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Wearable Fitness Devices

In 2015 alone, the United States spent 17.8% of the total GDP on health care (U.S Center for Medicare and Medicaid Services, 2015). Despite having the highest cost of health care in the world as a percentage of GDP, outcomes are not up to par with other similar developed nations; the United States has lower life expectancy at birth and lower survival with many different diseases (Moses et al. 2013). The biggest health care problem in our country, therefore, is cost effectiveness. The price of health care, however, continues to rise. 91% of the increase in costs can specifically be attributed to professional services, drugs and devices, and administrative costs (Moses et al. 2013). Within these categories, there is a huge potential for emerging technologies to improve patient outcomes. Improving outcomes in relation to cost will be beneficial to the overall system and help the United States work its way up to the level of other developed countries. Specifically, this paper will explore how one new technological device, wearable fitness devices, can be beneficial in increasing cost-effectiveness and improving health. First, their popularity will be evaluated, followed by their barriers to use, accessibility, accuracy, and finally, how they can lead to improved health outcomes.

1) Background

As a working definition in this paper, a health tracking device is a device that detects any combination of distance travelled, calories consumed, heartbeat, and quality of sleep (Wikipedia definition). There are many brands and models with widely varying functions. These devices usually have the capacity to sync to a computer or smartphone for long-term data tracking (Kaewkannate & Kim, 2015). Some recognizable devices include the Apple Watch and Nike

Fitbit. Wearable health tracking devices are hugely popular in this day in age, and their increased use has the potential to improve patient outcomes. The various options available in the market for wearable devices are also increasing. Customers have a variety of different personal needs and reasons to buy fitness trackers, searching for the one that best aligns with their health or fitness goals (Kaewkannate & Kim, 2015).

2) Popularity

The first issue that must be addressed is the market for health tracking devices. Even if these devices are accurate and lead to improved health outcomes, that may not matter if not enough people are using them. One study evaluated four of the most popular health tracking devices available: The Fitbit Flex, Withings Pulse, Misfit Shine, and Jawbone (Kaewkannate & Kim, 2015). Satisfaction and user friendliness were both evaluated, which are two important metrics that are helpful in determining whether or not these products appeal to enough people to become popular. They found that the Withings Pulse had the highest satisfaction score (Kaewkannate & Kim, 2015). However, many of the health tracking devices were not capable of displaying the metric information on the screen itself and were instead restricted to sending this data to a smartphone for display, which was one of the main user criticisms (Kaewkannate & Kim, 2015). Although, this study was conducted in 2015 and this issue has already been addressed in newer products such as the Apple Watch, so continued advances must be kept in mind.

While improving health might be the most important outcome of wearable health tracking devices, many people consider the aesthetics of a device just as much as the features it offers; in order for the devices to have success on the market, they must have sleek, modern, and lightweight designs (Kaewkannate & Kim, 2015). Additional features that are considered

desirable are “waterproof functionality, multiple options for recharging the battery, accuracy and repeatability for simple activities such as climbing or descending stairs” (Kaewkannate & Kim, 2015). The development of wearable devices is moving very rapidly; constantly, new features and add-ons are available for different products.

Lastly, the use of health and fitness apps is growing 87 percent faster than the entire mobile industry, and “Consumer use of mobile health and fitness apps in the first half of 2014 is almost double that of the mobile platform market in general” (Rhodes, 2014). These statistics demonstrate the huge potential and popularity of health tracking devices. Though there are still problems that need to be addressed, there is a huge variety of products on the market currently, with new innovations and designs coming out every year. Wearable fitness devices have the popularity, demand, and potential to improve health outcomes.

3) Use and barriers to use of health tracking devices for both monitoring and research

While it has been shown that there is an increased popularity and demand for health tracking devices, there are still barriers to their use present. Health tracking devices can be used among the young and active as training devices and ways to keep track of fitness goals, as well as older subpopulations who need to closely monitor their health. The increased risk of chronic illness and death in older populations can be partially attributed to the fact that they are more likely to be physically inactive and sedentary, which is why wearable activity trackers offer huge potential as technology to help the elderly become more active (Mercer et al. 2016). There are important barriers, though, that must be overcome in order for the elderly to utilize this technology. A study by Williamson et al. (2017) found that “The acceptability and value of these devices was strongly influenced by device features, ease of use, cost, appearance, the reliability of the GPS coordinates, the wearer’s health condition and the users familiarity with technology”.

