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Regular engagement in physical activity (PA) offers significant health benefits across the various dimensions of wellness. Over the past three decades, substantial decreases in physical activity worldwide have caught the attention of health organizations, leading them to incorporate initiatives to increase PA participation. Of particular importance is PA done at or above the recommended level to yield positive health outcomes. Those crafting physical activity interventions are consistently trying to better understand health-related human behavior and employ techniques that will lead to long-term behavior change. Wearable activity trackers (WAT), typically worn as smartwatches, are useful tools in promoting physical activity engagement. Traditional interventions that have been shown to increase physical activity focus on eliciting support, self-monitoring of the behavior, and goal setting to promote change, and WAT often offer the very same features (e.g., self-regulation, goal setting, and opportunities to provide and receive support) (Myong-Won et al., 2020; Sullivan & Lachman, 2017). Current research has revealed moderate improvements on daily step count in wearable tracker users across all populations but consistent increases in moderate-to-vigorous physical activity are inconclusive (Brickwood et al., 2019; Ferguson et al., 2022; Laranjo et al., 2021; Li et al., 2021). Many health-related behavior theories highlight the role that social environments play in activity engagement. But the relationship between the use of social elements and contexts that are important to behavior choice on wearable devices is not well understood. The present study compared weekly physical activity of 112 adults from the greater New York City area randomized into conditions that employed either use or no use of the social engagement physical activity features on their wearable trackers over an 8-week period. Changes in exercise self-

efficacy were also measured, given its importance to PA engagement, and the relationship between exercise self-efficacy and physical activity was evaluated. Although there was not a statistically significant difference between those who engaged about their activity with WAT social features and those who did not on weekly PA, there was an average increase of 60.5 ± 20.5 minutes of physical activity per week across all study participants. Exercise self-efficacy and physical activity were positively related (p = .004) and participants using the social comparison feature (the evaluation and comparison of one's personal activity data to the activity data of those they are socially connected to on the device) most frequently had the greatest increase in physical activity. Given the prevalence of device ownership and digital communication in today's society, these results suggest that conscious monitoring of WAT can significantly increase physical activity in an urban population.

THE EFFECT OF WEARABLE ACTIVITY TRACKER SOCIAL BEHAVIORS ON MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY AND EXERCISE SELF-EFFICACY

by

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Dr. Paul Davis
Committee Chair

DEDICATION

This work is dedicated to my best friend and husband. You have sacrificed for me to get through this, and it does not go unnoticed. Thank you for your support, encouragement, and the space you provided for me to pursue and achieve this goal.

And to my perpetual peer-reviewer, I cannot thank you enough for the countless hours, FaceTime sessions, thousands of chat messages, so many laughs and critical feedback you have provided over the past four years. My work is better because of you and your unrelenting review of this document – you have read this as many times as I have. This work is dedicated to you and here's to our future research collaborations.

APPROVAL PAGE

This dissertation written by Amanda M. Bireline has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I: PROJECT OVERVIEW

Given the rising prevalence of physical inactivity, finding relevant ways to increase PA participation is crucial for improving health outcomes and long-term behavior change. Wearable activity trackers (WAT), typically worn as smartwatches, are everyday devices with built-in features that track and display fitness and health data in live time. These devices also have social features where users can engage with others about their daily activity and fitness goal progress. One well studied area is the positive role that social environments play in health-related behavior change. However, one area that is not well studied is whether social environments on digital devices, such as WAT, can positively affect physical activity and improve exercise self-efficacy.

Background Literature

Over the past three decades there has been a vast decrease in adequate physical activity participation (Guthold et al., 2018). Physical inactivity is the fourth leading risk factor of global mortality; moreover, an estimated 8.3% of annual deaths (3.2 million) can be prevented with regular engagement in physical activity (World Health Organization, 2022).

Physical inactivity is a term used to describe a state in which individuals do not meet health-related physical activity recommendations (World Health Organization, 2020). Adequate participation in physical activity, generally in the moderate-to-vigorous-intensity range, is known to result in numerous health benefits, including lower all-cause and cardiovascular disease mortality, lower incidence of obesity, hypertension, type 2 diabetes, and certain site-specific cancers, and improved sleep and mental and cognitive health (World Health Organization, 2020). While inadequate activity is a global issue, inactivity levels in the United States are especially concerning. The most recent report from the CDC found that only 25% of US adults (18 and older) met the weekly aerobic and muscle strengthening recommendations (≥ 150 minutes of

moderate intensity or ≥ 75 minutes of vigorous intensity aerobic activity; and ≥ 2 non-consecutive days of muscle strengthening activity) (Centers for Disease Control and Prevention, 2023). Current statistics suggest that, since the COVID-19 pandemic, there have been heightened decreases in daily physical activity (Amini et al., 2021; Stockwell et al., 2021).

Inadequate physical activity has detrimental effects on health, including the top four causes of death worldwide (heart disease, stroke, chronic obstructive pulmonary disease, and lower respiratory tract infections). Furthermore, insufficient physical activity has negative effects on mental health, such as increased levels of anxiety and depression (Galper et al., 2006). Fortunately, epidemiologists have provided substantial evidence of the protective effects of physical activity at or above the recommended level to the various dimensions of wellness and is recognized as both a preventative and treatment measure to health (CDC, 2021).

Many of the health challenges related to inactive lifestyles can be reduced or eliminated with regular physical activity. Addressing suboptimal activity levels in young adulthood may help to reduce the risk of developing health conditions later in life. To best achieve this, recognition of where and how young people spend their time is imperative for change. Today, that place is immersed in technology (Kemp, 2022). Recently the vast growth in wearable trackers that incorporate behavior change techniques (e.g., goal setting, self-regulation, social support), has led to their use in physical activity interventions. The purpose of this study is to examine how wearable tracker features can be used to increase physical activity. By understanding how the features may address barriers to activity engagement, interventions can incorporate their use in individual and community-based programs.

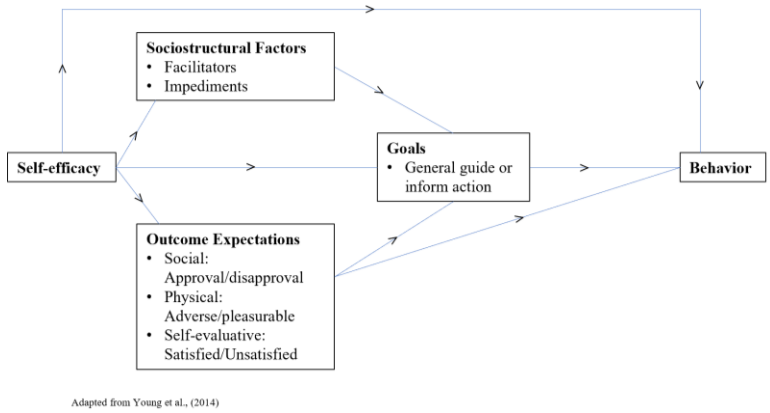
Social Cognitive Theory & Physical Activity

Many theories and models have been created to identify factors that influence health-

related behavior, with many focusing on the social foundations of behavior choice (e.g., *The Health Belief Model, Theory of Planned Behavior). Social Cognitive Theory (SCT)* shows the greatest amount of evidence for predicting, explaining, and intervening in PA engagement and is the most widely used model in activity interventions (Hu et al., 2021; Jekauc et al., 2015).

Social Cognitive Theory postulates that learning occurs in social contexts with both dynamic and reciprocal interactions among the person, environment, and behavior (Bandura, 2004). This theory consists of constructs that impact behavior (outcome expectations, self-efficacy, sociostructural factors, and goals) and seeks to understand behavioral regulation through control and reinforcement. According to Bandura (1986), *outcome expectations* occur when an individual observes situations or events within their environment and the associated outcomes from the actions taken (e.g., pleasurable or adverse, social approval or disapproval, satisfied or unsatisfied), subsequently leading to the decision for engagement (Bandura, 2004; Young et al., 2014). *Self-efficacy* is the belief in one's ability to enact change, be committed to achieve one's goals, and control one's health habits. It is thought to be the foundation of human motivation and action, brought about by self-regulation (Bandura, 1986; Bandura, 2004). Young et al. (2014) noted that increases in self-efficacy have been consistently associated with greater amounts of physical activity. With all health-related behaviors, facilitators and impediments, or *sociostructural factors*, directly affect engagement. Regarding physical activity, reductions to impediments via social support and increased self-efficacy have been found to positively affect activity levels (Bandura, 2004). The final construct under *SCT* is *goals*. According to Bandura (2004), goals mediate all other constructs and can act as a general guide or inform action.

Figure 1. Social Cognitive Theory & Human Behavior



Note: This figure displays the model of *Social Cognitive Theory*, showing a reciprocal interaction between each of the four constructs and their influence on human behavior.

Social Environment & Self-efficacy

In consideration of physical activity, *Social Cognitive Theory* provides space for social influence by instilling positive or negative outcome expectations and collective efficacy of the behavior (Bandura, 2004). As individuals are exposed through their environment to physical activity behaviors, goals, and the achievements of others, their own belief in their abilities for engagement and goal achievement may increase (John et al., 2020; Wang et al., 2019). Social support can positively influence outcome expectations by adding feelings of pleasure and acceptance, increase self-efficacy through social approval, act as a facilitator to PA via communication from those close to the individual, and goal achievement through accountability. Regarding wearable trackers, Sturts & Gupta (2018) observed that their use can improve self-efficacy and further increases in PA may be seen due to social support the wearer receives from their connections through the device (Gowin et al., 2019). By understanding how social support can facilitate activity engagement and produce changes in self-efficacy, implementing techniques that use social support may result in significant increases in PA behaviors.

Currently, most research has been limited to the influence of social support and social environments from in-person experiences, though it is thought that equivocal levels can be mimicked within online social platforms (Clark et al., 2018; Nick et al., 2018). It is worth examining how connections specifically on digital devices affect human behavior. Zhang et al. (2016) discovered that social interaction through digital connectivity enhances physical activity. While social influence is not the only determinant of activity behavior, it is important to understand how it can affect behavioral action as the world becomes more digitally immersed.

Wearable Activity Trackers

Wearable trackers are electronic monitoring devices that enable users to track and observe health-related physical fitness and health data in real time (Shin et al., 2020). Information provided to the user includes step count, energy expenditure, excessive sedentary time, and displays progress towards individualized goals (Fritz et al., 2014). Of particular interest to those promoting physical activity, wearable trackers offer the opportunity for data to be collected in free-living contexts, translatable to practical recommendations.

The use of these devices could present a paradigm shift in the prevention of chronic diseases, as a key known measure is regular physical activity (Mehdi & Alharby, 2018). Use of wearable trackers can be an effective tool in physical activity interventions as device features (e.g., self-regulation, goal setting, social support) allow for the design of a multicomponent intervention, leading to more successful behavior change (Conn et al., 2011). Mercer et al. (2016) also discovered that device features offer the very same techniques used in evidence-based clinical interventions (e.g., social support, goal setting) and are relevant to all populations. Using wearable trackers for activity interventions may eliminate some of the limitations in previous work such as boundaries on resources, time, and the integration of social connectedness

in physical activity environments. One advantage is that they address more than one construct under *SCT,* such as allowing the user to set specific goals or observe the achievements of others, and may act as a facilitator to PA, therefore furthering the likelihood for long-term change (Luszczynska & Schwarzer, 2020).

Wearable Activity Trackers & Fitness Sharing

Current literature on the use of wearable trackers spans across many factors that are related to improved health behaviors, especially increases in daily step count (Brickwood et al., 2019; Ferguson et al., 2022; Laranjo et al., 2021; Li et al., 2021). One factor is the exposure to fitness data in live time. This enables on-going self-regulation, which is foundational to changes in self-efficacy (Bandura, 1986). Extending into one's environment, these devices provide the capability to share fitness data with selected digital connections. Fitness sharing exposes users to others' daily activity progress and provides notifications on goal achievement and earned rewards. Those who are digitally sharing can "like" their connections achievements and send customized messages providing support and feedback (see Figure 4). Literature has identified how sharing fitness data on wearable trackers increases exercise intention and engagement (Cho & Tian, 2021; Zhu et al., 2017). Cho & Tian (2021) also determined that the social presence of others causes people to evaluate and adjust their exercise habits based on comparison (i.e., social comparison), a natural reaction in human behavior. Additionally, Zhu et al. (2017) noted that these active digital communities exposed individuals' attitudes, emotions, and norms towards physical activity engagement, leading to further increases of activity. These findings connect with the sociostructural factors (facilitators) of Bandura's *Social Cognitive Theory,* suggesting that by being exposed to others' fitness data, receiving notifications on the completion of a

workout or activity goal, and comparing daily activity might facilitate further increases in PA.

Wearable Activity Trackers & Competition

One area growing in popularity within the scope of technology and fitness is gamification. “Exergames” infuse elements of computerized video games such as point systems, levels, and badges encouraging users to engage in physical activity competitions (Burton, 2019; Shameli et al., 2017). DiMenichi & Tricomi (2015) suggest that competition drives an increase in attention to task and enhances social motivation towards striving for a goal. Cho et al. (2021) additionally noted that competition fulfills the need for social recognition and status. Thus, proposing that competition is and can be an effective tool for increasing activity engagement.

When WAT users are connected, they may invite others to a competition, working towards a collaborative PA goal. These competitions provide daily notifications of those goals and progress made (see Figure 4), foundational for change (Bandura, 2004). Additionally, participating in a competition can be a facilitator to increase PA and assist in the reduction of barriers. Several studies have supported increases in step count when WAT users competed against others (DiFrancisco-Donoghue et al., 2019; Shameli et al., 2017; Shin, 2020; Zhang et al., 2016). It is important to note that when individuals lose a competition, it may negatively influence future engagement in activity; but, if users win the competition, a focus on personal achievement may enhance self-efficacy and positively affect physical activity (Bandura, 1997).

Wearable Activity Trackers & Social Support

Being connected by sharing fitness data on a wearable tracker creates an opportunity to provide and receive social support and expand exercise experiences across one’s social network (Cho & Tian, 2021). The feedback on activity provides users positive reinforcement and boosts self-efficacy when fitness goals have been met (Girginov et al., 2020; Gowin et al., 2019;

Karapanos et al., 2016). In fact, the use of social support via wearable trackers is linked to all the other constructs under *SCT*. Li et al., (2021) suggest that external facilitators such as social support may help overcome barriers to physical activity. Tong et al. (2018) suggests that social tools on WAT help users work towards their fitness goals and enhance self-regulation, which may subsequently lead to increases in activity. In another study, Myong-Won et al. (2020) discovered that when users received social support from connected family and friends, exercise-efficacy increased, resulting in greater cumulative daily physical activity. Finally, Zhang et al. (2016) noted that with social support from connections, the perceived costs associated with adopting healthy behaviors decreases, resulting in a higher adoption of physical activity.

Gaps in the Literature

Previous studies indicated that WAT use consistently results in increased daily step count (Brickwood et al., 2019; Ferguson et al., 2022; Laranjo et al., 2021; Li et al., 2021). However, one understudied area is how the use of social features on WAT targets formal exercise over lifestyle physical activity and given its importance to activity engagement, how exercise self-efficacy is impacted by using these features. In a recent systematic review, Girginov et al. (2020) identified seven studies related to wearable trackers and social behavior, but each explored the effect on exercise intention or daily step count. The absence of research on the social elements limits our scope of knowing how the use of wearables may enhance physical activity and health, along with the theoretical application in activity interventions. Of particular importance is the understanding of how modern technologies can be used in these interventions as individuals in the younger generations embrace digital lift at greater rates. If socially connecting on a wearable device can influence physical activity and improve exercise self-efficacy, then it is likely that significant changes will be seen in health outcomes across participating groups.

Purpose & Aims

The purpose of this study is to examine how social behavior features on wearable activity trackers affect moderate-to-vigorous physical activity and exercise self-efficacy in adults 18 and older in a large urban setting.

Aim #1: Examine the overall effect of using the wearable activity tracker fitness sharing feature on moderate-to-vigorous physical activity and assess which component (social comparison, competition, or social support) has the greatest influence on activity engagement.

Aim #2: Examine the effect of the various wearable tracker social features on exercise self-efficacy.

Aim #3: Examine the relationship between changes in exercise self-efficacy and changes in moderate-to-vigorous physical activity.

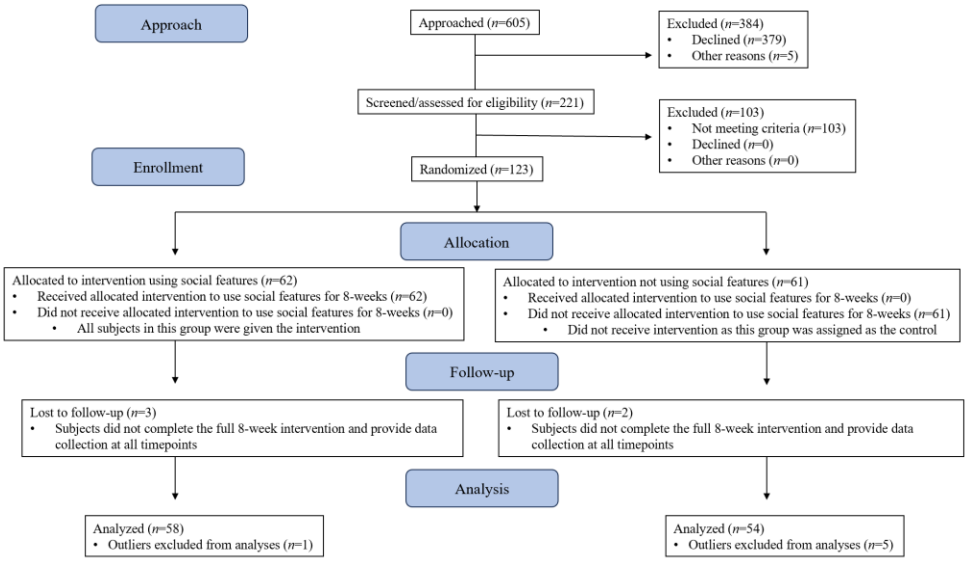
Methods

To understand how social behaviors on wearable activity trackers affect physical activity and exercise self-efficacy, this quantitative study gathered objective data from devices (Apple Watch) used in free-living environments and survey responses. Measurements were obtained pre-, mid-, and post 8-week intervention. Inferential statistics determined if main effects and/or interactions were found between the two conditions (those engaging about physical activity using the built-in social features on the WAT and those not engaging with the social features) in minutes per week of physical activity and exercise self-efficacy scores and which, if any, social feature had the greatest influence on both activity levels and self-efficacy. Additionally, the relationships between changes in exercise self-efficacy and changes in minutes of physical activity across the three timepoints was assessed.

