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Utilizing Wearable Activity Trackers in the Intervention of Sedentary Lifestyles

There is an ever-present need to combat the growing prevalence of sedentary behaviors to prevent morbidity and mortality and smartwatches may be the solution. Activity trackers built into certain smartwatches are gaining global recognition as companies design these devices to utilize behavior change components such as goal-setting and self-monitoring to allow people to track, monitor, and ideally improve their physical activity levels. These wrist wearable devices are both easily accessible to consumers online and in stores and convenient as they allow for continual objective monitoring of physical activity levels. This type of technology may reduce resource, labor, cost, and time burdens associated with traditional methods of lifestyle intervention systems such as group or individual education, provision of written materials, counseling, etc.¹ Though activity trackers within smartwatches may still be considered new technology, research is being published about the correlation between trackers and improved health. There is, however, a need for more extensive studies to be done on the long-term effects. Moreover, this research is on individuals of a general population who are not facing specific morbidity. With the rising prevalence of sedentary lifestyles in adults worldwide, consumer wearable activity trackers can act as an intervention system that may create positive psychological experiences and increase exercise behavior changes to combat inactivity in the short term.

The behavior of being physically active is one of the most important lifestyle choices an individual can make for their health. Physical activity is the movement of the body produced by skeletal muscles and requires energy expenditure.² The World Health Organization recommends

adults, aged 18 to 64, complete at least 150 to 300 minutes of moderate-intensity aerobic physical activity or at least 75 to 150 minutes of vigorous-intensity aerobic physical activity throughout the week.² Completing this minimum recommendation for regular physical activity is linked to the prevention and management of noncommunicable diseases such as cardiovascular disease, type-2 diabetes, and breast and colon cancer, benefits for mental health, delays in the onset of dementia, maintenance of healthy weight, and overall improvements in well-being.² Although extensive research continues to be done on the direct correlation between physical activity and improved health, physical inactivity remains the fourth leading contributor to global mortality with between an estimated four and five million preventable deaths per year.^{2,3} The World Health Organization determined in their latest global study “about 27.5% of adults and 81% of adolescents did not meet their physical activity recommendations” and sedentary behavior rates are continuing to grow.² Sedentary behavior is any waking behavior when the body is in a sitting, reclining, or lying position with low energy expenditure.² This type of behavior is within the context of occupational, educational, home and community settings, and transportation.² Individuals who fall into the lowest quartile of physical activity, about five minutes per day, and also are sedentary for more than eight hours are at the highest risk of disease mortality.² However, any length of sedentary behavior is dangerous to health.

As the market for consumer wearable activity trackers continues to grow each year, this type of intervention system is increasing in popularity among populations around the world. In 2011, there were only three brands available, but by 2014, 41 new brands appeared.³ This was followed by 36 new brands in 2015 and 23 in 2016.³ Many companies tried adding to the growing smartwatch phenomenon, but by 2019, a majority of the watches were being produced by four companies: Apple, Xiaomi, Samsung, and Fitbit, with Apple dominating the industry with 106.5

of the 336.4 million units of shipment for the 2019 year.⁴ The consumer wearables have gained worldwide recognition and appeal for being user-friendly and featuring functions such as the ability to check notifications and texts, GPS tracking, physical activity tracking, and sleep monitoring. Moreover, a survey done by Alexander Kunst in 2017 of 1,455 adults in the United States reveals “34% of participants found the fitness component to be the most important feature of smartwatches followed by the communication function at 30%.”⁴ Total units of shipments are projected to fluctuate slightly, but overall have a steady increase over the next decade.⁴ Each brand produces a watch with unique features, but in the fitness category, they all have an accelerometer to estimate movement type, count steps, calculate energy expenditure and energy intensity, and can also estimate sleep patterns.³ The validity and reliability vary between brands based on the technology they use, but overall, they offer similar data to an individual utilizing it. Today, individuals are more limited in the brands they can choose from as there are fewer companies producing the high-tech options consumers demand. The devices that are on the market are constantly being perfected and offering more features to add to the functionality of the device. From a physical activity perspective, the wearables can offer an insight into an individual’s habits which may assist in behavior changes with device motivational features such as step and stand goals to better manage personal health.³ The growing prevalence of consumer wearable activity trackers built into smartwatches may aid in decreasing sedentary behaviors through the self-tracking of physical activity and motivational features.