To ensure successful utilization of these devices by older populations, designs need to be tailored to specific health conditions and consider the fact that older populations often are not as familiar with technology (Williamson et al. 2017). It is especially important for older populations to easily use the device, as they are not usually as comfortable with technology as younger people (Mercer et al. 2016).

In one study of adults 50 years and older living with chronic illnesses, “wearable activity trackers are perceived as useful and acceptable” (Mercer et al. 2016). However, Mercer et al. concluded that older consumers need additional help in the initial set up of their device and interpreting what their health data means. Among the different kinds of activity trackers used, the most popular tracker was the Fitbit, with 50% saying that they would buy one after the end of the study, while none of the participants would purchase the simple pedometer because of its poor accuracy and data loss (Mercer et al. 2016). These findings suggest that simple models may not have enough data to realistically improve health, but more advanced models face the barrier in which they must be easy enough to use for the elderly to understand their functions and metrics (Mercer et al. 2016).

Because is so important that the features of wearable fitness devices are understood in older populations, “having a medical team member request that patients use a fitness tracker and work with them over time to understand the data and learn to use more technologically advanced features of devices could help promote a positive feedback loop” (Rosenberg et al. 2017). In this way, the patients are transferring from relying on a medical team member to help them with the features and interpretation to being able to do both of those themselves. This would use less resources in health care and give patients a sense of self-efficacy in determining their own health outcomes (Rosenberg et al. 2017). Simple interventions such as “giving

patients clear instructions for using their devices, syncing them, and using their features could also facilitate adoption of the devices" (Rosenberg et al. 2017).

While barriers to personal use have been addressed, there also exists the barrier to using health tracking devices for improving health outcomes in terms of research (Bietz et al. 2015). This barrier exists not at an individual level, but at a population level. According to Bietz et al. (2015), there are three major stakeholders who contribute to the barriers of using health tracking data for research: "early adopter individuals who track data about their health, researchers who may use personal health data as part of their research, and companies that market self-tracking devices and manage the data that are generated". Challenges to using health tracking devices in research were identified in six areas: "data ownership; data access for research; privacy; informed consent and ethics; research methods and data quality; and the unpredictable nature of the rapidly evolving ecosystem of devices, apps, and other services that leave digital footprints" (Bietz et al. 2015). Therefore, more complex barriers are present for using the data from the devices for research.

The barriers to use in research are not impossible to solve, however. As long as individuals knew that their health data would be used to advance research for the common good, they reported that they would be okay with anonymously sharing their data (Bietz et al. 2015). Researchers want to use this data that would be anonymously provided, but had some concerns, namely in related to intellectual property, licensing, the legal agreements that would be necessary with companies that produce the devices (Bietz et al. 2015). These companies were also willing to participate in research but communicated that they value customer relationships over research so would not be willing to harm those relationships (Bietz et al. 2015). Overall, consumers are concerned about the privacy of their data, researchers are concerned about jumping through legal loopholes, and companies care more about selling their

product than research (Bietz et al. 2015). Although these barriers are present in using these personal health metrics for research, “experimentation with these data is taking place… with the potential to positively transform how health research is conducted” (Bietz et al. 2015).

Another main issue in the usage of health tracking devices is standardization. According to Rhodes (2014), “with so many vendors competing in the personal health data space and no effort to establish interoperable standards, consumers will have trouble exchanging their health data across disparate platforms or with provider health IT systems”. This research demonstrates that there needs to be a solution that can “balance the needs and concerns of privacy, security, intellectual property, and science” (Rhodes, 2014). Other methods of health research such as clinical trials or surveys are not able to capture the continuous health metrics that health tracking devices are capable of; therefore, their use in research shows great promise for improving human health (Rhodes, 2014).

4) Accuracy of health tracking devices

Health tracking devices can positively impact quality of life and improve health (El-Amrawy et al. 2015). However, accuracy and precision of such trackers is necessary to properly implement health interventions and improve outcomes. One study evaluated the accuracy, precision, and overall performance of seventeen wearable devices currently available by comparing them with the actual observed step counts and monitored heart rate (El-Amrawy et al. 2015). The analysis found that “the accuracy and precision of the selected the fitness trackers are reasonable and can indicate the average level of activity and thus average energy expenditure” (El-Amrawy et al. 2015).