Participants

Adult residents of the New York/New Jersey metropolitan area were recruited through flyers displayed in public facilities such as recreation centers, on community boards, in local businesses, and across the campuses of Mercy University. Digital versions of the flyer were also posted in select courses through the institution's learning management system. Additional recruitment efforts included word of mouth and snowball sampling, as well as email communication by the principal investigator (see Appendix A). For feasibility, participants needed to be current Apple Watch users. Individuals who had been told by their physician that they could not currently participate in higher levels of PA or those already engaging socially about their activity on the WAT were excluded from this study. Additionally, those who were, or thought they might be pregnant were excluded as limitations to PA engagement may confound study findings. Study enrollees were screened and assessed for eligibility (n = 221) and 123 were randomized and allocated to either the social feature user condition (n = 62) or the non-user condition (n = 61). At the end of the intervention, three subjects from the user condition and two from the non-user condition did not complete data collection in its entirety, thus their data was discarded (see Figure 2). SPSS descriptives were run to determine the mean, standard deviation, and distributions of baseline exercise self-efficacy and weekly exercise minutes to determine outliers. Statistical outliers (>2 standard deviations from the mean) that had self-efficacy scores <12 (n = 2) and weekly exercise minutes >629 (n = 4) were removed, leaving a total of 112 data points for analysis. Tables 1-5 include data with the outliers removed (see notes under each table for specifics). Demographics of study participants can be found in Appendix B.

Figure 2. CONSORT Diagram of Research Participants



Note: This figure reports a flow diagram of recruitment, enrollment, allocation, follow-up, and analysis of study participants.

Measures

Data collection included objective measures (exercise minutes) from the wearable activity tracker and surveys. The surveys gathered participant demographics and information about the use of the wearable device, included the Resnick & Jenkins (2000) Self-efficacy for Exercise Scale (SeES) (see Appendix C), and the Physical Activity Social Support Scale (PASSS) (see Appendix D) (Golaszewski & Bartholomew, 2018).

Wearable Activity Tracker

The Apple Watch was used for physical activity measures as it is the most owned wearable device (Mehdi & Alharby, 2018). On this device, the "exercise minutes" parameter is designed to parallel moderate-to-vigorous-intensity physical activity (MVPA). MVPA is defined as physical activity ≥ 3 metabolic equivalents of task (METs; 1 MET is the estimated energy expenditure when seated at rest) or ≥ 40% heart rate reserve (HRR: the amount the heart rate can

increase above resting level) (Garber et al., 2011) and can be subjectively quantified as an effort of ≥ 5 on a 0-10 scale (U.S. Department of Health and Human Services, 2018; World Health Organization, 2020). Public health recommendations for physical activity typically exemplify MVPA as intensities at or above that of "brisk walking" (Pate et al., 1995). The Apple Watch automatically measures "exercise minutes" during all wear time, which are specific to the user based on biometric data and algorithms and are recorded for "every full minute of movement that is equal to or exceeds the intensity of a brisk walk" (*Get the most accurate measurements using your Apple Watch*, 2022). More precisely, the algorithms use the device wearer's age, height, weight, sex, motion data (via accelerometry and Global Positioning System), and cardiorespiratory fitness level (i.e., estimated maximal oxygen consumption) to determine what is considered a brisk walking intensity for each individual (*Using Apple Watch to estimate cardio fitness with VO_2max,* 2021). Physical activity measurements (i.e., exercise minutes) on an Apple Watch have been reported to have moderate validity and reliability (Veerabhadrappa et al., 2018; Xie et al., 2018; Zhang et al., 2019).

Apple Watch Activity Rings

The Apple Watch allows users to track and view daily activity in live time via the use of three "rings" (i.e., red, green, and blue). These rings represent a metric used to promote movement throughout the day and engagement in healthy behaviors. The red ring displays the users "Move" total. Move is equivalent to the total number of active calories the user has burned. The green ring displays the users "Exercise" minutes, which are equivalent to the number of minutes spent doing brisk activity. And the blue ring displays the users "Stand" time. Stand is equivalent to how many times the user has stood and moved in a day for at least one minute out of the hour (if the user has specified, they are a wheelchair user, the blue stand ring becomes a

roll ring, measuring the total number of times the user has rolled for at least one minute per hour). Users may adjust their daily goals through their device and have their activity rings displayed on their watch home screen or can be accessed through the activity application on their watch and fitness application on their phone. They may also select to receive notifications of their goal progress to promote moving more, sitting less, and engaging in intentional exercise.

Figure 3. Apple Watch Activity Rings

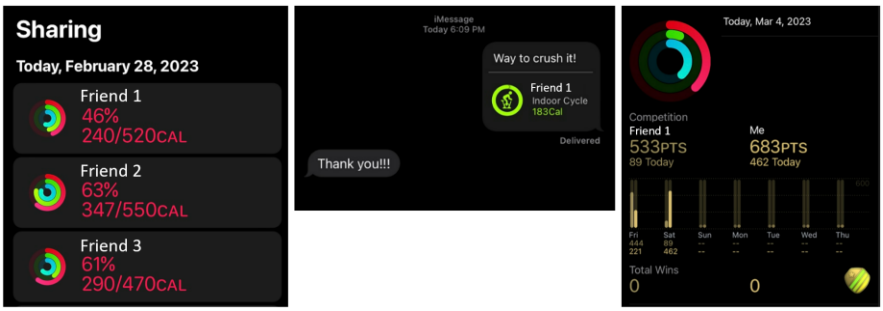
Note: The figure displays the Apple Watch Activity Rings, showing the users "Move" total in red, their "Exercise" total in green, and their "Stand" total in blue.

For this study, weekly exercise minutes were the measure used for the dependent variable. Participants in this study were prompted to upload a screenshot of one full week of their exercise minutes into the Qualtrics surveys at pre-, mid-, and post-intervention.

The activity rings are the premise for which social engagement occurs on the Apple Watch. Users can view connections activity rings and compare their ring status in live time (social comparison) (see Figure 4, first image). When connected with other device users, a notification will display on the watch about connection's activity progress (e.g., completed workout, "closing" their rings) and earned rewards (e.g., new personal records, completing a monthly challenge), allowing for personalized or automated comments to be made in return (social support) (see Figure 4, middle image). Finally, connected users can initiate a one-week competition through the device in which each party earns one point for each percent added to the

activity rings each day (competition). Live feedback on the status of the competition is provided directly through the device and can be repeated weekly (see Figure 4, last image).

Figure 4. Apple Watch Social Engagement Dashboards



Note: The figure displays the social engagement features offered on the Apple Watch, showing social comparison, social support, and competition dashboards respectively.

Surveys

Participants completed a pre-intervention survey to identify demographics (i.e., age, gender, education level, socioeconomic status, and body mass index), use of the device to monitor activity and socially engage, stages of change measures (Marcus et al., 1992; Norman et al., 1998), location of residency, Physical Activity Social Support Scale (Golaszewski & Bartholomew, 2018), and clearance for physical activity participation (see Appendix E). To measure exercise self-efficacy, subjects completed the SeES (Resnick & Jenkins, 2000) that was integrated into the pre- and post-intervention surveys, as well as at the midpoint independently (see Appendix F). The Resnick & Jenkins Self-efficacy for Exercise Scale shows sufficient evidence of internal consistency (alpha = 0.92) (Resnick & Jenkins, 2000; Resnick et al., 2004) and the PASSS shows internal consistency between 0.87-0.91 (Reis, et al., 2011). Following the intervention, participants in the social feature user condition completed a survey reporting the most frequently used social feature and which, if any, had the greatest effect on physical activity and exercise self-efficacy. Questions also addressed use of both the device and its social features

as they related to constructs under *SCT* (i.e., goals, outcome expectations, and sociostructural factors), and stages of change (see Appendix G). Those in the non-user condition received a post-intervention survey measuring the use of the device to address *SCT* constructs, measures of exercise self-efficacy, and stages of change (see Appendix H).

Functional Definitions

The following definitions related to the WAT fitness sharing feature were provided to best understand the design of the methods and for accurate responses in the post-intervention survey:

- *Fitness sharing*: the disclosure of activity data with other users through selected digital connections on the wearable device.
- *Social comparison*: the evaluation and comparison of one's personal activity data to the activity data of those they are socially connected to on the device.
- *Competition*: active engagement in the device's competition feature (social connections can engage in weekly activity competitions earning points for each percent of daily activity completion).
- *Social support*: active engagement in comments, feedback, and/or "likes" of social connections activity progress, workout completion, and/or earned rewards.

Procedures

Individuals interested in participating in the study scanned the QR code from the recruitment flyer that directed them to the consent and pre-intervention survey. Once completed, the data was recorded and deidentified, and participants received email or text communication (whichever preference they selected in the survey) about which condition (social feature users or non-users) they were randomly assigned to and were encouraged to continue with their regular activity habits. To promote ease of use, those assigned to the social feature user condition were

provided instructions on how to set up fitness data sharing, invite and accept invitations from other device users, view connections data (social comparison), compete with others (competition), and provide feedback such as “likes” or comments to their connections about their activity and progress towards personalized fitness goals (social support) on the device (see Appendix I). At mid-point of the study (four weeks preceding enrollment), participants received the mid-intervention survey and upon completion of the eight-week intervention, participants received the final survey based on which condition they were assigned to.

Pre-intervention

The participants completed the pre-intervention survey through Qualtrics upon consenting to participate in the research study. Definitions of important terms such as physical activity index and social feature engagement were provided in the survey so participants could answer as accurately as possible. One week of free-living physical activity data (i.e., exercise minutes) was collected from the participant's device to obtain baseline measures. To collect total weekly exercise minutes, the participant was given instructions on how to take a screenshot of the data points from their device and prompted to upload it into the survey. All data was coded, and participants were assigned a study ID number to keep subject identity anonymous.

Mid-intervention

Four weeks following study enrollment, participants completed the mid-intervention survey. This survey included the SeES (Resnick & Jenkins, 2000) and participants were prompted to upload a screenshot of their current week’s exercise minutes from their device.

Post-intervention

At the conclusion of the intervention, participants completed a series of questions using a Likert scale and completed the SeES (Resnick & Jenkins, 2000). Subjects were again prompted

to upload a screenshot of their eighth week of exercise minutes from their device into the survey. Eight weeks has been reported to provide a fairly accurate average of the user's regular weekly physical activity, accounting for variations across weeks (Bassett et al., 2010; Berlin et al., 2006; Tudor-Locke et al., 2005). Additionally, participants were thanked for their participation and entered a drawing to receive a $20 Apple Gift Card (10 total were selected and distributed).

Data Analysis

Statistical analyses were performed using SPSS comparing baseline vs. post-intervention, baseline vs. midpoint, and midpoint vs. post-intervention measurements between social feature users and non-users. "Exercise minutes" from the Apple Watch were expressed as "weekly physical activity minutes". A two-way mixed analysis of variance (ANOVA) was used to determine if effects were found between social feature users and non-users on PA and if there was a statistically significant difference between specific social feature use and physical activity (*aim #1*). A two-way mixed ANOVA was also used to determine effects between the conditions and changes in exercise self-efficacy and if any specific social feature had a greater effect on the participants self-efficacy towards PA (*aim #2*). Tukey HSD post hoc tests were run to determine where significant means were found. Finally, change scores were calculated for exercise self-efficacy and weekly physical activity from baseline to mid-intervention, from mid-intervention to post-intervention, and from pre-intervention to post-intervention. A Pearson Coefficient Correlation was then computed to determine the relationship between changes in exercise self-efficacy and changes in physical activity (*aim #3*).

Results

A two-way mixed ANOVA was conducted to investigate the impact of engaging with social features on a wearable activity tracker on weekly physical activity. There was a main

effect of exercise minutes within subjects across the repeated measures both before outliers were removed ($p < .001$) and after they were removed ($p < .001$), with the largest difference coming from baseline to post-intervention. A Tukey HSD post hoc test indicated an average overall increase of approximately 60 minutes of PA from pre- to post-intervention on both sets of data. There was no significant interaction between weekly PA and condition when outliers were not removed across the 8-week study ($p = .322$) or after they were removed ($p = .679$) (see Table 1 or Appendix J, Table 1 for a detailed report). Among WAT users, another two-way mixed ANOVA was conducted to investigate if a specific social feature (social comparison, competition, or social support) had a greater impact on weekly physical activity across the study time points. After grouping the participants by which social feature they used most, a statistically significant interaction was found between the top used social feature and weekly exercise minutes when original data was analyzed ($p = .031$) and when outliers were removed ($p = .019$) (see Table 2 or Appendix J, Table 2 for a detailed report). A Tukey HSD post hoc test revealed those engaging with social comparison most frequently during the study to average increases of 62 and 112 more minutes per week than those reporting the use of competition or social support, respectively, from pre- to post-intervention.

Table 1. Weekly Physical Activity Minutes Based on WAT-Use Condition*

Randomized Condition	Pre-intervention	Mid-intervention	Post-intervention
Social Feature User Condition ($n = 58$)	$M = 275 \pm 153$	$M = 319 \pm 182$**	$M = 337 \pm 172$**
Non-user Condition ($n = 54$)	$M = 237 \pm 152$	$M = 261 \pm 162$	$M = 296 \pm 174$**
Overall Sample ($n = 112$)	$M = 257 \pm 153$	$M = 291 \pm 174$**	$M = 317 \pm 174$**

*Data reflects removal of participants with baseline self-efficacy scores >2SD's from the mean.
**Indicates a significant difference from Pre-intervention compared to other repeated measures.

Table 2. Weekly Physical Activity Minutes Based on Top Reported Social Feature Use*

Social Feature	Pre-intervention	Mid-intervention	Post-intervention
Social Comparison (*n* = 22)	*M* = 247 ± 137	*M* = 356 ± 187**	*M* = 358 ± 153**
Competition (*n* = 23)	*M* = 298 ± 143	*M* = 290 ± 173	*M* = 347 ± 207
Social Support (*n* = 13)	*M* = 284 ± 197	*M* = 306 ± 192	*M* = 283 ± 134

*Data reflects removal of participants with baseline self-efficacy scores >2SD's from the mean.
**Indicates a significant difference from Pre-intervention compared to other features.

A two-way mixed ANOVA was conducted to investigate the impact of engaging with social features on a wearable activity tracker on changes in exercise self-efficacy. Descriptive statistics revealed inflated mean baseline scores (i.e., there were a number of scores approaching 90, the highest possible), resulting in a decrease in self-efficacy scores at mid-intervention. Since this carried the potential to cloud an observation of improvement in participants with low-to-moderate scores, further removal of data (baseline self-efficacy scores >60, $n = 39$) and additional analyses were computed. There was a significant reduction of exercise self-efficacy ($p = .035$) within all subjects across the repeated measures when the first round of outliers were removed (mainly due to a drop from pre- to mid-intervention) but, when those reporting baseline self-efficacy >60 were removed, no effect was found ($p = .227$). There was also not a significant interaction between the two conditions and self-efficacy on the data with the first removal of outliers ($p = .291$) or when the additional baseline data were removed ($p = .835$) (see Table 3 or Appendix J, Table 3 for a detailed report). An additional two-way mixed ANOVA investigated if a specific social feature had a greater impact on exercise self-efficacy across the study time points. The results indicated there was a significant main effect within subjects across the repeated measures ($p = .024$), but when the second set of high baseline self-efficacy scores were removed, no significant effect was found ($p = .369$). In addition, no statistically significant interaction between a specific social feature and self-efficacy was found when the first removal

of outliers occurred (p = .735) or when the second removal of outliers occurred (p = .859) (see Table 4 or Appendix J, Table 4 for a detailed report).

Table 3. Exercise Self-efficacy Scores Based on WAT-Use Condition*

Randomized Condition	Pre-intervention	Mid-intervention	Post-intervention
Social Feature User Condition (n = 34)	M = 42 ± 12	M = 40 ± 18	M = 44 ± 16
Non-user Condition (n = 39)	M = 41 ± 12	M = 41 ± 14	M = 44 ± 17

*Data reflects removal of participants with baseline self-efficacy scores >60.

Table 4. Exercise Self-efficacy Scores Based on Top Reported Social Feature Use*

Social Feature	Pre-intervention	Mid-intervention	Post-intervention
Social Comparison (n =12)	M = 43 ± 12	M = 50 ± 23	M = 43 ± 17
Competition (n = 16)	M = 39 ± 12	M = 39 ± 13	M = 40 ± 13
Social Support (n = 6)	M = 47 ± 11	M = 43 ± 21	M = 53 ± 22

*Data reflects removal of participants with baseline self-efficacy scores >60.

Change scores among the conditions were calculated and a Pearson Correlation Coefficient were computed to determine the relationship between changes in exercise self-efficacy scores versus changes in weekly physical activity across various time points during the study (pre- to mid-intervention, mid- to post-intervention, and pre- to post-intervention). Because this data also uses self-efficacy scores, two sets of analyses were done (original removal of outliers and the additional removal of data points with baseline self-efficacy scores >60). A significant relationship between change in exercise self-efficacy and change in weekly physical activity was not present from pre- to mid-intervention with the original removal of outliers (p = .359) or with the additional removal of participants with elevated self-efficacy scores (p = .403). From mid-intervention to post-intervention, results from the first round of data indicated a nonsignificant positive relationship between change in exercise self-efficacy and change in weekly PA (p = .081) that became statistically significant when those with elevated self-efficacy

scores were removed ($r = 0.058$, $p = .040$). Finally, the results from pre- to post-intervention indicated a positive significant relationship ($r = 0.0112$) between the change scores in both rounds of outlier removal ($p = .016$) (first removal) and ($r = .335$, $p = .004$) (second removal). In summary, these positive correlations show that as exercise self-efficacy scores increase, time spent doing physical activity also increases. And when there is a decrease in self-efficacy scores, there is also a decrease in PA (see Table 5 or Appendix J, Table 5 for a detailed report). Scatter plots for both sets of data at the various time points can be found in Appendix K.