The utilization of consumer wearable activity trackers to increase physical activity levels may lead to psychological benefits that improve an individual’s well-being. Physical inactivity can have a negative psychological impact on an individual by increasing stress, depression, and anxiety levels.⁵ Conversely, physical activity can intervene with negative feelings by reducing

these same symptoms of anxiety and depression.² Wearable activity trackers can act as an intervention system to get an individual moving, thus leading to psychological benefits. Two of the most prominent techniques used by wearable activity trackers to motivate an individual to be active are self-monitoring and reinforcing.⁶ The wearable tracker may have a display screen built into it or one that can connect to a phone, that provides insights into everyday behavior. *Fitbit*, for example, displays summaries of data collection such as steps taken in a day or month, which supports self-monitoring to motivate people to make a change.⁶ Goal setting, a key feature of self-monitoring, has been confirmed to make a positive effect on task motivation.⁷ In a study done by Asimakopoulos et al., “Motivation and User Engagement in Fitness Tracking”, users of the devices report real-time percentage metrics to goal data provided a powerful motivator for securing autonomy and competency of the activity tracked.⁸ This qualitative finding shows the motivational value from seeing their step to goal completion reinforced autonomy which positively influenced sustained or repeated use of the device.⁸ Users can set specific goals such as walking 10,000 steps per day and track their progress throughout the day. *Apple* watches also offer goals such as standing ten times and engaging in thirty minutes of exercise per day. The ability to track throughout the day, at any time, should increase the probability of achieving fitness goals.⁶ Reinforcing occurs when “badges” are awarded for completing certain activity goals. To further increase the incentive to complete activity goals, badges are often shared with peers, thus incorporating a psychosocial aspect.⁶ These motivational mechanisms have been shown to increase task motivation and therefore, are effective tools in fulfilling numerous psychological needs.

There is a multitude of positive psychological effects associated with the activity trackers. According to Karapanos et al. in “Wellbeing in the Making”, wearable activity trackers shape

physical activity experiences to be empowering psychologically and have a positive impact on perceived well-being.⁷ Users of these devices report increased levels of mainly physical thriving, autonomy, and competence, but also pleasure-stimulation, self-esteem, and self-actualization.^{6,9} In the Karapanos et. al study, 133 study participants rated which psychological needs were fulfilled by wearable activity trackers. The findings revealed “physical thriving, autonomy, and competence were the most salient needs with mean ratings higher than four on a five-point intensity scale”, while pleasure-stimulation, self-esteem, and self-actualization had a three rating.⁶ Positive psychological effects are those which lead to an increase in the overall well-being of an individual. The increase in autonomy is specifically related to people gaining more control over their exercise regime. Additionally, significant increases in relatedness of a three on the five-point scale were reported as individuals encouraged their peers to join them in wearing a tracker and sharing their progress.⁶ The many reported psychological benefits associated with using wearable activity trackers are improving the mental health of millions of individuals around the world.

The effectiveness of wearable activity trackers in producing psychological benefits is driven by users’ characteristics. Personality traits, age, an affinity for technology, desire for information, personal involvement, and motivation status are all factors that may influence an individual’s desire to use an activity tracker.⁷ An individual would need to use the wearable activity tracker for the intervention to take place. There is a significant correlation between positive psychological effects and conscientiousness and agreeableness.⁷ According to Ryan et al. in “Anxious or Empowered”, adults using wearable activity trackers report “low conscientious participants and those less open to experience are at a greater risk of experiencing negative psychological effects such as anxiety.”⁹ Additionally, those who are older have less of

an affinity for technology and thus, are less likely to use a wearable fitness tracker.⁷ Conversely, those who have a general interest in technology and its relevancy are more inclined to try the wearable activity tracker.⁷ An individual who has high hopes of completing their tasks and actively seeks out health information is likely to be motivated to use the wearable device.⁷ One of the most important factors, individual status, is a large driving force over the others. If an individual has specific health, exercise, or self-improvement goals in mind, and is internally motivated, they are likely to increase their physical activity levels and find it motivating to use the device.⁷ Someone who is already physically active is highly likely to continue being active when they start using the device. When people are physically inactive, or sedentary, they are less likely to use the device, and if they were to, they are at high risk for abandonment of the wearable.⁷ These factors could all contribute to how effective the intervention is, as it may even discourage people from purchasing the wearable device to begin with.

As with any intervention system changing behavior, there are risks of negative responses in some individuals. Failure to meet the goals set within the tracker may lead to negative psychological experiences such as discouragement and guilt.⁷ Ryan et al. have also found in their study that “when an individual is unable to wear their device, such as the battery dying, there is a significant association with negative psychological effects such as guilt, self-consciousness, and anxiety.”⁹ Negative psychological effects are those which hinder an individual’s well-being. The risks of a negative experience may be outweighed by the potential psychological benefits in the short term that research is finding. Everyone responds to interventions differently, and there is not a definitive answer if the device will be effective or not for a particular person. Individuals who are sedentary may have goals to increase their exercise levels, and the wearable device could act as an effective intervention for them, but it will not be known until it is tried.