However, the same is not to be said about all health tracking devices. In a study by Wen et al., ten pieces of health tracking devices were studied to determine their accuracy in tracking

multiple health metrics. Unfortunately, the devices were only reliable for measuring the distance walked or run and the number of steps taken (Wen et al. 2017). These two measures, though, can still be useful for tracking fitness and goals. They found, though, that “The measurement consistencies of activity duration, total energy expenditure, and sleep quality are still inadequate, which require further investigation and improved algorithms” (Wen et al. 2017). A different systemic review of 22 studies had similar results and found that there was a high validity of steps counted on wearable fitness devices but that there was lower validity for energy expenditure and sleep (Evenson et al. 2015).

A popular use of the devices is by serious runners who wish to track their distances. One study found that “GPS-enabled devices, especially sports watches and mobile phones, were found to be accurate in terms of recorded course distances” (Pobiruchin et al. 2017). The accuracy of distance recording is important to the athlete, as these distances can be used to optimize training activities. It is interesting to note, however, that females and older runners aged 50-59 are less likely to use distance trackers so this could be a metric that is specifically tailored towards runners (Pobiruchin et al. 2017).

While these studies are useful in determining which metrics are the most reliable, the wearable fitness device industry is evolving rapidly, and new technology on the market could make the results of past studies not as applicable. A study published last month evaluated the validity of three of the newest models that track fitness data; the Apple Watch, Fitbit Charge HR, and Garmin Forerunner 225 (Dooley et al. 2017). Among all three, the measure of heart rate was valid, with error ranging from 1% to 24% (Dooley et al. 2017). However, energy expenditure was significantly different from true energy expenditure, with some having error up to 210%. None of the devices had error lower than 14% (Dooley et al. 2017). New studies must be

constantly conducted to assess accuracy and precision of the newer models available on the market.

While all the previous studies taken together are somewhat inconclusive about the overall accuracy of wearable fitness devices, these health tracking devices do track a number of different fitness metrics. Overall, distance, steps, and heart rate are metrics that are reliable and valid across the board of wearable fitness devices. Data reporting energy expenditure and sleep quality should be regarded as not as accurate and should not be used in health interventions or by evaluation by a healthcare provider.

5) Improved outcomes from health tracking devices

Wearable fitness devices can improve health outcomes across a variety of populations. They can be especially helpful among those living in remote areas with chronic diseases (Rhodes, 2014). This is because the information can be sent to doctors and they can make a medical decision without the need for an in-person physical examination (Rhodes, 2014). The greatest benefit of self-tracking data is that "it can provide better measures of everyday behavior and lifestyle, filling the gaps in more traditional clinical data collection and presenting a more complete picture of health" (Rhodes, 2014). In one study that utilized remote patient monitoring versus live nurse visits, there were no significant difference in the utilization and hospital costs between the two (Pekmezaris et al. 2012). Allowing medical researchers to access this data could have a positive impact on health while also encouraging medication compliance (Rhodes, 2014).

Another vulnerable subpopulation that could benefit from physical activity and wearable fitness devices is men with prostate cancer (Rosenberg et al. 2017). Physical activity could actually help improve the conditions that these men are at risk for (Rosenberg et al. 2017).

Rosenberg et al. tested the Fitbit Zip in a sample of men with prostate cancer to evaluate its acceptability. Participants found that the device was “comfortable and easy to wear” and thought that it was important to share their health metrics with their doctors (Rosenberg et al. 2017). These findings support the use of easy-to-use and simple fitness trackers among men with prostate cancer and concluded that wearable activity trackers have the potential to be useful for self-management of chronic disease, but it is still unclear if they can be accepted in clinical settings (Rosenberg et al. 2017).

Wearable fitness devices can also improve health outcomes in the chronically ill and frail who are preparing for surgery (Rumer, Sarawathula, Melcher, 2016). Frailty makes people less able to deal with stressors, including surgery, and these patients have “increased complications, longer length of hospital stay, and increased mortality after surgery” (Rumer, Sarawathula, Melcher, 2016). However, frailty can be improved through prehabilitation. Wearable fitness devices have been shown to lead to promising results; when used to monitor patient activity during prehabilitation, they have led to “improved activity, weight loss, and blood pressure”, which in turn reduces frailty and improves health outcomes immediately after surgery. (Rumer, Sarawathula, Melcher, 2016).

Yet another sensitive subpopulation is those with serious mental illnesses. This group faces elevated cardiovascular risk and high obesity rates, making this an important group to address with exercise interventions (Naslund et al. 2016). They face unique barriers to activity such as “mental health symptoms, low motivation and limited access to safe and affordable options for physical activity” (Naslund et al. 2016). Rates of obesity among the mentally ill are actually double that of the general population (Allison et al., 2009). In the study by Naslund et al. (2016) those who used the Fitbit Zip device had a higher step count which was subsequently

associated with greater weight loss, indicating promising results for the use of health tracking device interventions for the mentally ill.