Table 5. Pearson Correlation Coefficient of Changes in Exercise Self-efficacy Scores versus Changes in Weekly Physical Activity Minutes*

	Pre- to Mid-intervention	Mid- to Post-intervention	Pre- to Post-intervention
Pearson Correlation	.099	.241*	.335*
P-value (2-tailed)	.403	.040*	.004*

*Data reflects removal of participants with baseline self-efficacy scores >60.

Descriptive statistics (i.e., frequencies) were run to summarize measures related to the use of a wearable tracker on constructs under *Social Cognitive Theory* (i.e., goals, sociostructural factors, outcome expectations). All questions on the post-intervention surveys used a Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree) and those in the social sharing condition had an additional set of questions related to their use of specific social features on the constructs. For reporting purposes, ratings of seven or above were considered as positive responses. Most (88%) of the participants indicated they plan to continue to use their WAT to set and monitor exercise goals (see Appendix L, Figure 1), 78% of the participants found physical activity more pleasurable compared to when they did not use their device (see Appendix L, Figure 2), and 80% felt that using their WAT was a facilitator to increased PA (see Appendix L, Figure 3). Additionally, those who were in the social feature user condition suggested sharing

their activity with others on their device was a facilitator to greater amounts of physical activity (76%) (see Appendix L, Figure 4) compared to when they did not share their data. In consideration of specific feature use on the device, 74% felt that being able to view and compare their activity to others (i.e., social comparison) increased their physical activity (see Appendix L, Figure 5) and 67% of the users agreed that social comparison also increased their self-efficacy (see Appendix L, Figure 6). Those who reported using the competition feature most frequently (62%) thought it was a facilitator to increasing weekly PA (see Appendix L, Figure 7) but did not find it helped to increase their self-efficacy. Finally, considering social support provided by connections on the device about their activity, 72% thought that social support helped to increase their physical activity levels (see Appendix L, Figure 9) and 71% of the feature users felt that it improved their exercise self-efficacy (see Appendix L, Figure 10).

Discussion and Implications

With the prevalence of wearable tracker ownership on the rise, it is important to understand if and how these everyday devices can be implemented for promoting increases in physical activity. These devices offer built-in features that address constructs under the *Social Cognitive Theory* (e.g., goal setting) that have shown promising results in health-related behavior change. This study was designed to determine if engaging with social features on WAT regarding one's physical activity improves total weekly PA and/or exercise self-efficacy compared to those who do not engage socially about their activity on their device. Although it has been suggested that socially engaging with others about one's PA results in an increase in activity (Kahn et al.,2002; Kouvonen et al.,2012), no studies have investigated this with smartwatch technology or examined specific features and their impact on physical activity or its potential determinants. Thus, the study also aimed to determine if a specific social feature

(competition, social comparison, or social support) had a greater effect on physical activity and/or exercise self-efficacy, and how changes in exercise self-efficacy might affect changes in physical activity.

With physical inactivity being one of the top modifiable risk factors of chronic disease and all-cause mortality (World Health Organization, 2022), it is critical that effective and practical means to increase physical activity participation be identified. This study revealed that while participants under both conditions (social feature users and non-users) were comfortably meeting the physical activity recommendations at baseline (average of 257 minutes of PA per week), there was still an overall increase of approximately 60 minutes regardless of condition. Although no difference was present between those who were and were not assigned to use their WAT's social features, participating in a study that required conscious tracking of PA through wearable technology appears to increase weekly physical activity participation. A majority of participants also reported they plan to continue to use their device to set and monitor PA goals, showing that WAT use may spur individuals on to more activity through goal setting. Though the null hypothesis that socially engaging on a WAT about activity increases physical activity is rejected, the results are consistent with current literature that the use of WAT in general does increase weekly PA (Li et al., 2021).

Previous literature indicates a positive relationship between self-efficacy and physical activity (McAuley et al.,2011; Pekmezi et al., 2009; Perkins et al., 2008). While this study did not determine that engaging socially on a device about activity improves exercise self-efficacy, descriptive statistics yielded interesting results, showing a drop in scores between the pre- and mid-intervention measures. This is likely due to overreporting (i.e., failure to recognize the difficulty of behavior change) at baseline and realism setting in by the second measure (four

weeks following baseline). While literature suggests using techniques such as vicarious experiences and verbal persuasion may enhance self-efficacy (Prestwich et al.,2014; Wright et al., 2016) this study may not have been long enough or did not provide background knowledge on the importance of meeting the PA guidelines (factors that are important under these constructs) to employ a change. Additionally, Rieder et al., (2019) suggest that the use of WAT's provide users information that can enhance self-efficacy (e.g., performance accomplishments, vicarious experiences) but these devices do not address task difficulty or provide an evaluation of external circumstances that can influence both self-efficacy and activity engagement. It is important to note that in consideration of WAT and self-efficacy, Reider et al. (2020) highlight that changes in self-efficacy can be highly contextual and transient. Nonetheless, though significant changes in self-efficacy were not seen, significant changes in weekly physical activity were still found. Aligning with previous literature, the ability to set goals and self-monitor activity (French et al., 2014; Li et al.,2021) on the device likely contributed to the changes seen. Using wearable technology that tracks activity data in live time combined with the capability to set individualized and specific goals allows for those using the device an increase in conscious awareness of activity habits and the opportunity to adjust them based on their current status towards achieving those goals.

This study revealed that the use of social comparison and competition were preferred on the device more so than social support and that using social comparison most frequently resulted in increases of 62-112 more minutes per week of PA than those who reported using the other features most often. Many of the participants also felt that being able to view and compare their activity data to others in live time (i.e., social comparison) was a facilitator of increased physical activity. Furthermore, while participants also felt that social comparison increased their exercise

self-efficacy, there was no significant difference between use of any of the features and self-efficacy scores. These results align with literature on physical activity perceptions vs. reality that often individuals think they are increasing or meeting PA recommendations, but objective measures show otherwise (Corder et al., 2010; Wells et al., 2016). The variation in results may be explained by the variation in individual preferences of social engagement or which social feature one relies on most. One may be seeking social support for motivation and acceptance while another is more interested in winning a competition or quietly comparing themselves to others. It is important to also consider the design of the features on the WAT when discussing the most frequently used feature. Both the competition and social support feature require on-going active engagement from the device user, however with social comparison, the user can simply access their dashboard of connections and compare their activity data without further effort. This is likely to contribute to some preferring this feature over the others. When working with others to increase PA behaviors, identifying ways they may be most socially motivated may allow for an accurate recommendation to features on a device that would have a more significant impact.

Consistent with previous literature, the present study revealed a significant relationship between changes in exercise self-efficacy and changes in physical activity. This study concluded homogenous results of the positive linear relationship between these two measures. As exercise self-efficacy scores went up, so did weekly PA and vice versa. Those working to promote increases in physical activity could measure a patient or clients exercise self-efficacy using valid and reliable scales (e.g., Resnick & Jenkins Self-Efficacy for Exercise Scale) and implement evidence-based strategies (e.g., social support, goal setting, self-regulation) for improvement, further leading to increases in activity levels.

These results align with current literature on the use of wearable devices to improve time

spent doing physical activity, at least in the short-term. This study filled a gap identified in the literature on whether socially engaging about physical activity on a wearable tracker would increase PA and if changes in self-efficacy were also related to sharing and engaging about activity with others. Of importance, this study shows social comparison to increase physical activity most (approximately 111 minutes per week). Subjective data also uncovered how social engagement regarding physical activity on WATs might impact constructs within the *Social Cognitive Theory* (i.e., goals, outcome expectancies, sociostructural factors). It was found that using the wearable tracker to set and monitor activity goals was thought to increase PA, using the device to monitor activity through self-regulation was a facilitator to increase activity levels, and users found activity more pleasurable than when they didn't use their device.

It is important to address the strengths and limitations of this study. The most recent ACSM Worldwide Survey on Fitness Trends reports that wearable technology tops the charts as the number one trend for 2024. It was suggested that with these devices offering real-time feedback, health professionals could better tailor programs for their clients and patients and build community connections and social support (Newsome et al., 2024). The same survey done in 2023 also noted an increase in implementation of wearable devices into clinical programming with the prevalence of ownership being anticipated to rise across a wide variety of populations (Thompson, 2023). It is also important to note that this study recruited subjects in a very large metropolitan area allowing for a diverse subset of participants. And with the use of WAT, numerical data was collected in free-living environments, allowing for more practical implementation. Finally, with these devices being a part of many individuals' everyday attires, they can easily be utilized to promote PA engagement in several contexts.

Regarding limitations, the inclusion criteria of being a current Apple Watch owner

eliminates the number of potential participants and singles out one type of wearable device. And with this group of participants (mainly young adults females) already being technologically immersed, it may be challenging to consider if the results could be generalized to populations who may be less tech-savvy. Additionally, the length of the intervention may not give an accurate snapshot of PA behaviors over the long-term and device compliance and accurate reporting of social feature use may impact precise measures. All social features analyzed in this study were self-chosen rather than being randomized, thus while users were encouraged to and may have engaged with all three, the data reflects only that which the participants reported as most used and eliminates knowing to what extent the other features were engaged with. It is also important to note that the location of this study was in a very large metropolitan area (NYC/NJ) where many people rely on commuting via public transit (e.g., walking, subway, bus, train, and ferry) rather than using automobiles. Individuals may walk several miles per day between locations and/or public transit facilities. This may be a factor in the high baseline physical activity levels (participants comfortably meeting the PA recommendations) that was reported. However, this study suggests that consciously monitoring PA can still add to leisure time physical activity in a large urban setting. Thus, further studies should be done recruiting less active individuals. Future research should also be completed in geographical areas that are less dependent on foot traffic for commuting as the results of this study may not be generalizable to those who reside in areas that are automobile dependent. Nevertheless, knowing how features on these devices affect physical activity and exercise self-efficacy, even in short-term bouts, may allow for implementation in appropriate contexts and bring about awareness of activity habits.

The results of this study can be applied by those working with patients and clients in contexts where increases in physical activity are being emphasized. As the world becomes more

technologically saturated, understanding how these everyday devices can be used to promote healthy habits may provide long-term benefits to users. Practical takeaways from this study include how WAT wearers engage in more weekly PA when consciously tracking activity, thus device usage to set and monitor activity goals can be encouraged where increased physical activity is a focus. Additionally, when WAT users shared their activity data with others, a higher prevalence in weekly PA was found. This aligns with previous literature (Cho & Tian, 2021; Zhu et al., 2017) on how being exposed to others data increases awareness of personal activity habits, exercise intention, and subsequent engagement. Professionals can work to build a digital community by connecting patients and clients. While each feature may not result in similar outcomes related to increased activity levels, it would be important for professionals to help those they work with to consider which type of social engagement (e.g., competition, social support, social comparison) would best suit their needs. As findings are shared with current undergraduate exercise science and graduate physical therapy students, device use can be added as a tool to provide individualized interventions in future health-related professions.

CHAPTER II: DISSEMINATION

The results from this study looking at how social behaviors on wearable trackers affect physical activity and exercise self-efficacy will serve as a tool for those working in health promotion fields to implement into client and patient programs. Specifically, individuals working to increase physical activity behaviors (e.g., personal trainers, public health professionals, physical therapists) may benefit from key takeaways on technology integration given its importance in today's society.

The immediate dissemination of the results from this study will include an abstract presentation at Mercy University's Annual Faculty Research Salon (see Figure 5). Faculty are invited to present a poster abstract of their current research that is open to the institution and public community. Individuals who work locally outside of the institution that could benefit from the presented information on how everyday technology can be implemented into health interventions are health and wellness facility professionals, allied health professionals, other health science faculty members, and public health advocates. Invitations to attend the abstract event are sent to local public health facilities, health club and recreational center general managers and physical therapy clinics. The aims of the abstract presentation will be for attendees to 1. Receive information on how the use of everyday technology may increase PA behaviors, 2. Strategize practical ways to use smartwatches to build a digital community amongst their patient/client population, and 3. Share the needs for future research within their respective population to help inform future research directions that can have a larger community impact. Upon completion of the research abstract event, the poster will be hung in the undergraduate exercise science lab where student and faculty research projects are displayed for current and prospective students to view and engage with.

As individuals attend the salon, the following talking points will be emphasized for further discussion and application: 1. How wearable trackers can be used to track, monitor, and increase physical activity, 2. What social features WAT offer and how to get users to connect and engage with them, 3. How socially engaging on WAT impacts exercise self-efficacy and the relationship of exercise self-efficacy and physical activity levels, and 4. Application of the use of wearable trackers to the professional field.

Wearable Activity Tracker Physical Activity Measures

Through this study and others, wearable trackers have been found to increase aspects of health-related physical activity such as daily step count and physical activity through self-regulation. Currently, wearables are being integrated into clinical settings across all populations as users learn to monitor their PA through exposure to live data (Ferguson et al., 2022). Discussions with attendees will occur about what WAT offer regarding health-related physical activity measures and for those who do not use a WAT, demonstrations of these features will be provided. Specifically, the focus of the discussion will be on what types of activity and health data can be monitored (e.g., step count, energy expenditure, stand time) and discussions on what features may best help their clients and patients improve activity habits.

Wearable Activity Tracker Social Features

Some individuals may benefit from integrating social elements related to their physical activity to spur on further engagement. During the abstract session, participants will learn what social elements are offered on these devices (e.g., social support, competition) and consider ways in which the populations they work with could benefit from these. Additionally, practitioners will be educated on how they can use these features as gentle nudges (i.e., cues to action) to reminder patients and clients about engaging in prescribed activity. Thus, discussions will occur

around not only what features are offered on the device and how to best engage with them, but also strategize ways they can be used to keep people adherent and interested about their physical activity. Some examples can include elements such as competitions amongst clients for small prizes, recognition on leaderboards, or providing customized messages for patients going through rehabilitation when an activity bout that has been prescribed has been completed.

Wearable Activity Trackers & Self-efficacy

While many may have heard the term "self-efficacy," there may be a gap in understanding how it relates to physical activity. Attendees will learn how changes in exercise self-efficacy affect physical activity and consider how self-efficacy could be a measure used in clinics or gym settings during the intake process of a new member or patient to predict activity engagement. Measuring exercise self-efficacy can easily be done by using a simple nine item questionnaire and examples of the Resnick & Jenkins (2000) scale will be available for attendees to review and consider implementation into their setting. Further discussions about evidence-based strategies to improve self-efficacy using features on a wearable tracker may occur depending on the audience needs and/or interest. Examples provided will be practical and easily implemented across all settings, such as setting personalized activity goals on the device and the on-going monitoring of those or vicarious experiences by having device users connect and share their activity data with others, they are then exposed to completion of activity, earned rewards, and the meeting of the personalized goals of the connected device user. Finally, it will be shared that certain features (i.e., social comparison and social support) can have a positive impact on exercise self-efficacy and health professionals can consider which features may best help their population see improvements in this area.

Applying Wearable Activity Trackers in Professional Practice

Learning about what these devices can offer is important, however understanding how they can be used to promote improvements in physical activity habits within specific settings trumps this knowledge. The application of device use will be considered during discussions with those who attend the event. Questions will be asked, and responses document about how these practitioners can see wearable devices being used in their clinics or clubs to increase PA, how regular monitoring could impact activity habits, ways to use the devices to improve exercise compliance, and further considerations around elements such as social engagement and community building. The emphasis during this time will be to allow the practitioners and health professionals to generate ideas of device application that is specific to their facility and patient/client needs and to ask questions on implementation strategies. While the use of these devices is not the only answer to promoting moderate-to-vigorous physical activity and improving health outcomes, introducing these individuals as an additional tool that can be potentially helpful will be the goal.

Figure 5. Poster Abstract for Institutional Research Salon

MERCY UNIVERSITY

The Effect of Wearable Activity Tracker Social Behaviors on Physical Activity & Exercise Self-efficacy

Amanda Bireline: In collaboration with The University of North Carolina at Greensboro

ABSTRACT

Regular engagement in physical activity (PA) offers significant health benefits to the various dimensions of wellness. However, over the past three decades, substantial decreases in PA have been seen (Guthold et al., 2018; Kohl et al., 2012). Physical inactivity is the fourth leading risk factor of global mortality; moreover, an estimated 8.3% of annual deaths (3.2 million) can be prevented with regular engagement in physical activity (WHO, 2022). This issue has caught the attention of many health organizations, leading them to create initiatives that promote increases in physical activity. Wearable activity trackers (WAT), typically worn as smartwatches, are useful tools in promoting physical activity engagement and are being used in both clinical and free-living environments. These devices have integrated behavior change features such as self-regulation, goal setting, and opportunities to provide and receive support, techniques that are shown to improve activity behaviors in traditional interventions (Myong-Won et al., 2020; Sullivan & Lachman, 2017). Many health-related behavior theories highlight the role that social environment plays in activity engagement, particularly Bandura's *Social Cognitive Theory*. But the relationship between the use of social elements and contexts that are important to behavior choice on wearable devices is not well understood. If everyday items such as wearable devices can influence physical activity (PA) and exercise self-efficacy, then it is likely that significant changes will be seen in health outcomes across participating groups.

STUDY AIMS

1. Examine the overall effect of using the wearable activity tracker fitness sharing feature on physical activity and assess which component (social comparison, competition, or social support) has the greatest influence on activity engagement.
2. Examine the effect of the various wearable tracker social features on exercise self-efficacy.
3. Examine the relationship between changes in exercise self-efficacy and changes in physical activity.