Research on the psychological benefits from wearable physical activity trackers are primarily short-term studies, and thus these positive effects may not necessarily be sustainable in the long term. The devices create positive psychological effects initially by increasing step counts and encouraging people to stand up, but could eventually lead to detrimental experiences.

Karapoanos et al. argue that the wearables “took the enjoyment out of walking by adding the measuring component of tracking steps.”⁶ People are less likely to walk for fun, and instead, are more inclined to complete the task to cross it off their to-do list. This is a switch from an internal motivator to an external reward, which is not sustainable.⁶ There is not enough research available to determine if wearable activity trackers have psychological benefits longitudinally, thus further research is needed. Ultimately, there is research to back the short-term psychological benefits from using this type of technology.

Consumer wearable activity trackers may aid in the intervention of sedentary behaviors by increasing physical activity levels. As previously stated, in addition to the psychological impacts of physical inactivity, inactivity is also linked to all-cause mortality, cardiovascular disease mortality, and cancer mortality, and incidence of cardiovascular disease, cancer, and type-2 diabetes according to the World Health Organization.² An individual can rid their chances of these preventable, life-threatening conditions by increasing their physical activity levels with the use of a wearable activity tracker. Regular physical activity can also lead to other health benefits such as improved muscular and cardiorespiratory fitness, bone health, and healthy body weight.² Individuals who are sedentary and do not meet the World Health Organization physical activity recommendations have the opportunity to improve their health, but it may not come as easily as it does for those who are already meeting the recommendations. Important to note, someone can meet the activity recommendations, but then spend the rest of their day in a sedentary state, and

therefore still be at risk of morbidity, although a much lower risk.¹⁰ Physically active people already have created a habit of being active and the wearables help sustain the established behavior. On the other hand, sedentary or physically inactive people have to first break a habit to then form a new one. A habit is an act that is acquired by repetition and occurs without conscious thought.¹¹ Sedentary individuals have well-formed habits of sitting for extended periods which is difficult to break. Forming new habits is also difficult due to the neuronal imprinting that must occur for the behavior to no longer be conscious.¹¹ *Salem Press Encyclopedia of Health* states “habits can take anywhere between 18 and 254 days to form”, which makes a sedentary individual less likely to maintain physical activity goals established within the wearable tracker.¹¹ Short-term studies show there is possible behavior change in sedentary individuals, but not in the long-term.

Wearable activity trackers can act as an intervention system that may lead to an increase in steps, moderate and vigorous physical activity, and energy expenditure. In a short-term study by Dunn and Robertson-Wilson, “Behavior Change Techniques and Physical Activity”, 28 adults using *Fitbits* had “an average increase in step volume of 1971.79 steps per day.”¹² Furthermore, researchers found that the goal-setting aspect of the watch frequently encouraged users to choose activity over inactivity and self-monitoring progressed them in their step goals.¹² Eighty percent of the participants set a default goal of 10,000 steps per day and these individuals reported several ways setting a goal influenced their personal physical activity levels.¹² “Eight participants reported motivation to reach their target, six felt they were held accountable for their activity level, five were ensured they were active through the day, two achieved their step goals to lead to a sense of achievement, and two reported having a goal helps with self-monitoring.”¹² Increasing steps per day is also a tool for getting people unable to participate in high-intensity

physical activity due to physical or health issues, equally as active and moving. Barwais et al. in “Physical Activity, Sedentary Behavior, and Total Wellness Changes Among Sedentary Adults” found the wearable activity tracker to cause significant increases in light-, moderate- and vigorous-intensity physical activity over a 4-week trial in 33 males and females.¹⁰ “Light- increased by 36.7% or to 2.5 hours per day, moderate- by 67% or 455 MET- minute per week, and vigorous-intensity physical activity by 60% or 442 MET-min per week.”¹⁰ MET is a unit to measure activity in metabolic equivalents, or rather, the energy required to do a task. Brickwood et al., in their meta-analysis “Consumer-Based Wearable Activity Trackers Increase Physical Activity”, found significant increases in energy expenditure, the amount of energy required to carry out a task, with “approximately 300 kcal more per week following the intervention with a tracker.”¹¹ These data collections portray the extent to which trackers encourage replacing previous sedentary time with equal amounts of light-, moderate- and vigorous-intensity physical activity which could be built into an individual’s daily schedule.¹⁰ This approach is likely to be sustainable as they are being physically productive with their time, as opposed to being sedentary and trying to create additional time to be active.