Another potential use of health tracking devices is in preventing cardiovascular problems in their early stages (Ding et al. 2014). Because one of the main strengths of wearable fitness devices is their heart rate sensors, they have a huge potential in the area of treating and preventing cardiovascular problems, since heart rate is a useful tool in the diagnosis and monitoring of problems (Ding et al. 2014). This would be a low-cost and effective preventative health measure for those who may be at risk for developing cardiovascular problems (Ding et al. 2014).

Wearable fitness devices can affect health outcomes by sharing information with doctors and allowing a change in course of treatment based on individual metrics. However, it is not only the clinical changes that a doctor prescribes to certain subpopulations that can affect health; users can influence the behavior of each other (Swan, 2012). While early fitness trackers such as pedometers used to simply relay data to the individual, people now communicate their fitness data with each other through social features on the device, which has been found to be essential in encouraging physical activity (Kreitzberg et al, 2016). In fact, “Many of these technologies that collect and visually display users’ data, such as smart watches, monitoring patches, and home automation devices, impel meaning-making and action-taking” (Swan, 2012). The social layer of this technology, therefore, can encourage behavior change and promote physical activity (Kreitzberg et al, 2016). One example of the social layer is the leaderboards which most which wearable health fitness devices utilize – this allows users to engage in competitions with each other (Kreitzberg et al, 2016). Participants in one study felt that “communication surrounding their fitness trackers helped them reach fitness goals” (Kreitzberg et al. 2016). Also, users were motivated to engage in physical activity and meet their

fitness goals by receiving notifications, sounds, and messages from their devices (Kreitzberg et al. 2016).

Discussion:

For wearable fitness devices to increase in popularity and appeal to a greater number of subpopulations, some issues must be addressed. First of all, most of the research so far regarding wearable fitness devices has been in regards to certain subpopulations such as those who are going to receive a transplant, the mentally ill, those at risk for developing heart conditions, and those with weight loss goals. These populations all benefited from the devices, with some limitations. The metrics must be easy to understand for these sensitive subpopulations. If they are not, the data will be of no use to those owning the devices. The most beneficial intervention to ensure understanding is to have a medical team member work with the patients over time to help them understand their device and data. This is a more economical solution than having a doctor continually interpret data for the patient. If they are able to understand their own health data, there would eventually be no need for a medical team member to continue working with them, thus saving money. It is also important that their device comes with a detailed operating manual, which some do not. This independence also gives the patient a sense of self-efficacy in determining their own health outcomes, promoting a positive feedback loop. Wearable devices by themselves are unlikely to contribute to behavior change unless they can create a sense of self-efficacy, induce social competition, and include strategies to keep users motivated to keep using the device.

While current research has shown that wearable fitness trackers are very effective among certain subpopulations, more research needs to be done for the general population. Ideally, everyone would be motivated to improve their health. However, that is not that case,

which means that fitness trackers would not be as effective for different subpopulations. It could be helpful to identify additional populations that could benefit the most from wearable fitness devices and would have increased motivation to use them. Additional populations worth researching could include other specific chronic conditions that could be improved by physical activity such as diabetes. Surprisingly, not a lot of research has been done regarding using wearable fitness devices specifically for weight loss goals. There is a need for future research in this area to see if it is actually an effective intervention.

Because having the patient interpret his or her own data and then make lifestyle changes is a more economical and perhaps a more effective intervention than having a doctor continually monitor their metrics, wearable fitness devices have more use among social groups than in doctor-patient settings. Users have the capability of setting goals, posting to social media sites, creating networks with friends and family, and displaying their data. Through the use of social media and sharing, people are motivating each other to pursue physical activity and meet their goals. The social aspect of wearable health fitness devices is one of the most important components of promoting physical activity. Competition among family and friends is an important motivator in fitness, and the easy-to-read platforms and interfaces of new devices make for an efficient way to promote competition. One problem with social media, sharing, and competition, though, is that because of the diversity of trackers on the market, people may own different devices than their peers. The activity data, then, would not synchronize across platforms and be able to provide the same amount of sharing and motivation as if everyone had the same device with the potential to share information across the same platform.

One potential study regarding this issue of standardization that could be done is to measure improvement in activity level (steps and calories burned) in a sample of people with all different wearable fitness devices versus another sample with the same tracker that allows them

to share their data on a common platform. The aspect of sharing and competition is important enough in activity trackers as to warrant a significant difference in the improvement in activity level among the two groups.