METHODS

To understand how social behaviors on WAT affect moderate-to-vigorous physical activity and exercise self-efficacy, subjects (n=118) from the NY/NJ metro area provided objective data from their smartwatches worn in free living environments over an 8-week span. Upon enrollment, subjects were randomly assigned to one of two conditions: 1. those who engaged about PA using the device social features, or 2. those who did not engage about PA on the device. Data was collected at pre-, mid-, and post-intervention by sharing the devices automatically recorded exercise minutes. Those assigned to the social sharing condition were given instructions on how to connect and engage with specific social features on the device (i.e., social comparison, competition, and social support) and encouraged to use all three features throughout the duration of the study. Participants also completed three surveys (baseline, mid-, and post-intervention) using Qualtrics that collected demographic information, prevalence of device usage, stages of change measures (Marcus et al., 1992; Norman et al., 1998), PA social support satisfaction measures (Golaszewski & Bartholomew, 2018), and the Resnick & Jenkins (2000) exercise self-efficacy scale. Post-intervention, each condition received a specific set of questions related to how WAT use impacted constructs under *Social Cognitive Theory* (Bandura, 1986). Statistical analyses (i.e., two-way mixed ANOVA, one-way ANOVA, Pearson Correlation, independent t-tests, and descriptive statistics) determined if statistical significance was found for each of the aims.

Objective Measures

WAT exercise minutes were used as the objective measure of weekly physical activity. Exercise minutes are specific to the user based on biometric data and algorithms and are recorded for every full minute of movement that is equal to or exceeds the intensity of a brisk walk during both exercise and activities of daily living (see Figure 1).

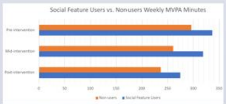
Figure 1

WAT Social Features

When connected through the device, users can view others activity rings and compare their data (social comparison), provide customized comments or "like" connections activity progress or earned rewards (social support), and can compete in weekly PA competitions (see Figure 1).

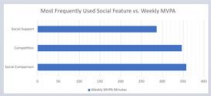
Figure 2

RESULTS



Data analysis indicated there was a significant main effect of PA $F(2,220) = 12.678$, $p < .001$ across the 8-week study with the largest differences in pre- to post-intervention. However, there was not a significant interaction between PA and social feature users or non-users $F(2,220) = 0.380$, $p = .679$.

It was found there was a significant main effect $F(2,110) = 4.709$, $p = .011$ and significant interaction $F(4,110) = 3.084$, $p = .022$ on a specific social feature and PA. Users equally reported using social comparison and competition most frequently (n=12) and there was an average of ~41-54 minutes more of weekly PA in those who reported using social comparison most often.



The use of social features did not have an affect on exercise self-efficacy (ESE), $F(2,220) = 1.242$, $p = .291$. But those who used the social features averaged higher ESE scores than those who didn't use the features. Pearson correlations revealed that changes in ESE had a positive correlation with changes in MVPA, $r(112) = .227$, $p = .016$.

Other key findings: Those who use a WAT to monitor activity (self-regulation) increases PA, subjects using the device to monitor PA found it more pleasurable and a facilitator to increased activity levels, and those who share their activity data with others through their device found it increased weekly PA,

CONCLUSIONS

- Using a wearable tracker increases weekly PA by approximately 60 minutes
- Physical activity and exercise self-efficacy significantly differs across repeated measures
- When comparing social feature users and non-users on the device, weekly PA does not differ
- Socially engaging on a WAT about activity does increase weekly PA compared to not socially engaging on the device
- Specifically, social comparison has the largest positive effect on weekly activity levels and social support may have a positive impact on exercise self-efficacy
- As exercise self-efficacy increases, subsequently PA increases and vice versa

REFERENCES

1. Bandura, 1986.
Golaszewski & Bartholomew, 2018. https://doi.org/10.1123/jsep.2018-0234
2. Guthold et al., 2018. https://doi.org/10.1016/S2214-109X(18)30357-7
3. Kohl et al., 2016. https://doi.org/10.1016/S0140-6736(12)60898-8
4. Marcus et al., 1992. https://doi.org/10.1080/02701367.1992.10607557
5. Myong-Won et al., 2020. https://doi.org/10.3390/su12218803
6. Norman et al., 1998. https://web.uri.edu/cprc/measures/exercise/stages-of-change-short-form/
7. Resnick & Jenkins, 2000. https://journals.lww.com/nursingresearchonline/abstract/2000/05000/testing_the_reliability_and_validity_of_the.7.aspx
8. Sullivan & Lachman, 2017. https://www.frontiersin.org/article/10.3389/fpubh.2016.00289
9. WHO, 2022. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3416

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CHAPTER III: ACTION PLAN

The results of this study have shown the potential to provide benefits that serve beyond the short-term, especially with the anticipated growth of wearable device ownership and on-going evolution of this technology. Building a digital community using wearable technology is one attainable way to continue to promote and encourage support of regular physical activity behaviors and covers some of the noted barriers of cost and time in traditional activity interventions. Implementing aspects of the research process into academic courses is another way to move experience into practice. And the goal of future research and dialogue with community allied health professionals will provide opportunities for further research needs, technology integration across various populations and in different professional settings, and implementation of device use to promote increases in physical activity.

Building a Digital Community

As seen in the results of this study, building a digital community can be one way to help promote an increase in physical activity behaviors and possibly changes in exercise self-efficacy. With the vast prevalence of negative health outcomes related to physical inactivity, an immediate goal is to work to see changes in this area. A short-term actionable step will be to begin building a digital community amongst individuals across the three institutional campuses and community members. As the faculty advisor of the Exercise Science Club at Mercy University, the students and I will work collaboratively to encourage wearable users to set and monitor activity goals on their device, begin to connect smartwatch users, and encourage engagement about physical activity using the social features offered on the device. We will also consider how to create support systems through the wearables with those close to the individual and competitions to get people to further engage in activity. Seeing the steps involved in the research process and sharing

those with students in the Exercise Science Club, many have expressed interest in conducting a study as a club and consider how those results can be shared with others. Capitalizing off the results of this study and relevance of wearable trackers, the students have already begun to encourage others, via the club's social media outlets, to use their device to set and monitor activity goals as well as get them to connect with other device users. It will be important as technology continues to evolve to stay abreast of the latest features offered on the wearables and how to further promote engagement. Additionally, I will be meeting with the general manager of a large and respected health club in the area (with additional club locations all over the boroughs of NYC) to discuss the findings of this study and how wearable trackers can be a tool used by the clubs to further build a physical activity community and increase activity behaviors.

Practical Implementation into Courses

One of the courses I teach in the undergraduate exercise science program is Research Methods in Physical Activity. This is a required course for all students in the program and offered as an elective for others in the pre-professional (e.g., pre-physical therapy, pre-occupational therapy, and pre-physician assistant) tracks to take. This course introduces students to the process of research from creating a question, completing a literature review, selecting the most appropriate measurement tools, designing the methods, and consideration into how to practically apply the results of a study. This research project lends perfectly as an example of the steps required to complete a study in its entirety. I will use this as a framework to build out a more solidified curriculum for the course and share lessons learned (e.g., challenges, timeframes, measurement tools) with the students in the course. Additionally, to accompany the future research goal, the course will integrate the creation of a research study that the exercise science club will conduct in the subsequent term, and students in the course that do not participate in the

club will have the option to participate in this process if interested.

Future Research & Publication

Through the dissemination of the results and presenting of practical key takeaways to those in the community working in allied health (e.g., physical therapists, health & wellness professionals) at the abstract poster session, I hope to gain insight into future directions in research. In consideration of current gaps in the literature, this study will add new information on the use of wearable trackers and highlight areas of needed research for practical implementation (e.g., identifying demographic characteristics that benefit most from tracker feature use). My hope is to hear the questions, ideas, and the perspectives of others that would inform future scholarship and consider how the results from additional studies will benefit those in professional practice. These future studies will also address some of the limitations of this study such as the length of the intervention, ownership of one specific type of wearable tracker, and the study sample size considering the opportunity of gathering data from a much larger group based on geographical location. Additional data was collected during this study that can be further analyzed to address some of these limitations. Once this data is analyzed and further edits are made to the written portion, publication of this work is something being considered. Appropriate journals being considered include the *Journal of Physical Activity and Health, Journal of Science in Sport and Exercise, and* the *Journal of Physical Activity Research.*

The long-term goal is to continue research on the use of wearable trackers (and future relevant technological developments) to increase physical activity and assist my students, campus, and local community, those working in health and physical activity promoting professions, and beyond in integrating these modern technologies to do so. As gaps are identified and future research is proposed, it would be my hope and goal to get undergraduate exercise

science students and graduate physical therapy students involved in the research process and provide the opportunity to put together a research abstract to take part in respective professional organization presentations.

REFERENCES

Amini, H., Habibi, S., Islamoglu, A. H., Isanejad, E., Uz, C., & Daniyari, H. (2021). Covid-19 pandemic-induced physical inactivity: The necessity of updating the global action plan on physical activity 2018-2030. *Environmental Health and Preventive Medicine*, *26*(1). https://doi.org/10.1186/s12199-021-00955-z

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman and Company.

Bandura, A. (2004). Health promotion by social cognitive means. Health Education & Behavior, 31(2), 143–164. http://doi.org/10.1177/1090198104263660

Bassett, D. R., Wyatt, H. R., Thompson, H., Peters, J. C., & Hill, J. O. (2010). Pedometer-measured physical activity and health behaviors in U.S. adults. *Medicine & Science in Sports & Exercise*, *42*(10), 1819–1825. https://doi.org/10.1249/MSS.0b013e3181dc2e54

Berlin, J. E., Storti, K. L., & Brach, J. S. (2006). Using activity monitors to measure physical activity in free-living conditions. *Physical Therapy*, *86*(8), 1137–1145. https://doi.org/10.1093/ptj/86.8.1137

Brickwood, K. J., Watson, G., O'Brien, J., & Williams, A. D. (2019). Consumer-based wearable activity trackers increase physical activity participation: Systematic review and meta-analysis. *Jmir Mhealth and Uhealth*, *7*(4), 11819. https://doi.org/10.2196/11819

Burton, T. (2019, August 2). *New apps, wearables and VR: How gamification has transformed fitness*. UpperHand Technology. https://upperhand.com/gamification-the-future-of-fitness/

CDC. (2021, November 1). *Benefits of physical activity* [Government]. Centers for Disease Control and Prevention. https://www.cdc.gov/physicalactivity/basics/pa-health/index.htm

Centers for Disease Control and Prevention. (2023). *Behavioral risk factor surveillance system: Prevalence & data trends* [Government]. https://www.cdc.gov/brfss/brfssprevalence/index.html

Cho, I., Kaplanidou, K., & Sato, S. (2021). Gamified wearable fitness tracker for physical activity: A comprehensive literature review. *Sustainability*, *13*(13), 7017. https://doi.org/10.3390/su13137017

Cho, S. J., & Tian, Y. (2021). Investigating the role of communication between descriptive norms and exercise intentions and behaviors: Findings among fitness tracker users. *Journal of American College Health*, *69*(4), 452–458. https://doi.org/10.1080/07448481.2019.1679819

Clark, J. L., Algoe, S. B., & Green, M. C. (2018). Social network sites and well-being: The role of social connection. *Current Directions in Psychological Science*, *27*(1), 32–37. https://doi.org/10.1177/0963721417730833

Conn, V. S., Hafdahl, A. R., & Mehr, D. R. (2011). Interventions to increase physical activity among healthy adults: Meta-analysis of outcomes. *American Journal of Public Health*, *101*(4), 751–758. https://doi.org/10.2105/AJPH.2010.194381

Corder, K., Van Sluijs, E. M. F., McMinn, A. M., Ekelund, U., Cassidy, A., & Griffin, S. J. (2010). Perception versus reality awareness of physical activity levels of British children. *American Journal of Preventive Medicine*, *38*(1), 1–8. https://doi.org/10.1016/j.amepre.2009.08.025

DiFrancisco-Donoghue, J., Jung, M.-K., Stangle, A., Werner, W. G., Zwibel, H., Happel, P., & Balentine, J. (2018). Utilizing wearable technology to increase physical activity in future physicians: A randomized trial. *Preventive Medicine Reports*, *12*, 122–127. https://doi.org/10.1016/j.pmedr.2018.09.004

DiMenichi, B. C., & Tricomi, E. (2015). The power of competition: Effects of social motivation on attention, sustained physical effort, and learning. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01282

Ferguson, T., Olds, T., Curtis, R., Blake, H., Crozier, A. J., Dankiw, K., Dumuid, D., Kasai, D., O'Connor, E., Virgara, R., & Maher, C. (2022). Effectiveness of wearable activity trackers to increase physical activity and improve health: A systematic review of systematic reviews and meta-analyses. *The Lancet Digital Health*, *4*(8), e615–e626. https://doi.org/10.1016/S2589-7500(22)00111-X

French, D. P., Olander, E. K., Chisholm, A., & Mc Sharry, J. (2014). Which behaviour change techniques are most effective at increasing older adults' self-efficacy and physical activity Behaviour? A systematic review. *Annals of Behavioral Medicine*, *48*(2), 225–234. https://doi.org/10.1007/s12160-014-9593-z

Fritz, T., Huang, E. M., Murphy, G. C., & Zimmermann, T. (2014). Persuasive technology in the real world: A study of long-term use of activity sensing devices for fitness. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 487–496. https://doi.org/10.1145/2556288.2557383

Get the most accurate measurements using your Apple Watch. (2022, January 31). Apple Support. https://support.apple.com/en-us/HT207941

Galper, D. I., Trivedi, M. H., Barlow, C. E., Dunn, A. L., & Kampert, J. B. (2006). Inverse association between physical inactivity and mental health in men and women. *Medicine & Science in Sports & Exercise*, *38*(1), 173–178. https://doi.org/10.1249/01.mss.0000180883.32116.28

Girginov, V., Moore, P., Olsen, N., Godfrey, T., & Cooke, F. (2020). Wearable technology-stimulated social interaction for promoting physical activity: A systematic review. *Cogent Social Sciences*, *6*(1), 1742517. https://doi.org/10.1080/23311886.2020.1742517

Golaszewski, N. M., & Bartholomew, J. B. (2019). The development of the physical activity and social support scale. *Journal of Sport and Exercise Psychology*, *41*(4), 215–229. https://doi.org/10.1123/jsep.2018-0234

Gowin, M., Wilkerson, A., Maness, S., Larson, D. J., Crowson, H. M., Smith, M., & Cheney, M. K. (2019). Wearable activity tracker use in young adults through the lens of social cognitive theory. *American Journal of Health Education*, *50*(1), 40–51. https://doi.org/10.1080/19325037.2018.1548314

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1.9 million participants. *The Lancet Global Health*, *6*(10), e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hu, L., Hu, Q., & Xu, Y. (2021). Social cognitive correlates of physical activity among Chinese university employees: A cross-sectional study. *International Journal of Environmental Research and Public Health*, *18*(13). https://doi.org/10.3390/ijerph18137116

Jekauc, D., Vakle, M., Wagner, M. O., Mess, F., Reiner, M., & Renner, B. (2015). Prediction of attendance at fitness center: A comparison between the theory of planned behavior, the

social cognitive theory, and the physical activity maintenance theory. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00121

John, J. M., Haug, V., & Thiel, A. (2020). Physical activity behavior from a transdisciplinary biopsychosocial perspective: A scoping review. *Sports Medicine - open*, *6*(1), 49. https://doi.org/10.1186/s40798-020-00279-2

Kahn, E., Ramsey, L., Brownson, R., Heath, G., Howze, E., Powell, K., Stone, E., Rajab, M., & Corso, P. (2002). The effectiveness of interventions to increase physical activity; A systematic review1 and 2. *American Journal of Preventive Medicine*, *22*(4), 73–107. https://doi.org/10.1016/S0749-3797(02)00434-8

Karapanos, E., Gouveia, R., Hassenzahl, M., & Forlizzi, J. (2016). Wellbeing in the making: Peoples' experiences with wearable activity trackers. *Psychology of Well-Being*, *6*(1), 4. https://doi.org/10.1186/s13612-016-0042-6

Kemp, S. (2022). *Digital 2022: Global overview report*. https://datareportal.com/reports/digital-2022-global-overview-report?utm_source=Global_Digital_Reports&utm_medium=Article&utm_campaign=Digital_2022

Kouvonen, A., De Vogli, R., Stafford, M., Shipley, M. J., Marmot, M. G., Cox, T., Vahtera, J., Vaananen, A., Heponiemi, T., Singh-Manoux, A., & Kivimaki, M. (2012). Social support and the likelihood of maintaining and improving levels of physical activity: The Whitehall II Study. *The European Journal of Public Health*, *22*(4), 514–518. https://doi.org/10.1093/eurpub/ckr091

Laranjo, L., Ding, D., Heleno, B., Kocaballi, B., Quiroz, J. C., Neves, A. L., Gabarron, E., Dao, K. P., Rodrigues, D., Antunes, M. L., Coiera, E., & Bates, D. W. (2021). Do smartphone

applications and activity trackers increase physical activity in adults? Systematic review, meta-analysis and metaregression. *British Journal of Sports Medicine*, *55*(8), 422–432. https://doi.org/10.1136/bjsports-2020-102892

Li, C., Chen, X., & Bi, X. (2021). Wearable activity trackers for promoting physical activity: A systematic meta-analytic review. *International Journal of Medical Informatics*, *152*, 104487–104487. https://doi.org/10.1016/j.ijmedinf.2021.104487

Li, L., Peng, W., Kononova, A., Kamp, K., & Cotten, S. (2021). *Rethinking wearable activity trackers as assistive technologies: A qualitative study on long-term use*. https://doi.org/10.24251/HICSS.2021.475

Luszczynska, A., & Schwarzer, R. (2020). Changing behavior using social cognitive theory. In M. S. Hagger, L. D. Cameron, K. Hamilton, N. Hankonen, & T. Lintunen (Eds.), *The Handbook of Behavior Change* (1st ed., pp. 32–45). Cambridge University Press. https://doi.org/10.1017/9781108677318.003

