multiple studies have shown that fitness trackers are feasible and acceptable including in middle-aged and older populations.[13-15] However, is important to recognize that for most patients, simply providing a fitness tracker will not result in substantial, lasting changes in activity level.[16] Other determinants of activity – such as beliefs, attitudes, perceive barriers, and lack of knowledge, social support, and self-efficacy – must still be addressed. The fitness tracker is a tool to assist with self-monitoring, one of the most effective strategies for long-term behavioral change and data show that many trackers align well with concepts used in behavioral science.[17] However the greatest promise for health promotion likely relies on the combination of the wearable device with one or more other intervention components.

Of course, despite the benefits of fitness trackers, there are still many research questions that are better served by other forms of measurement and intervention. For example, a step-counting intervention in a very large sample with low access to technology would be better served by a traditional pedometer than a fitness tracker. There are also some concerns about the potential for wearables to exacerbate socioeconomic health inequalities.[18] Finally, it is important to consider potential HIPAA or privacy concerns related to gathering data using fitness trackers.[19] These can be usually be navigated without excessive difficulty but are important to identify prior to engaging in research. Thus nurse practitioners should carefully consider their patient group, research question, and local resources in order to determine whether a wearable sensor will be useful and appropriate.

Choosing a brand and model

Researchers may wish to try out several different trackers in order to determine what best suits the needs of a particular project or study. For example, clip-on trackers appear to be more accurate than wrist-worn trackers, but require additional vigilance on the part of the participant (must be switched each time the person changes clothes, kept out of the laundry, etc.). Trackers with no display may be suitable for studies in which the researchers are seeking a blinded assessment tool but are likely to be less effective for health promotion interventions because the patient cannot get much feedback without opening the app. Trackers that use a watch battery (such as the Garmin) remove one source of non-compliance because patients do not need to charge the battery. A balance of features, usability, and cost will usually be sufficient to identify the appropriate tracker.

Ensuring good compliance

There are a number of best practices that can be taken to facilitate a good user experience for patients and to maximize the adherence to using the tracker. First, it is recommended that patients receive some initial training, tailored to the population. This could include hands-on training, printed handbooks, or setting up user accounts for the patient ahead of time. Expectations about how the tracker should be used must be clearly communicated. If it is important to wear the tracker during all waking hours, this can be reinforced with a handout or other materials. Troubleshooting information and contact information for questions should be provided.

Extracting and using the data

Many clinicians and investigators wish to obtain the data collected directly by the tracker. Many manufacturers offer an Application Program Interface (API) to assist programmers with extracting and using their data. However this requires personnel to do the coding, which is not practical in most clinical research contexts. An easier option is to use a third-party application designed to extract and process tracker data for use by researchers. The most common of these is Fitabase (San Diego, CA), which offers a web-based application to aggregate and process Fitbit data. This application is designed to be easy to use and requires no special expertise. Thus it is relatively straightforward to obtain datasets of Fitbit data ready for analysis in any statistical package. However these datasets will contain activity data only (e.g., steps, intensity, HR) but will not include other behaviors logged manually by the participant, such as food intake or blood pressure.

Conclusions

To summarize, wearable technologies play an increasing role in patients' lives and may have substantial utility for clinical research. Previous studies have demonstrated that fitness trackers are highly acceptable and feasible for use in a variety of populations. Although the integration of consumer-based wearable technologies into health research is still new, the field is evolving rapidly. Nurse practitioners and other clinicians are likely to receive questions from patients who are interested in using trackers for physical activity or weight management. Clinicians should be prepared to provide basic information about how fitness trackers work and to educate patients that trackers are a tool to assist with self-monitoring, goal-setting, and motivation. Patients may benefit from a reminder that the tracker alone will not be sufficient to initiate and sustain behavior change but that it can provide substantial assistance in helping the patient to understand his or her current activity level and track progress over time. Patients also need to understand that trackers are generally accurate enough to be useful for these purposes. Thus they are ideally suited for use in an iterative process of behavior change in which patients observe their current level of activity, set a somewhat higher goal, achieve and sustain that goal, and repeat this cycle until the eventual goal is reached.

Future research will continue to provide more detailed data regarding the validity and reliability of various features on specific tracker models, methods for incorporating wearables into behavioral interventions, the use of wearables to enhance "just-in-time" interventions (JITAI's),[20] the degree to which consumer-based products encompass evidence-based behavior change techniques,[21] and best practices for integrating data streams with electronic health records (EHRs) and clinical care. Despite some limitations, wearable trackers and smartphone apps present an exciting new era in physical activity promotion and research.

Acknowledgments

Funding: Dr. Cadmus-Bertram is supported by the National Cancer Institute (1K07CA178870).