While standardizing wearable fitness devices would be beneficial to researchers, physicians, and consumers because of the social sharing component of the devices, standardization is impossible and unfeasible in our free market economy. There is a huge diversity of products available from many different companies. Standardization might not even be the best option for everyone; the devices offer a variety of features that differ with each device. Someone with a heart condition might be more concerned about the accuracy of the heart rate monitor, while a long-distance runner training for a marathon might buy the device with the greatest accuracy in measuring distance. Individual choice is greatly valued, and the variety of devices available to consumers can better fit individual need. So, while standardization could lead to improved health outcomes and more potential for research, it may not be feasible.

While so far, activity trackers have been found useful for self-management of chronic disease and other improvements in fitness activity levels, they may not be as useful in health care integration. Health information from wearable tracking devices has the potential to be used by researchers, but there are many limitations regarding this sharing. Consumers are concerned about the privacy of their information. Researchers would have to jump through legal loopholes, and the companies that sell the devices are more concerned about their sales than allowing the health metrics to be used for research. Although using this data could positively transform how health research is conducted and offer more insight into how continuous information could be used for patient health interventions, overcoming these barriers to research would be difficult because they exist in three different spheres. Currently, the greatest use of wearable health

tracking devices is to improve patient self-efficacy in regards to their health and to use the devices in sensitive subpopulations in need of self-monitoring to improve their chronic conditions.

The accuracy of the wearable fitness devices varies across different products and metrics. In general, distance, heart rate, and steps are measured validly across most devices. These measures seem like enough to promote physical activity and lead to active goal-setting among consumers. While accuracy is obviously an important component of any piece of fitness technology, one could argue that the health outcome is more important than accuracy of tracking. If the trackers are able to promote physical activity and increase fitness, the precise number of steps counted may not be as important if they have an effect on someone's desire to participate in a physical activity that would be beneficial to their health. Obviously, accuracy would be more important in those with chronic conditions who may be using the trackers as ways to monitor their diseases, but could be less important in those who are just using the devices to pursue their fitness goals.

While studies have indicated how wearable tracking devices are accurate and can improve health outcomes, they do not specifically give recommendations on how to encourage people to use the devices. This is helpful because no matter how beneficial the technology is, it is only beneficial if enough people use it, continue to use it, and understand the metrics that they are provided. From the research, a good way to get consumers to invest in the devices is if a recommendation comes straight from their primary care doctor. Recommendations for health improvements and interventions coming from the patient's own primary care doctor would be a good way for them to take their health seriously and invest in a wearable activity tracker. Then, the social components of the devices and applications could keep the users motivated to continue their use.

Another way to get more people to use these devices would be through a work-sponsored fitness competition. Companies could distribute the trackers to their employees and offer prizes for those who get the most steps and lose the most weight. This would be beneficial to the company because healthier employees in their workplace would lead to the employees using less health care for preventable diseases, thus save the company money in health insurance costs. The intervention would be effective because of two reasons; standardization and socialization. Because the fitness competition would use the same product, standardization would be present. Also, the employees would be able to share their data and see the data of their peers, thus motivating them to lose more weight and increase their activity levels through competition. The prizes offered at the end of the time period would be an added benefit and encourage greater participation. While this is only a “temporary fix”, many users will likely continue using their activity tracker even after the competition time period is over.

Conclusion:

Wearable fitness devices have been greatly increasing in popularity over the past few years. These devices measure many different metrics and come in a variety of options, giving the consumer a huge amount of choice in their purchase. These wearable fitness devices have been shown to be especially effective in improving health outcomes in subpopulations such as those with chronic conditions, the mentally ill, post-transplant patients, and those with prostate cancer. While more research could be done to address additional subpopulations that could benefit from the devices, preliminary results are promising. Not only do sensitive subpopulations benefit, though, the general population can also improve their health by using these devices. In the general population, one of the most important aspects of improving health is through the social component of the device and by its motivation through competition with peers. Many

people have smartphones that allow them to integrate their device with apps that track their physical performance. These devices seem to incentivize people to be more physically active.

While the cost-effectiveness of the use of wearable fitness devices has not been empirically measured, the simple increase in physical activity itself will make people healthier and decrease their rate of disease, lowering costs for doctor's visits and the treatment of medical conditions that result from a lack of physical activity and sedentary lifestyle. While some issues exist such as the standardization of information-sharing platforms and the use of health metric data by researchers, wearable fitness devices have a huge potential to improve human health in a world that is quickly adopting the newest technology.

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