Marcus, B. H., Selby, V. C., Niaura, R. S., & Rossi, J. S. (1992). Self-efficacy and the stages of exercise behavior change. *Research Quarterly for Exercise and Sport*, *63*(1), 60–66. https://doi.org/10.1080/02701367.1992.10607557

McAuley, E., Szabo, A., Gothe, N., & Olson, E. A. (2011). Self-efficacy: Implications for physical activity, function, and functional limitations in older adults. *American Journal of Lifestyle Medicine*, *5*(4), 361–369. https://doi.org/10.1177/1559827610392704

Mehdi, M., & Alharby, A. (2018). Purpose, scope, and technical considerations of wearable technologies. In I. Management Association (Ed.), *Wearable Technologies: Concepts, Methodologies, Tools, and Applications* (pp. 1-19). IGI Global. https://doi.org/10.4018/978-1-5225-5484-4.ch001

Mercer, K., Li, M., Giangregorio, L., Burns, C., & Grindrod, K. (2016). Behavior change techniques present in wearable activity trackers: A critical analysis. *JMIR MHealth and UHealth*, *4*(2), e40. https://doi.org/10.2196/mhealth.4461

Myong-Won, S., Kim, Y., Jung, H. C., Kim, J. H., & Lee, J. M. (2020). Does online social connectivity promote physical activity in a wearable tracker-based intervention? A pilot randomized controlled study. *Sustainability*, *12*(21), 8803–8803. https://doi.org/10.3390/su12218803

Newsome, A. M., Reed, R., Sansone, J., Batrakoulis, A., McAvoy, C., & W. Parrott, M. (2024). 2024 ACSM Worldwide Fitness Trends: Future directions of the health and fitness industry. *ACSM'S Health & Fitness Journal*, *28*(1), 14–26. https://doi.org/10.1249/FIT.0000000000000933

Nick, E. A., Cole, D. A., Cho, S.-J., Smith, D. K., Carter, T. G., & Zelkowitz, R. L. (2018). The online social support scale: Measure development and validation. *Psychological Assessment*, *30*(9), 1127–1143. https://doi.org/10.1037/pas0000558

Norman, G.J., Benisovich, S.V., Nigg, C.R. & Rossi, J.S., (1998). Examining three exercise staging algorithms in two samples. Poster presented at SBM. New Orleans, LA. https://web.uri.edu/cprc/measures/exercise/stages-of-change-short-form/

Pate, R. R., Pratt, M., Blair, S., Haskell, W., Macera, C., Bouchard, C., Buchner, D., Ettinger, W., Heath, G., & King, A. (1995). Physical activity and public health: A Recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*, *273*(5), 402. https://doi.org/10.1001/jama.1995.03520290054029

Pekmezi, D., Jennings, E., & Marcus, B. H. (2009). Evaluating and enhancing self-efficacy for physical activity. *ACSM'S Health & Fitness Journal*, *13*(2), 16–21. https://doi.org/10.1249/FIT.0b013e3181996571

Perkins, J. M., Multhaup, K. S., Perkins, H. W., & Barton, C. (2008). Self-Efficacy and participation in physical and social activity among older adults in Spain and the United States. *The Gerontologist*, *48*(1), 51–58. https://doi.org/10.1093/geront/48.1.51

Prestwich, A., Kellar, I., Parker, R., MacRae, S., Learmonth, M., Sykes, B., Taylor, N., & Castle, H. (2014). How can self-efficacy be increased? Meta-analysis of dietary interventions. *Health Psychology Review*, *8*(3), 270–285. https://doi.org/10.1080/17437199.2013.813729

Reider, A., Lehrer, C., & Jung, R. (2019). *How behavior change support systems influence self-efficacy: A qualitative study using wearables*. Twenty-Seventh European Conference on Information Systems, Stockholm-Uppsala, Sweden.

Rieder, A., Eseryel, U. Y., Lehrer, C., & Jung, R. (2021). Why Users Comply with Wearables: The Role of Contextual Self-Efficacy in Behavioral Change. *International Journal of Human–Computer Interaction*, *37*(3), 281–294. https://doi.org/10.1080/10447318.2020.1819669

Reis, M. S. D., Reis, R. S., & Hallal, P. C. (2011). Validity and reliability of a physical activity social support assessment scale. *Revista de Saúde Pública*, *45*(2), 294–301. https://doi.org/10.1590/S0034-89102011000200008

Resnick, B., & Jenkins, L. S. (2000). Testing the reliability and validity of the Self-efficacy for Exercise Scale. Nursing Research, 49.

https://journals.lww.com/nursingresearchonline/abstract/2000/05000/testing_the_reliability_and_validity_of_the.7.aspx

Resnick, B., Luisi, D., Vogel, A., & Junaleepa, P. (2004). Reliability and validity of the Self-efficacy for Exercise and outcome expectations for exercise scales with minority older adults. *Journal of Nursing Measurement*, *12*(3), 235–248. https://doi.org/10.1891/jnum.12.3.235

Shameli, A., Althoff, T., Saberi, A., & Leskovec, J. (2017). How gamification affects physical activity: Large-scale analysis of walking challenges in a mobile application. *Proceedings of the 26th International Conference on World Wide Web Companion*, 455–463. https://doi.org/10.1145/3041021.3054172

Shin, G. D. (2020). Investigating the impact of daily life context on physical activity in terms of steps information generated by wearable activity tracker. *International Journal of Medical Informatics*, *141*. https://doi.org/10.1016/j.ijmedinf.2020.104222

Stockwell, S., Trott, M., Tully, M., Shin, J., Barnett, Y., Butler, L., McDermott, D., Schuch, F., & Smith, L. (2021). Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: A systematic review. *BMJ Open Sport & Exercise Medicine*, *7*(1), e000960. https://doi.org/10.1136/bmjsem-2020-000960

Sturts, A., & Gupta, A., (2018). Wearable fitness tracking improves self-efficacy for exercise. *Stratford Campus Research Day.* 16. https://rdw.rowan.edu/stratford_reserach_day

Sullivan, A. N., & Lachman, M. E. (2017). Behavior change with fitness technology in sedentary adults: A review of the evidence for increasing physical activity. *Frontiers in Public Health*, *4*. https://www.frontiersin.org/article/10.3389/fpubh.2016.00289

Thompson, W. R. (2023). Worldwide survey of fitness trends for 2023. *ACSM'S Health & Fitness Journal*, *27*(1), 9–18. https://doi.org/10.1249/FIT.0000000000000834E

Tong, H. L., Coiera, E., & Laranjo, L. (2018). Using a mobile social networking app to promote physical activity: A qualitative study of users' perspectives. *Journal of Medical Internet Research*, *20*(12), e11439. https://doi.org/10.2196/11439

Tudor-Locke, C., Burkett, L., Reis, J., Ainsworth, B., Macera, C., & Wilson, D. (2005). How many days of pedometer monitoring predict weekly physical activity in adults? *Preventive Medicine*, *40*(3), 293–298. https://doi.org/10.1016/j.ypmed.2004.06.003

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for Americans, 2nd edition*. Retrieved from https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf

Using Apple Watch to estimate cardio fitness with VO2 max. (2021). Apple. https://www.apple.com/healthcare/docs/site/Using_Apple_Watch_to_Estimate_Cardio_Fitness_with_VO2_max.pdf

Veerabhadrappa, P., Moran, M. D., Renninger, M. D., Rhudy, M. B., Dreisbach, S. B., & Gift, K. M. (2018). Tracking steps on Apple Watch at different walking speeds. *Journal of General Internal Medicine*, *33*(6), 795–796. https://doi.org/10.1007/s11606-018-4332-y

Wang, T., Ren, M., Shen, Y., Zhu, X., Zhang, X., Gao, M., Chen, X., Zhao, A., Shi, Y., Chai, W., Liu, X., & Sun, X. (2019). The association among social support, self-efficacy, use of mobile apps, and physical activity: Structural equation models with mediating effects. *JMIR MHealth and UHealth*, *7*(9), e12606. https://doi.org/10.2196/12606

Wells, E., Eschbach, C., Avery, M., & Bunn, J. (2016). A comparison of perceived physical fitness and objective measurements. *The Sport Journal*, *24*.

https://thesportjournal.org/article/a-comparison-of-perceived-physical-fitness-and-objective-measurements/

World Health Organization. (2020). *WHO guidelines on physical activity and sedentary behaviour*. https://www.who.int/publications/i/item/9789240015128

World Health Organization. (2022). *Noncommunicable diseases*. https://www.who.int/health-topics/noncommunicable-diseases#tab=tab_1

World Health Organization. (2022). *Physical inactivity*. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3416

Wright, B. J., O'Halloran, P. D., & Stukas, A. A. (2016). Enhancing self-efficacy and performance: An experimental comparison of psychological techniques. *Research Quarterly for Exercise and Sport*, *87*(1), 36–46. https://doi.org/10.1080/02701367.2015.1093072

Xie, J., Wen, D., Liang, L., Jia, Y., Gao, L., & Lei, J. (2018). Evaluating the validity of current mainstream wearable devices in fitness tracking under various physical activities: Comparative study. *JMIR MHealth and UHealth*, *6*(4), e94. https://doi.org/10.2196/mhealth.9754

Young, M. D., Plotnikoff, R. C., Collins, C. E., Callister, R., & Morgan, P. J. (2014). Social cognitive theory and physical activity: A systematic review and meta-analysis. *Obesity Reviews*, *15*(12), 983–995. https://doi.org/10.1111/obr.12225

Zhang, J., Brackbill, D., Yang, S., Becker, J., Herbert, N., & Centola, D. (2016). Support or competition? How online social networks increase physical activity: A randomized controlled trial. *Preventive Medicine Reports*, *4*, 453–458. https://doi.org/10.1016/j.pmedr.2016.08.008

Zhu, Y., Dailey, S. L., Kreitzberg, D., & Bernhardt, J. (2017). “Social networkout”: Connecting social features of wearable fitness trackers with physical exercise. *Journal of Health Communication, 22*(12), 974–980. https://doi.org/10.1080/10810730.2017.1382617

APPENDIX A: PARTICIPANT RECRUITEMENT DOCUMENTS

Hello [Name],

This is Amanda contacting you about a new research study you may be interested in participating in. I have included a description of the study below. If you are interested in taking part in this study, please scan the QR code below or use this link. If you have any questions about this study, please contact Amanda Bireline at ambireline@uncg.edu.

This research is going to investigate how social behaviors on wearable activity trackers may affect moderate-to-vigorous physical activity and exercise self-efficacy. Participants will be adults 18 and older that reside in the NYC/NJ metro area and currently need to be able to participate in physical activity. Additionally, you will need to own an Apple Watch. This study is going to use the Apple Watch exercise minutes, which are automatically recorded on your device, and digital surveys through Qualtrics to gather data. Over the 8 weeks, I will be asking for around 20 minutes of your time, and this will include completing the surveys at baseline, week four, and the end of the eight weeks, which can be done on your phone or a computer. Upon enrollment into the study, you may also be asked to share your fitness data with other selected users on the device and engage in the social features (social support, social comparison, and competition). You will have the choice to connect with other device users and accept or reject their invitations. Videos and written instructions will be provided for those who are randomly selected to be in the sharing condition.

Participation in this study is voluntary and if you choose to participate, at any time, you may leave the study with no penalty. There will not be compensation for participation, but by completing the study, you will be entered into a drawing for a chance to receive one $20 Apple Gift Card, ten total will be selected.

To participate in this study, scan this QR code:

APPENDIX B: STUDY PARTICIPANT DEMOGRAPHICS

Participant Demographics

Measure	**Social Feature User Condition**	**Non-user Condition**	**Overall**
Age	18-64	18-71	18-71
Gender	Male: 16 Female: 41 Non-binary/Third Gender: 1	Male: 17 Female: 37 Non-binary/Third Gender: 0	Male: 33 Female: 78 Non-binary/Third Gender: 1
Body Mass Index	Underweight: 0 Healthy weight: 21 Overweight: 19 Obese: 18	Underweight: 0 Healthy weight: 21 Overweight: 17 Obese: 16	Underweight: 0 Healthy weight: 42 Overweight: 36 Obese: 34
Education Level	High school or GED: 11 Associate's degree/Technical Degree/Some College: 12 Bachelor's Degree: 20 Master's Degree:11 Terminal Degree: 4	High school or GED: 11 Associate's degree/Technical Degree/Some College: 11 Bachelor's Degree: 11 Master's Degree: 11 Terminal Degree: 10	High school or GED: 22 Associate's degree/Technical Degree/Some College: 23 Bachelor's Degree: 31 Master's Degree: 22 Terminal Degree: 14
Annual Household Income	<$36,250: 13 $36,252-53,400: 6 $53,401-106,825: 18 $106,826-373,895: 18 >$373,896: 3	<$36,250: 13 $36,252-53,400: 4 $53,401-106,825: 16 $106,826-373,895: 18 >$373,896: 3	<$36,250: 26 $36,252-53,400: 10 $53,401-106,825: 34 $106,826-373,895: 36 >$373,896: 6
Residence Type	City dweller: 20 Suburban: 35 Rural: 3	City dweller: 23 Suburban: 20 Rural: 11	City dweller: 43 Suburban: 55 Rural: 14
Total	**58**	**54**	**112**

APPENDIX C: SELF-EFFICACY FOR EXERCISE SCALE

This set of nine questions will be evaluating your confidence level regarding engagement in physical activity. Please select the response that best answers the question prompt right now.

0= Not confident
10= Very confident

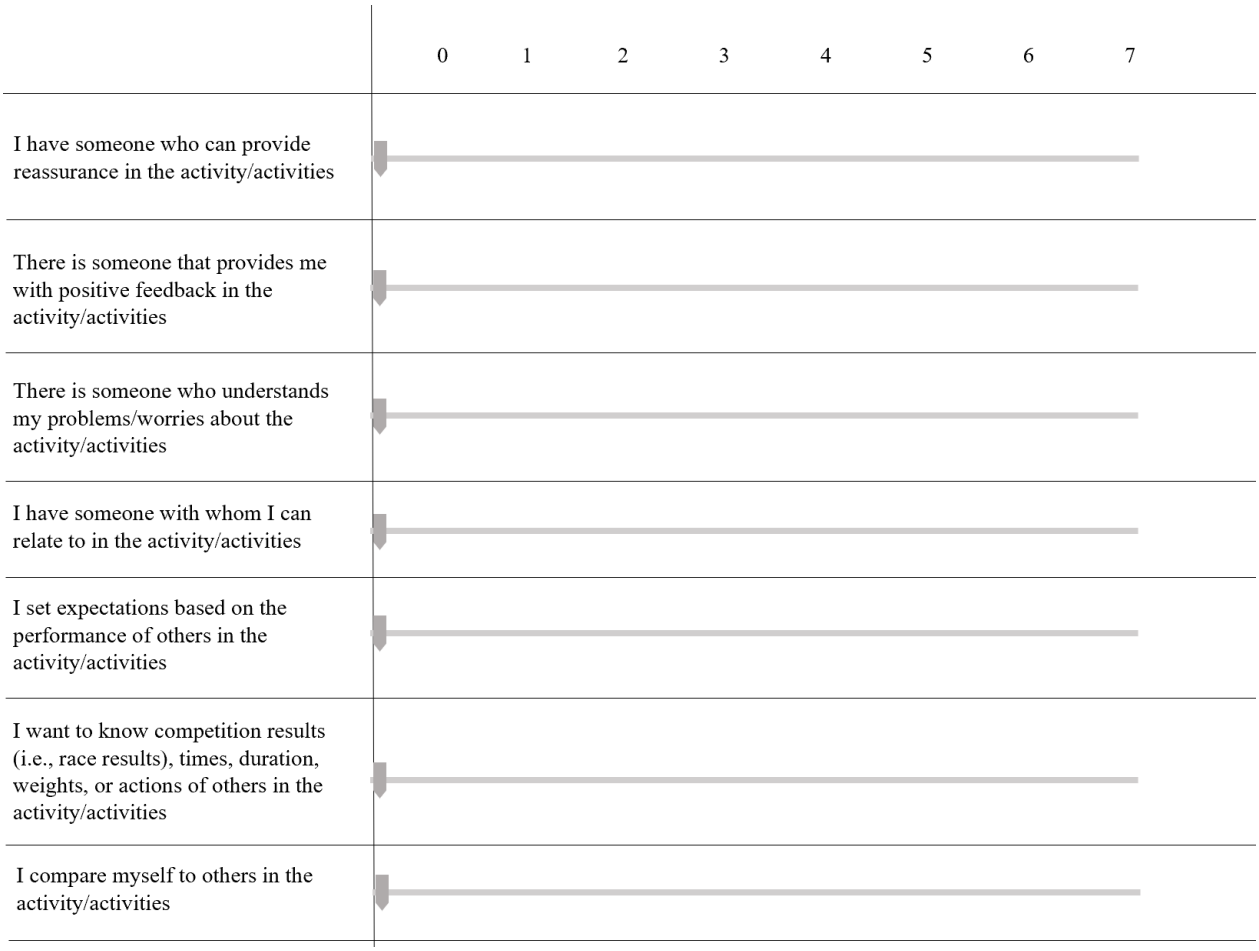
	0 = Not confident	1	2	3	4	5	6	7	8	9	10 = Very confident
The weather was bothering you	○	○	○	○	○	○	○	○	○	○	○
You were bored by the program or activity	○	○	○	○	○	○	○	○	○	○	○
You felt pain when exercising	○	○	○	○	○	○	○	○	○	○	○
You had to exercise alone	○	○	○	○	○	○	○	○	○	○	○
You did not enjoy it	○	○	○	○	○	○	○	○	○	○	○
You were too busy with other activities	○	○	○	○	○	○	○	○	○	○	○
You felt tired	○	○	○	○	○	○	○	○	○	○	○
You felt stressed	○	○	○	○	○	○	○	○	○	○	○
You felt depressed	○	○	○	○	○	○	○	○	○	○	○

APPENDIX D: PHYSICAL ACTIVITY SOCIAL SUPPORT SCALE

These questions pertain to the physical activity/activities that you do—from things like moderately paced walking to different types of exercise (gym, running, cycling) to various activities (hiking, climbing, dancing). Support for these activities can come from many different sources, including friends and family, live or virtual groups, online discussions, and even internet or magazine searches. Keep these in mind when answering the following questions.