References

1. Centers for Disease Control and Prevention. Adult participation in recommended levels of physical activity--United States, 2001 and 2003. MMWR Morb Mortal Wkly Rep. 54(47):1208–1212.
2. US Department of Health and Human Services. [January 15, 2016] 2008 Physical Activity Guidelines for Americans. 2008. http://www.health.gov/PAGuidelines.
3. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008; 40(1):181–188. [PubMed: 18091006]
4. Steinhubl SR, Muse ED, Topol EJ. Can mobile health technologies transform health care? JAMA. 2013; 310(22):2395–2396. [PubMed: 24158428]
5. Tudor-Locke C, Craig CL, Brown WJ, et al. How many steps/day are enough? For adults. Int J Behav Nutr Phys Act. 2011; 8:79. [PubMed: 21798015]
6. Tudor-Locke C, Craig CL, Aoyagi Y, et al. How many steps/day are enough? For older adults and special populations. Int J Behav Nutr Phys Act. 2011; 8:80. [PubMed: 21798044]
7. Tudor-Locke C, Craig CL, Beets MW, et al. How many steps/day are enough? For children and adolescents. Int J Behav Nutr Phys Act. 2011; 8:78. [PubMed: 21798014]
8. Shieh C, Knisely MR, Clark D, Carpenter JS. Self-weighing in weight management interventions: A systematic review of literature. Obes Res Clin Pract. 2016; 10(5):493–519. [PubMed: 26896865]
9. Case MA, Burwick HA, Volpp KG, Patel MS. Accuracy of smartphone applications and wearable devices for tracking physical activity data. JAMA. 2015; 313(6):625–626. [PubMed: 25668268]
10. Evenson KR, Goto MM, Furberg RD. Systematic review of the validity and reliability of consumer-wearable activity trackers. Int J Behav Nutr Phys Act. 2015; 12(1):159. [PubMed: 26684758]
11. Hekler EB, Buman MP, Grieco L, et al. Validation of physical activity tracking via Android smartphones compared to ActiGraph accelerometer: Laboratory-based and free-living validation studies. JMIR Mhealth Uhealth. 2015; 3(2):e36. [PubMed: 25881662]
12. Cadmus Bertram LA, Marcus BH, Patterson RE, Morey BL, Parker BA. Use of the Fitbit to measure adherence to a physical activity intervention among overweight/obese, postmenopausal women. Journal of mHealth and uHealth. 2015; 3(2):e36.
13. Cadmus-Bertram L, Marcus BH, Patterson RE, Parker BA, Morey BL. Randomized Trial of a Fitbit-Based Physical Activity Intervention for Women. Am J Prev Med. 2015; 49(3):414–8. [PubMed: 26071863]

14. Hartman SJ, Natarajan L, Palmer BW, Parker B, Patterson RE, Sears DD. Impact of increasing physical activity on cognitive functioning in breast cancer survivors: Rationale and study design of Memory & Motion. Contemp Clin Trials. 2015; 45(Pt B):371–376. [PubMed: 26427563]
15. McMahon SK, Lewis B, Oakes M, Guan W, Wyman JF, Rothman AJ. Older adults' experiences using a commercially available monitor to self-track their physical activity. JMIR Mhealth Uhealth. 2016; 4(2):e35. [PubMed: 27076486]
16. Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. JAMA. 2015; 313(5):459–460. [PubMed: 25569175]
17. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: A meta-regression. Health Psychol. 2009; 28(6):690–701. [PubMed: 19916637]
18. Allen LN, Christie GP. The emergence of personalized health technology. J Med Internet Res. 2016; 18(5):e99. [PubMed: 27165944]
19. Filkins BL, Kim JY, Roberts B, et al. Privacy and security in the era of digital health: what should translational researchers know and do about it? Am J Transl Res. 2016; 8(3):1560–1580. [PubMed: 27186282]
20. Riley WT, Rivera DE, Atienza AA, Nilsen W, Allison SM, Mermelstein R. Health behavior models in the age of mobile interventions: are our theories up to the task? Transl. Behav. Med. 2011; 1(1): 53–71. [PubMed: 21796270]
21. Mercer K, Li M, Giangregorio L, Burns C, Grindrod K. Behavior Change Techniques Present in Wearable Activity Trackers: A Critical Analysis. JMIR Mhealth Uhealth. 2016; 4(2):e40. [PubMed: 27122452]

Table 1

Considerations when using fitness trackers for measurement and/or intervention in research.

Features
• Which data collection features are necessary or just preferred? Are there any undesirable features? If so, can these be customized (turned on or off?) to suit the focus of the study?
• What goal-setting features are available? Can goals be set for the behaviors of interest? Are they automatically set by the tracker or can they be specified by users?
• Are there social features (such as adding "friends") and if so, will this be used in the study?
• Is a clip-on or wrist-worn tracker more suitable for the study?
• Is a water resistant tracker necessary?
On-device electronic display
• For measurement studies, minimal/no feedback n may be preferable (to minimize reactivity)
• For intervention studies, more detailed feedback may be useful
Patient characteristics
• Do they have broadband access and/or a smartphone? If not, how will this be provided?
• Do they have the technological skills and interest to learn to use the tracker? If technological skills are lacking, could training or assistance with device set-up be provided?
• Will the specific tracker model is likely to appeal to this population? Is the app easy to learn?
• How active is the patient population? For those who engage mostly in very low-intensity activity (slow walking without a distinct gait), a clip-on tracker worn at the hip may be more sensitive than a wrist-worn tracker.
• How diligent are patients likely to be with respect to wearing the tracker and charging the battery? If there are substantial concerns, a wrist-worn tracker with a coin cell battery may be recommended.
Motivational and behavioral considerations
• For intervention studies: What other motivational components or support will patients need in order to make the prescribed behavioral changes? Do not rely on tracker alone.
• For all studies: How will participants be educated to maximize compliance with wearing the activity tracker, keeping the battery charged (if applicable), and syncing the device regularly?
Data extraction and analysis
• What, if any, data is needed from the device/app itself?
• How will these data be extracted?
• How will the data be cleaned and processed? Is there a third party who can offer this service?
• How will researchers handle data that appears to reflect partial wear days? Unless compliance is uniformly high, there will be a need to correct for wear time in order to produce meaningful data.
Privacy considerations
• Are there any privacy issues or HIPAA concerns that need to be addressed?
Cost
• What resources are available?
• Can costs be lowered by staggering participant enrollment and reusing trackers?