The positive changes towards increased movement put people on track to meet the recommended World Health Organization physical activity goals. Small, gradual increases in overall daily physical activity are also associated with positive effects on health.¹³ Consumer wearable activity trackers are a type of intervention that can be designed based on individual goals and allow people to make their own choices regarding their active lifestyle.¹⁴ Some people may want to make drastic changes as soon as they receive their tracker, while others may be more resistant to change and would like it to occur gradually. Any increase in physical activity is better than the sedentary behaviors of individuals worldwide.

The rising prevalence of sedentary behaviors may be combatted with wearable activity trackers. Reductions in sedentary behaviors have also been studied in the short term. Jauho et al. in, “Effect of Wrist-Worn Activity Monitor Feedback” studied 273 young adults and found “those who spent less than 0.5 hours per week on physical activity decreased from 27.6% to 10.2% after the intervention.”¹³ Brickwood et al, in their meta-analysis found eight additional studies which reported “nonsignificant decreases, $P=0.09$, in sedentary behavior after the intervention with an activity tracker.”¹ Additionally, although the quality of evidence was rated very low, they found “individuals spent approximately 37 minutes less in sedentary behavior across the eight studies.”¹ Research is limited in finding significant decreases in sedentary behavior due to users’ characteristics driving the intervention. As previously stated, activity level before intervention and the motivational aspect plays a role in how a habit will break and a new one will form. The studies which found nonsignificant decreases were on individuals who were not meeting the physical activity recommendations and remained sedentary throughout the day.¹ The studies done on increases in steps, exercise intensity, and energy expenditure were mainly on individuals who were already partaking in some amount of physical activity. Sedentary behaviors may change with the intervention of the wearable activity tracker, but its effectiveness is more person to person-based and cannot be determined at large for the entire sedentary population. However, it is promising to see a significant positive intervention that led to increases in physical activity.

Utilizing wearable activity trackers to increase physical activity levels may lead to further positive health improvements. An unanticipated result of many of the intervention system studies was weight loss in participants. In “Not Just Another Walking Program”, Ashe et al. performed a six-month study on providing inactive women with an intervention system and found by

decreasing sedentary behaviors by increasing steps, women lost on average of 4 kg.¹⁴ Decreasing sedentary behaviors and increasing physical activity “may be a ‘gateway’ to changes in diet, which in turn, can lower body mass index.”¹⁴ Obesity, a risk of physical inactivity, may be combatted in this way. Additionally, Ashe et al. found a significant “reduction in diastolic blood pressure of -8.54 mmHg in the intervention group.”¹⁴ Increases in systolic and diastolic blood pressure may occur with prolonged periods of sedentary behavior as it promotes the pooling of blood in the lower extremities and leads to endothelial dysfunction.¹⁵ American Heart Association defines hypertension as “systolic blood pressure of 130 mmHg or greater and diastolic blood pressure of 80 mmHg or greater.”¹⁶ Moreover, it is the leading contributor to cardiovascular morbidity and mortality.¹⁵ Therefore, decreasing time spent in sedentary behavior is a solution to prevent this health risk from developing. There is a multitude of health benefits including weight loss and decreases in diastolic blood pressure associated with using this type of intervention system.

Similar to the positive psychological experiences, increases in exercise behavior to combat inactivity are largely studied in the short term while long-term results are unknown. Based on the principles of habit-forming, an individual has to repeat a behavior until it no longer requires conscious thought, and this process can take days to months. If someone does not allow enough time and repetition of increased physical activity behaviors, the act will not last long-term. Consequently, long-term adherence to exercise is directly correlated to the user’s conscientiousness and agreeableness. Further research is needed to study the long-term effects of increased exercise behavior.

Consumer wearable activity trackers can act as a short-term intervention system that may create positive psychological experiences and increase exercise behavior changes to combat

inactivity and sedentary lifestyles of adults worldwide. This research is on adults of a general population who are not facing specific morbidities. Separate research may need to be done on utilizing this intervention system with particular health conditions. There is a growing prevalence of consumer wearable activity trackers built into smartwatches around the world, and they offer a labor-, resource-, cost-, and time-effective option of an intervention system. The trackers may be more effective for already healthy, physically active, and motivated adults, compared to sedentary, inactive adults, but it ultimately depends on the user's characteristics such as openness to change. Consequently, this intervention system may still be effective in combatting sedentary behaviors. Research has shown the intervention with a fitness tracker can increase physical activity levels which ultimately creates psychological benefits in users. The trackers cannot be guaranteed to be significantly effective psychologically or physically for every user, but they are an available option that should be considered. Additionally, they may not be a sustainable intervention system as the information available is mainly from shorter-length studies. The short-term results are encouraging, but further research needs to be done on both short-term and long-term effects. Consumer wearable activity trackers are growing in popularity as an intervention system and may be an effective option to combat sedentary behaviors and physical inactivity.

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