Please indicate to what extent each of the following items is associated with the physical activity/activities that you engage in:

1 = never true
4 = sometimes true
7 = always true
n/a = not applicable (score this as 0)



I have someone who can provide reassurance in the activity/activities	
I use social media to find other people's performance in the activity/activities to compare to my own	
I read articles about the activity/activities	
I seek out information from others to get better at the activity/activities	
I talk to people for assistance or to improve technique in the activity/activities	
I attend clinics, classes, and workshops to learn about the activity/activities	
I am part of a core group of people who do the activity/activities	
When not engaging in the activity/activities, I still spend time with people that I met while doing the activity/activities	

I feel a sense of belonging to a group that also does the activity/activities I do	
I can find someone to do the activity/activities with, even outside of my friends	
I can get help traveling if needed to perform the activity/activities	
I have someone that could loan or give me something to help carry out the activity/activities I do	
I have someone who could watch my child(ren) or pets if needed for me to engage in the activity/activities	
I can find someone to help on a short notice so that I can engage in the activity/activities	

APPENDIX E: PRE-INTERVENTION SURVEY

Project Title: The Effect of Wearable Activity Tracker Social Behaviors on Moderate-to-Vigorous Physical Activity and Exercise Self-efficacy.
Principal Investigator: Amanda Bireline
Faculty Advisor: Dr. Paul Davis

What is this all about?

I am asking you to participate in this research study because you are the owner of a wearable activity tracker (i.e., Apple Watch) that automatically tracks your moderate-to-vigorous physical activity and has built in social features that can be used to possibly encourage increases in intentional physical activity. By choosing to participate in this study, I will be able to analyze the data to understand if the use of everyday technologies like a wearable activity tracker may promote increases in physical activity and health, and if engaging socially on the device spurs activity on in even greater amounts. This research project will only take about 20 minutes of time across an 8-week span and will involve you completing three surveys (baseline, week four, and week eight), uploading a screenshot of your exercise minutes automatically recorded on your Apple Watch (directions will be provided), and you may be asked to connect with others of your choice on your device and engage with the social features. Your participation in this research project is voluntary.

How will this negatively affect me?

Engaging in physical activity does present remote potential risk of bodily injury, heart attack, stroke, or even death, but all engagement in physical activity will be to your discretion and you are not being asked to participate in intensities that you do not feel comfortable with. A potential risk of participant embarrassment may exist in completing the demographic information on the initial study survey. In addition, in web-based surveys and forms, absolute confidentiality of data provided through the Internet cannot be guaranteed due to limited protection of Internet access. Please be sure to close your browser so that others may not access your documents. The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants.

This is a research study that involves questions related to your mood or emotions. As researchers, we do not provide mental health services. However, we want to provide you with contact information for available resources, should you decide you need assistance at any time. You can contact the New York city Counseling Center by telephone at (212) 777-6922 or visit https://nyccounseling.com/ for more information. In the case of an emergency, please call the NYPD at (646) 610-5000, 9-1-1, or go to your nearest emergency room. You can also access immediate support by dialing "211" (National Mental Health Helpline) or the National Suicide Hotlines at 1-800-273-TALK (8255) or by texting "START" to 741-741.

What do I get out of this research project?

You might benefit from participating in this study. You may become more aware of your physical activity behavior, habits, and better understand how to use your device. Society may benefit from this study as results may be used by those working to promote increases in physical activity or health-related behavior change. In a technologically saturated society, the use of everyday devices may be found to improve people's belief in their capabilities to engage in physical activity and improve moderate-to-vigorous activity levels. Your participation in this study may further help practitioners and exercise professionals understand how the use of social elements and contexts that are important to behavior choice on wearable devices may be best implemented with their clients and patients.

Will I get paid for participating?

You will not be paid for participating in this study. However, for participating you will be entered into a drawing and have the chance to potentially receive one $20 Apple Gift Card upon completion of the intervention.

What about my confidentiality?

We will do everything possible to make sure that your information is kept confidential. All information obtained in this study is strictly confidential unless disclosure is required by law. All information shared through the Qualtrics digital surveys will be protected and kept confidential. Surveys will be password protected to add an additional layer of security. Participant information will be coded, and no identifiers will be included in the data analysis. Information stored in excel will be encrypted on a password protected flash drive and stored in a locked desk drawer that only the principal investigator can access. We will store all data in UNCG approved data storage locations as outlined in the UNCG Data classification policy.

Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close your browser when finished so no one will be able to see what you have been doing.

What if I do not want to be in this research study?

You do not have to be part of this project. This project is voluntary, and it is up to you to decide to participate in this research project. If you agree to participate at any time in this project, you may stop participating without penalty.

What if I have questions?

You can ask Amanda Bireline (ambireline@uncg.edu) or Paul Davis (pgdavis@uncg.edu) anything about the study. If you have concerns about how you have been treated in this study call the Office of Research Integrity Director at 1-855-251-2351.

By agreeing to continue with this survey, you are consenting to participate in this research study with the understanding that you are free to withdraw at any time. By consenting, you identify all your questions concerning this study have been answered and you confirm that you are at least 18 years of age and agree to participate in this study.

Approved (IRB-FY23-586): 6/26/23

The remainder of this survey will take approximately 9 minutes to complete.

The following questions will ask for general participant information, demographics, current use of the Apple Watch activity application and associated features, and measure exercise self-efficacy. You will also be asked to upload a screenshot of your exercise minutes from your iPhone (instructions provided in the survey). Please respond to the questions as accurately as possible.

You may request to receive a pdf copy your response upon submission.

How much time per day do you spend wearing your Apple Watch? If you don't know the exact time, please estimate.

- 1-4hrs.
- 4-7hrs.
- 7-10hrs.
- More than 10hrs.

The Apple Watch provides live metrics on your activity such as total daily exercise minutes, stand time, and movement calories provided on the device or fitness app. These are commonly known as the blue, green, and red "activity rings".

Do you currently monitor your activity rings on your device?

- Yes
- No

Do you currently share your activity data with other Apple Watch users?

- Yes
- No
- I am not sure

The Apple Watch has built in social features that you can engage with regarding your activity data. Some of these social features include competing against other connections, "liking" or commenting on your connection's activity progress or comparing your personal activity to others you are connected with on your activity dashboard.

In the last 4-weeks, have you been actively engaging on the built in social features on your Apple Watch with those you are connected with?

- Yes
- No

The current physical activity recommendations are to complete a minimum of 150 minutes per week of moderate intensity aerobic activity (e.g., brisk walking, playing doubles tennis, water aerobics, biking 10mph, jogging), and at least two days of muscle strengthening (e.g., resistance training, weightlifting) activity per week. If you meet both the aerobic and muscle strengthening recommendations, this would be defined as meeting the Physical Activity Index.

Do you currently meet the Physical Activity Index?

- Yes
- No

How long have you been exercising regularly?

- I do not exercise and have no intention to in the next 6 months
- I do not exercise but intend to in the next 6months
- I do not exercise but intend to in the next 30 days
- Regularly for less than 6 months
- Regularly for more than 6 months
- Regularly for 1-3 years
- Regularly for 3-5 years
- Regularly for more than 5 years

This set of nine questions will be evaluating your confidence level regarding engagement in physical activity. Please select the response that best answers the question prompt right now.

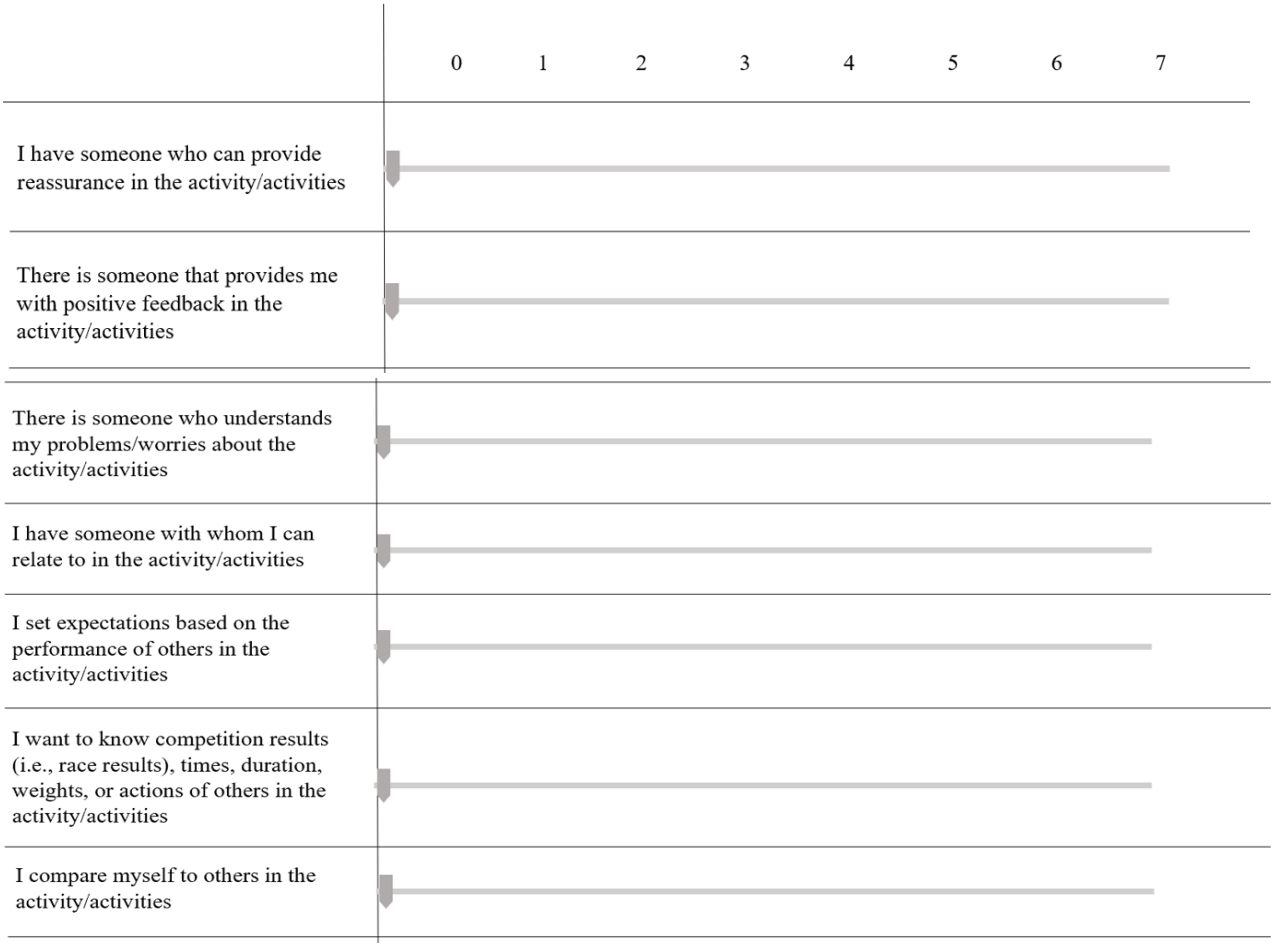
0= Not confident
10= Very confident

	0 = Not confident	1	2	3	4	5	6	7	8	9	10 = Very confident
The weather was bothering you	○	○	○	○	○	○	○	○	○	○	○
You were bored by the program or activity	○	○	○	○	○	○	○	○	○	○	○
You felt pain when exercising	○	○	○	○	○	○	○	○	○	○	○
You had to exercise alone	○	○	○	○	○	○	○	○	○	○	○
You did not enjoy it	○	○	○	○	○	○	○	○	○	○	○
You were too busy with other activities	○	○	○	○	○	○	○	○	○	○	○
You felt tired	○	○	○	○	○	○	○	○	○	○	○
You felt stressed	○	○	○	○	○	○	○	○	○	○	○
You felt depressed	○	○	○	○	○	○	○	○	○	○	○

These questions pertain to the physical activity/activities that you do—from things like moderately paced walking to different types of exercise (gym, running, cycling) to various activities (hiking, climbing, dancing). Support for these activities can come from many different sources, including friends and family, live or virtual groups, online discussions, and even internet or magazine searches. Keep these in mind when answering the following questions.

Please indicate to what extent each of the following items is associated with the physical activity/activities that you engage in:

1 = never true
4 = sometimes true
7 = always true
n/a = not applicable (score this as 0)



I have someone who can provide reassurance in the activity/activities	
I use social media to find other people's performance in the activity/activities to compare to my own	
I read articles about the activity/activities	
I seek out information from others to get better at the activity/activities	
I talk to people for assistance or to improve technique in the activity/activities	
I attend clinics, classes, and workshops to learn about the activity/activities	
I am part of a core group of people who do the activity/activities	
When not engaging in the activity/activities, I still spend time with people that I met while doing the activity/activities	
I feel a sense of belonging to a group that also does the activity/activities I do	
I can find someone to do the activity/activities with, even outside of my friends	
I can get help traveling if needed to perform the activity/activities	
I have someone that could loan or give me something to help carry out the activity/activities I do	
I have someone who could watch my child(ren) or pets if needed for me to engage in the activity/activities	
I can find someone to help on a short notice so that I can engage in the activity/activities	

Please upload a screen shot of the exercise minutes recorded on your Apple Watch.

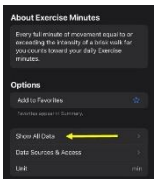
Instructions for retrieving Exercise Minutes:

1. Open the Health application on your iPhone. If you do not see this app on your phone, start typing “health” into the search bar.

2. Select "Show All Health Data".

3. Select "Exercise Minutes".

4. Select "Show All Data".



5. Be sure displayed on the screen are your exercise minutes over the past 8 days. Take a screenshot by pressing the volume up and power button at the same time. Upload this image from your photos on your iPhone.

Choose file

If you need assistance, please contact the researcher, Amanda Bireline (ambireline@uncg.edu).

Please provide your first and last name.

How would you like to receive communication about information regarding this study?

- Email
- Text message

Please provide your cell phone number and/or email address based on your selected communication preferences.

Please provide your age.

What is your affirmed gender?

- Male
- Female
- Non-binary/Third gender
- Prefer not to say

What is your height in feet and inches? If you do not know the exact number, please estimate as accurately as possible.

What is your weight in pounds? If you do not know the exact number, please estimate as accurately as possible.

What is the highest level of education you have completed?

- High school diploma or GED
- Some college, Associate's degree, or Technical School Training
- Bachelor's degree
- Master's degree
- Doctoral degree

What is your total combined family household income for the past 12 months, before taxes, from all sources, wages, public assistance/benefits, help from relatives, alimony, and so on? If you don't know your exact income, please estimate.

- Less than $36,250
- $36,251-$53,400
- $53,401-$106,825
- $106,826-$373,895
- More than $373,896

What is your current zip code?

Throughout the next 8-weeks, what type of environment will you reside in?

- City dweller
- Rural resident
- Suburban resident

Are your currently pregnant or suspect pregnancy?

- Yes
- No

Has your physician told you that you should not presently participate in physical activity?

- Yes
- No

APPENDIX F: MID-INTERVENTION SURVEY

This survey marks the half-way point (4-weeks) of the research study. It will take approximately 2-4 minutes to provide your responses to measure exercise self-efficacy and upload a screenshot of your exercise minutes.

All responses will be coded, and identifiers will be removed for anonymity. Your answers are secure and private. You may request to receive a pdf copy of your response upon submission.

This set of nine questions will be evaluating your confidence level regarding engagement in physical activity. Please select the response that best answers the question prompt right now.

0= Not confident
10= Very confident

	0 = Not confident	1	2	3	4	5	6	7	8	9	10 = Very confident
The weather was bothering you	○	○	○	○	○	○	○	○	○	○	○
You were bored by the program or activity	○	○	○	○	○	○	○	○	○	○	○
You felt pain when exercising	○	○	○	○	○	○	○	○	○	○	○
You had to exercise alone	○	○	○	○	○	○	○	○	○	○	○
You did not enjoy it	○	○	○	○	○	○	○	○	○	○	○
You were too busy with other activities	○	○	○	○	○	○	○	○	○	○	○
You felt tired	○	○	○	○	○	○	○	○	○	○	○
You felt stressed	○	○	○	○	○	○	○	○	○	○	○
You felt depressed	○	○	○	○	○	○	○	○	○	○	○

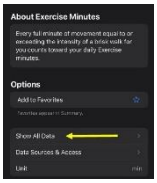
Please upload a screen shot of the exercise minutes recorded on your Apple Watch.

Instructions for retrieving Exercise Minutes:
1. Open the Health application on your iPhone. If you do not see this app on your phone, start typing “health” into the search bar.

2. Select "Show All Health Data".

3. Select "Exercise Minutes".

4. Select "Show All Data".



5. Be sure displayed on the screen are your exercise minutes over the past 8 days. Take a screenshot by pressing the volume up and power button at the same time. Upload this image from your photos on your iPhone.

Choose file

If you need assistance, please contact the researcher, Amanda Bireline (ambireline@uncg.edu).

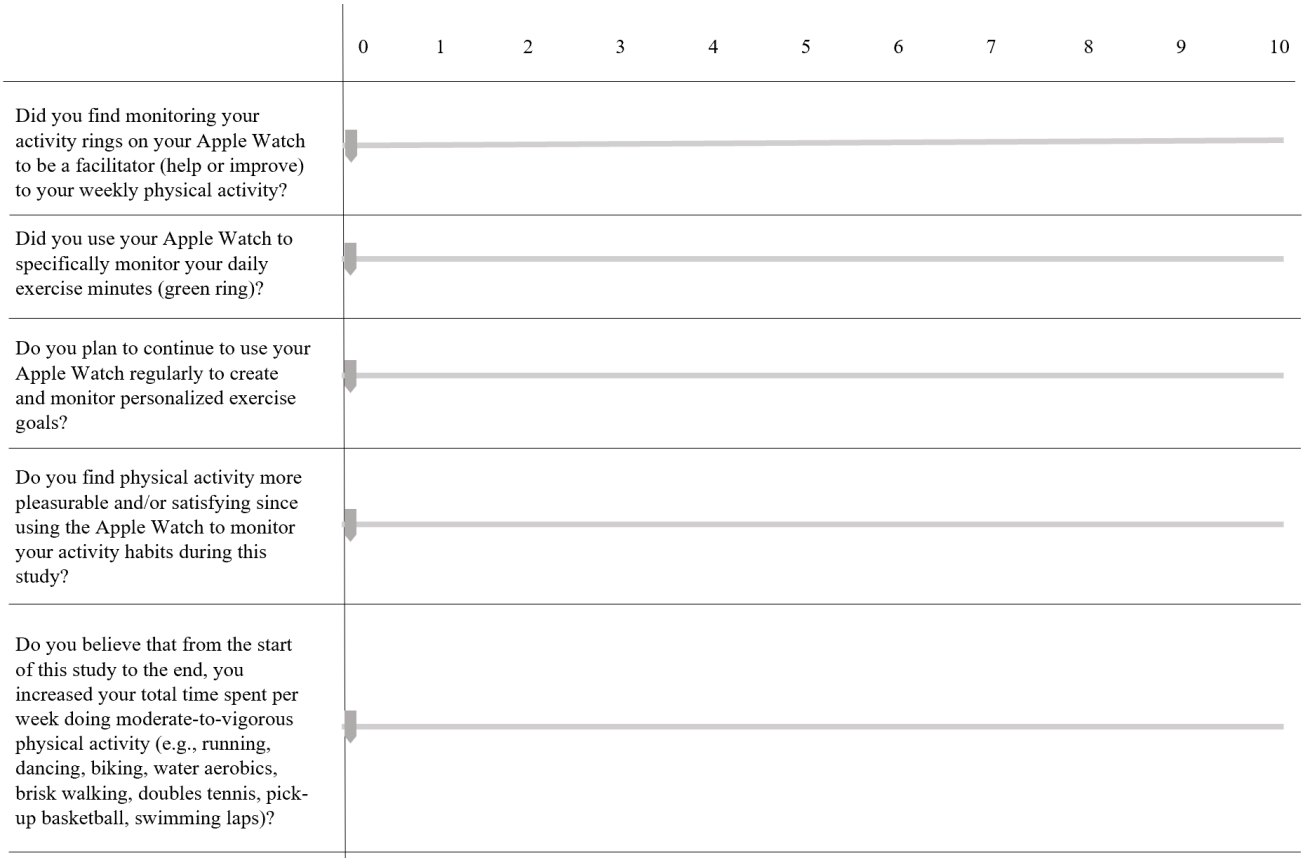
APPENDIX G: POST-INTERVENTION SURVEY SHARING CONDITION

Thank you for taking time to participate in this research study over the past 8-weeks. Please complete this final survey that will take approximately 7 minutes. The following questions will be asking you to consider your use of the Apple Watch and associated social features during this study. Please respond to the questions as accurately as possible.

All responses will be coded, and identifiers will be removed for anonymity. Your answers are secure and private. You may request to receive a pdf copy of your response upon submission.

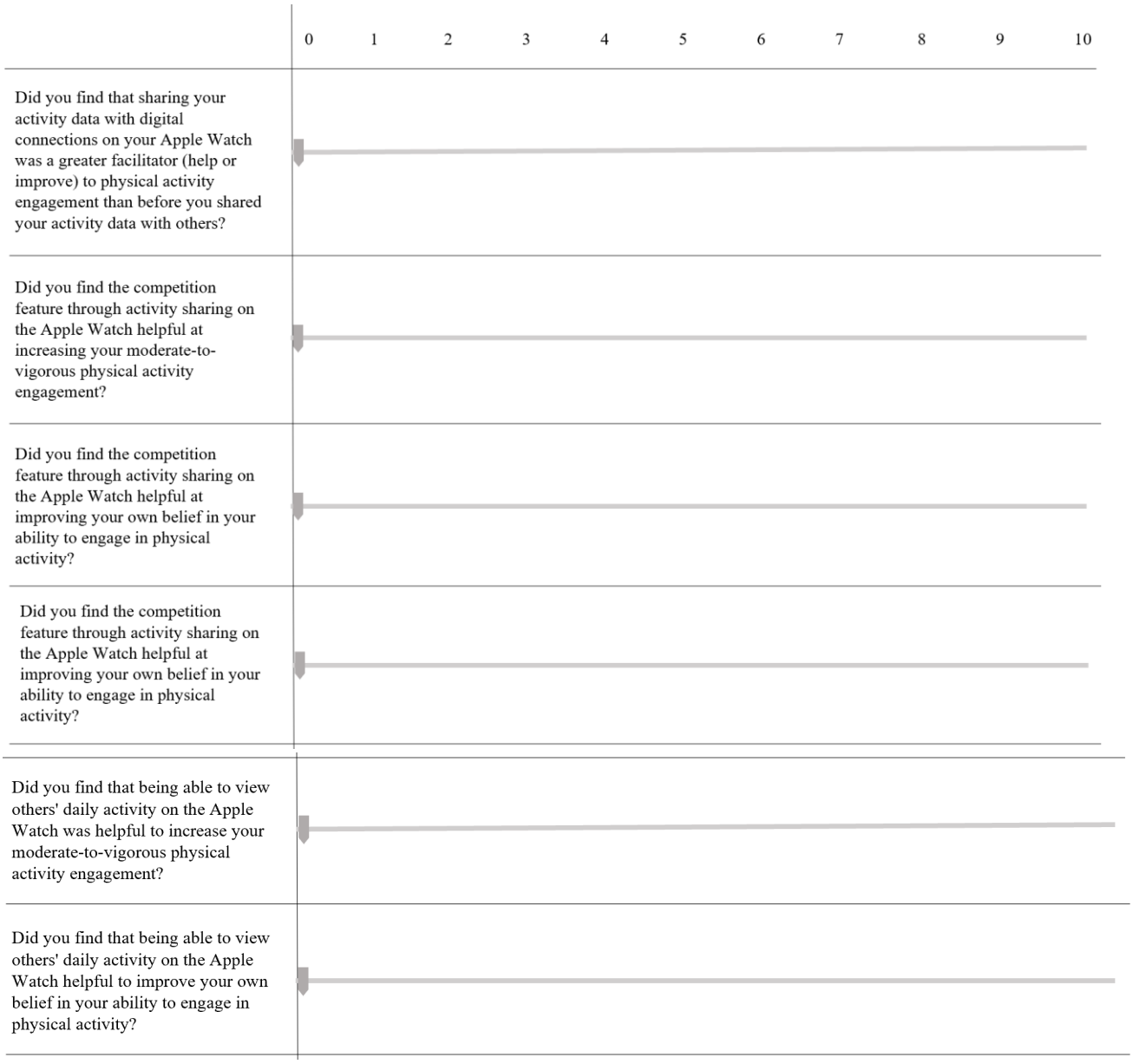
Thinking about your experience using the wearable activity tracker (Apple Watch) over the past eight weeks, please indicate the number between 1 and 10 that best represents your response.

1 = strongly disagree
5 = neither agree nor disagree
10 = strongly agree



The following questions are related to your use of the social features and sharing your fitness data with other Apple Watch users over the last 8-weeks.

1 = strongly disagree
5 = neither agree nor disagree
10 = strongly agree



Did you find the social support you received on your completed workouts and earned rewards provided by your digital connections on your Apple Watch was helpful to increase your moderate-to-vigorous physical activity engagement?	
Did you find the social support on your completed workouts and earned rewards provided by your digital connections on your Apple Watch helpful to improve your own belief in your ability to engage in physical activity?	
Were you satisfied with the level of social support you received from your digital connections on your Apple Watch about your physical activity engagement?	

Note the following important terms for the next three questions:

- **Social Comparison:** evaluating and comparing of personal activity data to the activity data of those you are socially connected to on the device.
- **Competition:** active engagement in the device's competition feature.
- **Social Support:** active engagement in comments, feedback, and/or "likes" of social connections activity progress, workout completion, and/or earned rewards.

Which social feature did you engage with most frequently over the last 8-weeks on the device?

- O Social Comparison
- O Competition
- O Social Support

Which social behavior was most influential on increasing your weekly physical activity?

- O Social Comparison
- O Competition
- O Social Support

Which social behavior was most influential on your own belief in your ability to engage in physical activity (exercise self-efficacy)?

- Social Comparison
- Competition
- Social Support

This set of nine questions will be evaluating your confidence level regarding engagement in physical activity. Please select the response that best answers the question prompt right now.

0= Not confident
10= Very confident

	0 = Not confident	1	2	3	4	5	6	7	8	9	10 = Very confident
The weather was bothering you	○	○	○	○	○	○	○	○	○	○	○
You were bored by the program or activity	○	○	○	○	○	○	○	○	○	○	○
You felt pain when exercising	○	○	○	○	○	○	○	○	○	○	○
You had to exercise alone	○	○	○	○	○	○	○	○	○	○	○
You did not enjoy it	○	○	○	○	○	○	○	○	○	○	○
You were too busy with other activities	○	○	○	○	○	○	○	○	○	○	○
You felt tired	○	○	○	○	○	○	○	○	○	○	○
You felt stressed	○	○	○	○	○	○	○	○	○	○	○
You felt depressed	○	○	○	○	○	○	○	○	○	○	○

Please upload a screen shot of the exercise minutes recorded on your Apple Watch.

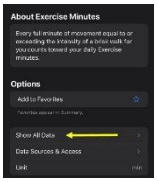
Instructions for retrieving Exercise Minutes:

1. Open the Health application on your iPhone. If you do not see this app on your phone, start typing “health” into the search bar.

2. Select "Show All Health Data".

3. Select "Exercise Minutes".

4. Select "Show All Data".



5. Be sure displayed on the screen are your exercise minutes over the past 8 days. Take a screenshot by pressing the volume up and power button at the same time. Upload this image from your photos on your iPhone.

Choose file

If you need assistance, please contact the researcher, Amanda Bireline (ambireline@uncg.edu).

How long have you been exercising regularly?

- O I do not exercise and have no intention to in the next 6 months
- O I do not exercise but intend to in the next 6months
- O I do not exercise but intend to in the next 30 days
- O Regularly for less than 6 months
- O Regularly for more than 6 months
- O Regularly for 1-3 years
- O Regularly for 3-5 years
- O Regularly for more than 5 years

Are you interested in receiving the results of this study?

Please enter your first and last name.

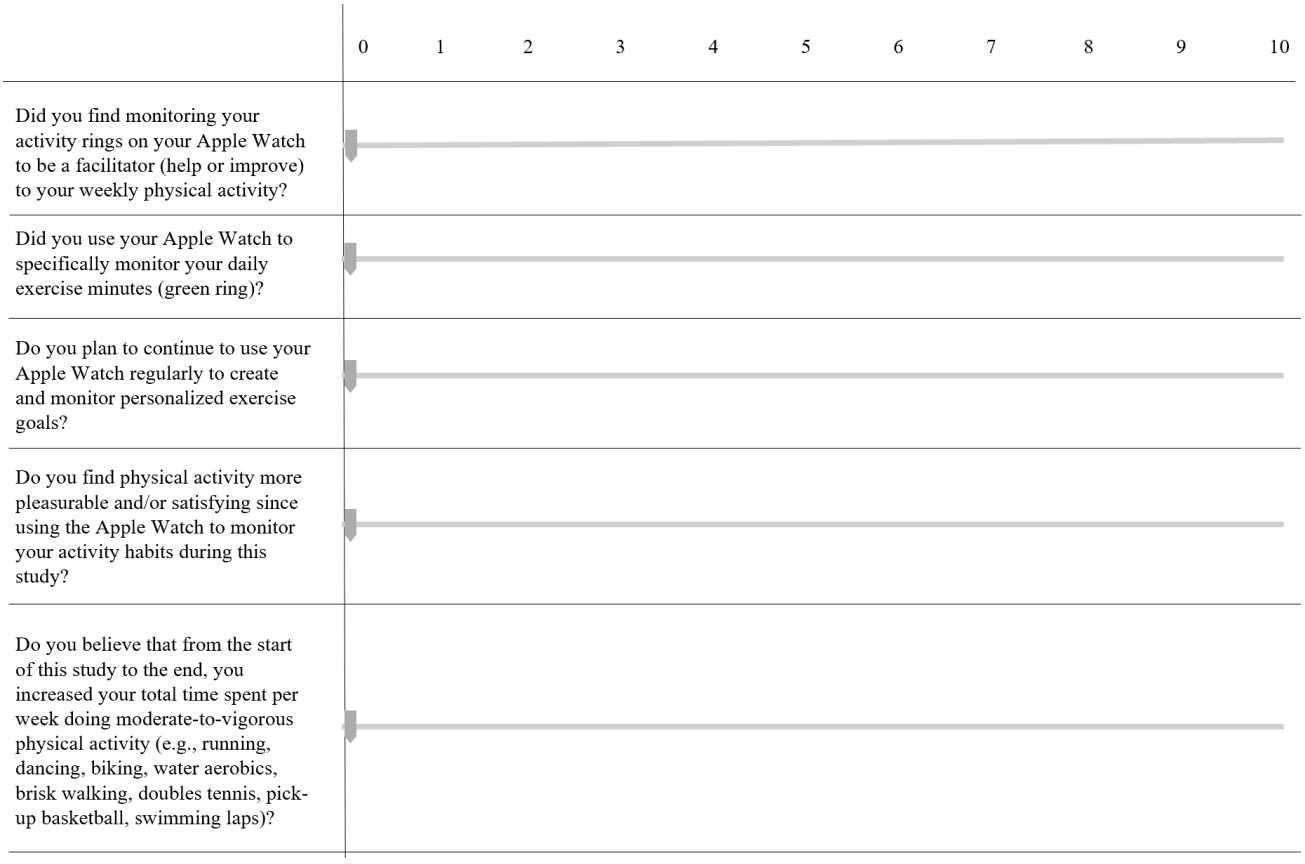
APPENDIX H: POST-INTERVENTION SURVEY NON-SHARING CONDITION

Thank you for taking time to participate in this research study over the past 8-weeks. Please complete this final survey that will take approximately 4 minutes. The questions will be asking you to consider your use of the Apple Watch during this study. Please respond to the questions as accurately as possible.

All responses will be coded, and identifiers will be removed for anonymity. Your answers are secure and private. You may request to receive a pdf copy of your response upon submission.

Thinking about your experience using the wearable activity tracker (Apple Watch) over the past eight weeks, please indicate the number between 1 and 10 that best represents your response.

1 = strongly disagree
5 = neither agree nor disagree
10 = strongly agree



This set of nine questions will be evaluating your confidence level regarding engagement in physical activity. Please select the response that best answers the question prompt right now.

0= Not confident
10= Very confident

	0 = Not confident	1	2	3	4	5	6	7	8	9	10 = Very confident
The weather was bothering you	○	○	○	○	○	○	○	○	○	○	○
You were bored by the program or activity	○	○	○	○	○	○	○	○	○	○	○
You felt pain when exercising	○	○	○	○	○	○	○	○	○	○	○
You had to exercise alone	○	○	○	○	○	○	○	○	○	○	○
You did not enjoy it	○	○	○	○	○	○	○	○	○	○	○
You were too busy with other activities	○	○	○	○	○	○	○	○	○	○	○
You felt tired	○	○	○	○	○	○	○	○	○	○	○
You felt stressed	○	○	○	○	○	○	○	○	○	○	○
You felt depressed	○	○	○	○	○	○	○	○	○	○	○

Please upload a screen shot of the exercise minutes recorded on your Apple Watch.

Instructions for retrieving Exercise Minutes:

1. Open the Health application on your iPhone. If you do not see this app on your phone, start typing “health” into the search bar.

2. Select "Show All Health Data".

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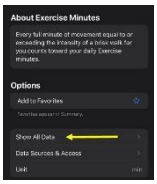


5. Be sure displayed on the screen are your exercise minutes over the past 8 days. Take a screenshot by pressing the volume up and power button at the same time. Upload this image from your photos on your iPhone.

Choose file

If you need assistance, please contact the researcher, Amanda Bireline (ambireline@uncg.edu).

How long have you been exercising regularly?

- I do not exercise and have no intention to in the next 6 months
- I do not exercise but intend to in the next 6months
- I do not exercise but intend to in the next 30 days
- Regularly for less than 6 months
- Regularly for more than 6 months
- Regularly for 1-3 years
- Regularly for 3-5 years
- Regularly for more than 5 years

Are you interested in receiving the results of this study?

Please enter your first and last name.

APPENDIX I: SHARING FITNESS DATA & SOCIAL ENGAGEMENT

HOW TO SHARE FITNESS DATA FROM YOUR IPHONE

1

Access the fitness app (app with exercise rings) on your iphone.

2

Select "Sharing" on the bottom right of the screen.

3

Select the icon in the top right corner with the green silhouette of a person and a + sign. Next, click the green + in the top right corner.

4

This should bring up your list of contacts. You may also manually add a phone number. Once you select someone (or more than one person), click send in the top right.

5

The person(s) you invited will appear on the screen until they have accepted the request. Once they have accepted, you will be able to view their fitness data on the sharing dashboard.

For assistance sharing fitness data, please text 630-890-9420 or email to ambireline@uncg.edu

HOW TO ACCEPT AN INVITE TO SHARE FITNESS DATA

1

On your iPhone: You will receive a small notification symbol on the Fitness app. By opening the app, you will see a similar notification on the sharing symbol at both the bottom and top right of the screen. Select the top right icon.

2

At the top of the screen, you will see "Accept" or "Decline" under "Awaiting Your Reply". By clicking "Accept" you agree to share your fitness data with the person who invited you.

3

On your Apple Watch: You will receive a notification of Activity Sharing asking if you would like to share your activity with the person who invited you.

4

Simply scroll down and "Accept", "Ignore", or "Dismiss". By clicking "Accept" you agree to share your fitness data with the person who invited you.

For assistance sharing fitness data, please text 630-890-9420 or email to ambireline@uncg.edu

USING SOCIAL FEATURES ON YOUR APPLE WATCH OR IPHONE

1

You can view your connections daily activity and compare your data! **On your iPhone**: Open the Fitness app and select the "Sharing" icon on the bottom right. Here you will be able to view your activity data compared to your connections.

2

To compare your activity to your connections **on your Apple Watch**: Open the Activity app and swipe left one time. Here you will be able to view your activity data compared to your connections.

3

Challenge your connections to a competition! **On your Apple Watch**: Open the Activity app and swipe left one time. Select the connection you want to compete with. Scroll to the bottom and select "Compete". This invites them to a 7-day competition.

4

On your iPhone: open the Fitness app and select the "Sharing" icon on the bottom right. Select the connection you want to compete with by clicking their name. Select "Compete with *name of the person*" and this will invite them to a 7-day competition!

5

Support your friends when they complete a workout or fitness goal! You will receive a notification on your watch when your connection(s) complete a workout or earn an award. Click on the notification, click "Reply", and choose a pre-created comment and write your own customized message!

For assistance on engaging with these social features, please text 630-890-9420 or email to ambireline@uncg.edu

APPENDIX J: FULL RESULTS OF STATISTICAL TESTNG

Table J6. Weekly Physical Activity Minutes Based on WAT-Use Condition

Within Subjects Repeated Measures

Measure	Pre-intervention		Mid-intervention		Post-intervention				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Data Set 1 SFU (*n* = 59)	281.61	159.40	323.81	184.33	341.83	174.99	2	11.135	< .001*
Data Set 1 SFNU (*n* = 59)	263.43	196.49	271.34	170.20	317.51	199.06			
Data Set 2 SFU (*n* = 58)	275.26	153.08	318.90	181.99	336.93	172.39	2	12.678	< .001*
Data Set 2 SFNU (*n* = 54)	236.54	151.80	261.02	162.38	296.20	174.03			

Repeated Measures Interaction Between Conditions

Data Set 1 Overall Sample (*n* = 118)	272.52	178.38	297.58	198.60	329.67	187.01	2	1.134	.322
Data Set 2 Overall Sample (*n* = 112)	256.59	153.01	290.99	174.48	317.29	173.61	2	.380	.678

Note. Data Set 1 includes all collected data without any outliers removed. Data Set 2 includes data with outliers (>2*SD*'s from the mean) removed. SFU = Social Feature User Condition and SFNU = Social Feature Non-User Condition.

*Indicates statistical significance.

Table J7. Weekly Physical Activity Minutes Based on Top Reported Social Feature Use

Repeated Measures Interaction Between Conditions

Data Set 1

Measure	Pre-intervention		Mid-intervention		Post-intervention				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Social Comparison (*n* = 23)	264.13	157.84	367.30	189.81	369.65	159.51	4	2.759	.031*
Competition (*n* = 23)	297.83	142.78	290.17	173.43	347.30	206.53			
Social Support (*n* = 14)	289.50	190.10	314.71	187.22	296.86	138.61			

Data Set 2

Social Comparison (*n* = 22)	246.59	136.70	356.32	186.64	358.00	152.92	4	3.084	.019*
Competition (*n* = 23)	297.83	142.78	290.17	173.43	347.30	206.53			
Social Support (*n* = 13)	283.85	196.64	306.38	192.14	282.92	133.67			

Note. Data Set 1 includes all collected data without any outliers removed. Data Set 2 includes data with outliers (>2*SD*'s from the mean) removed.

*Indicates statistical significance.

Table J8. Exercise Self-efficacy Scores Based on WAT-Use Condition

Within Subjects Repeated Measures

Measure	Pre-intervention		Mid-intervention		Post-intervention				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Data Set 1 SFU (*n* = 58)	55.24	19.45	48.55	21.29	52.34	18.80	2	3.398	.035*
Data Set 1 SFNU (*n* = 54)	49.24	17.56	47.63	17.97	49.56	19.02			
Data Set 2 SFU (*n* = 34)	41.79	11.71	40.12	17.64	43.62	16.11	2	1.499	.227
Data Set 2 SFNU (*n* = 39)	40.85	11.91	41.41	13.76	44.18	16.56			

Repeated Measures Interaction Between Conditions

Data Set 1 (*n* = 112)	52.35	18.72	48.11	19.68	51.00	18.88	2	1.242	.291
Data Set 2 (*n* = 73)	51.29	11.75	40.81	15.59	43.92	16.24	2	0.175	.835

Note. Data Set 1 includes data with outliers (>2*SD*'s from the mean) removed. Data Set 2 includes the additional removal of participants with baseline self-efficacy scores >60. SFU = Social Feature User Condition and SFNU = Social Feature Non-User Condition.

*Indicates statistical significance.

Table J9. Exercise Self-efficacy Scores Based on Top Reported Social Feature Use

Within Subjects Repeated Measures

Data Set 1

Measure	Pre-intervention		Mid-intervention		Post-intervention				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Social Comparison (*n* = 22)	55.68	16.99	45.73	21.09	51.59	17.63	2	3.684	.024*
Competition (*n* = 23)	50.22	20.84	47.43	19.20	49.83	19.57			
Social Support (*n* = 14)	63.38	19.37	55.31	25.16	58.05	19.67			

Data Set 2

Social Comparison (*n* = 12)	43.33	11.88	39.83	22.55	43.25	16.54	2	1.014	.369
Competition (*n* = 16)	38.75	11.52	39.19	12.59	40.31	12.88			
Social Support (*n* = 6)	46.83	11.43	43.17	21.20	53.17	21.64			

Repeated Measures Interaction Between Conditions

Data Set 1 (*n* = 59)	55.24	19.45	48.55	21.29	55.34	18.80	4	0.500	.735
Data Set 2 (*n* = 34)	41.79	11.71	40.12	17.64	43.62	16.11	4	0.322	.859

Note. Data Set 1 includes data with outliers (>2*SD*'s from the mean) removed. Data Set 2 includes the additional removal of participants with baseline self-efficacy scores >60.

*Indicates statistical significance.

Table J10. Pearson Correlation Coefficient of Chanes in Exercise Self-efficacy Scores Versus Changes in Weekly Physical Activity Minutes

Data Set 1

Measure	*n*	*M*	*SD*	1	2	3	4	5	6
1. BMSE1	112	-4.24	17.07	1	-.464**	.519**	.088	-.120	-.021
2. MPSE2	112	2.89	17.03	-.464**	1	.516**	.117	.165	.257**
3. BPSE3	112	-1.35	17.65	.519**	.516**	1	.197*	.043	.227*
4. BMEM1	112	34.40	129.16	.088	.117	.197*	1	-.409**	.601**
5. MPEM2	112	26.30	117.86	-.120	.165	.043	-.409**	1	.483**
6. BPEM3	112	60.71	134.58	-.021	.257**	.227**	.601**	.438**	1

Data Set 2

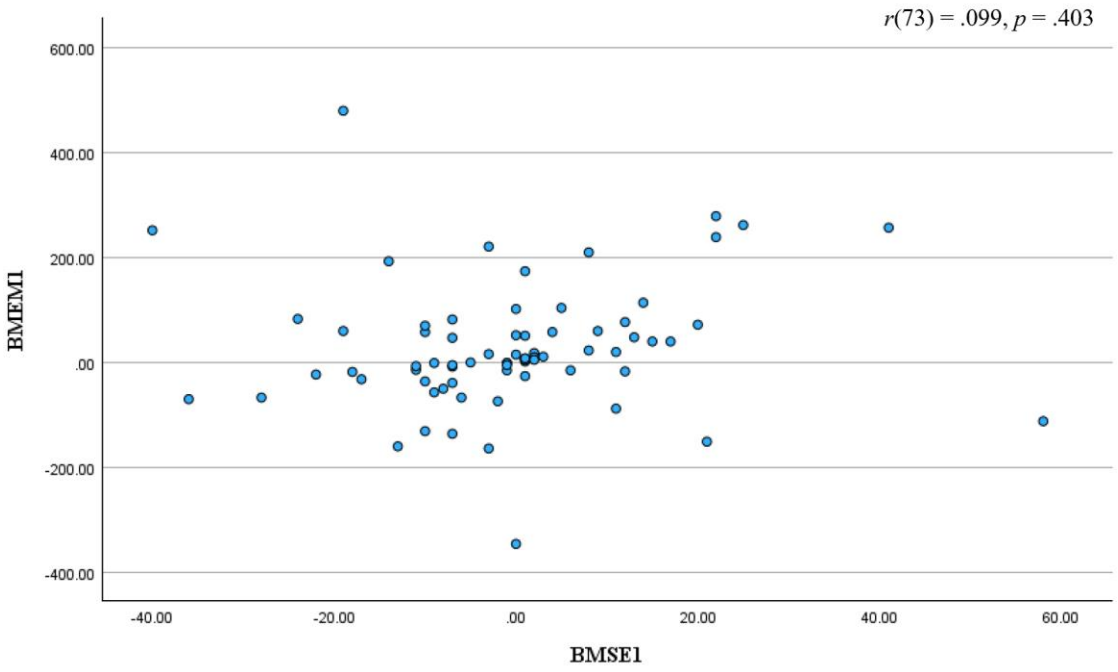
Measure	*n*	*M*	*SD*	1	2	3	4	5	6
1. BMSE1	73	-.48	15.31	1	-.387**	.516**	.099	-.104	.004
2. MPSE2	73	3.11	16.24	-.387**	1	.590**	.109	.241*	.357**
3. BPSE3	73	2.63	17.49	.516**	.590**	1	.189	.133	.335*
4. BMEM1	73	27.34	120.48	.099	.109	.189	1	-.534**	.545**
5. MPEM2	73	20.68	111.22	-.104	.241*	.133	-.534**	1	.418**
6. BPEM3	73	48.03	112.09	.004	.357**	.335**	.545**	.418**	1

Note. Data Set 1 includes data with outliers (>2*SD*'s from the mean) removed. Data Set 2 includes the additional removal of participants with baseline self-efficacy scores >60. BMSE1 = Baseline to mid-intervention self-efficacy score, MPSE2 = Mid- to post-intervention self-efficacy score, BPSE3 = Baseline to post-intervention self-efficacy score, BMEM1 = Baseline to mid-intervention PA minutes, MPEM2 = Baseline to mid-intervention PA minutes, BPEM3 = Baseline to mid-intervention PA minutes.

** Correlation is significant at the .01 level (2-tailed).
* Correlation is significant at the .05 level (2-tailed).

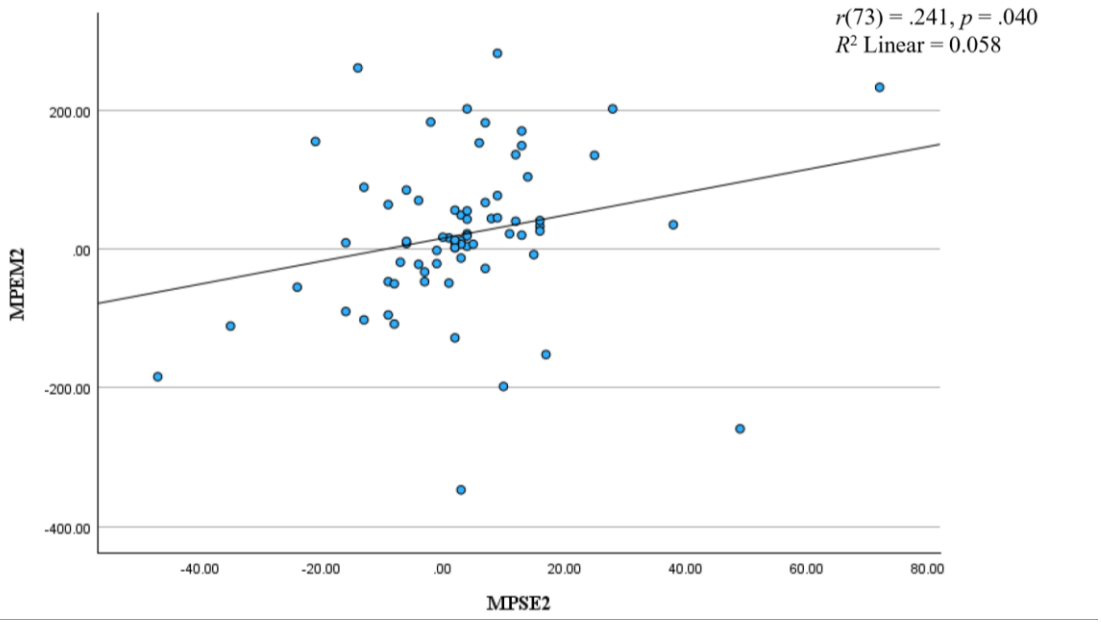
APPENDIX K: SCATTER PLOTS FOR CHANGES IN EXERCISE SELF-EFFICACY VERSUS CHANGES IN WEEKLY PHYSICAL ACTIVITY ACROSS STUDY TIME POINTS

Figure K6. Change Scores from Pre- to Mid-intervention with Elevated Self-efficacy Scores Removed (>60)



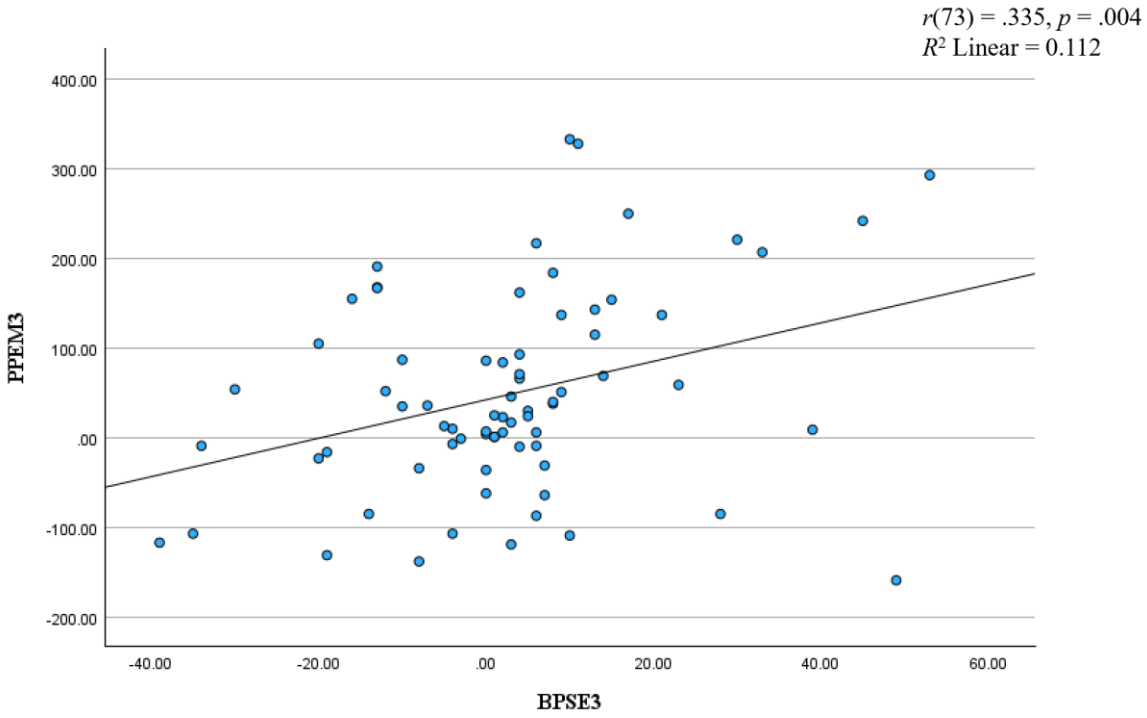
Note. The data represented includes the removal of outliers (those with baseline self-efficacy scores >60). BMSE1 = Baseline to mid-intervention self-efficacy score and BMEM1 = Baseline to mid-intervention weekly PA minutes.

Figure K7. Change Scores from Mid- to Post-intervention with Elevated Self-efficacy Scores Removed (>60)



Note. The data represented includes the removal of outliers (those with baseline self-efficacy scores >60). MPSE2 = Mid- to post-intervention self-efficacy score and MPEM2 = Mid- to post-intervention weekly PA minutes.

Figure K8. Change Scores from Pre- to Post-intervention with Elevated Self-efficacy Scores Removed (>60)



Note. The data represented includes the removal of outliers (those with baseline self-efficacy scores >60). PPSE3 = Pre- to post-intervention self-efficacy score and PPEM3 = pre- to post-intervention weekly PA minutes.

APPENDIX L: RESPONSE FREQUENCIES TO POST-INTERVENTION QUESTIONS RELATED TO *SOCIAL COGNITIVE THEORY* CONSTRUCTS

Figure L9.

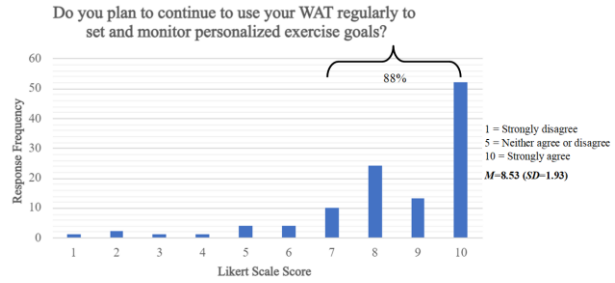


Figure L10.

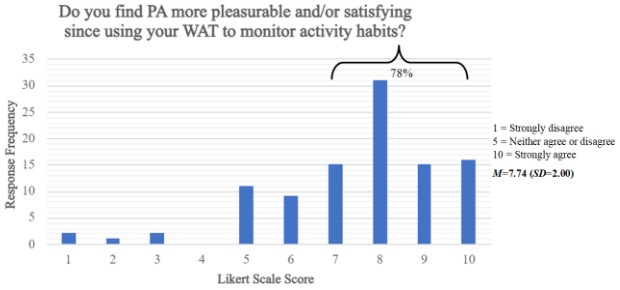


Figure L11.

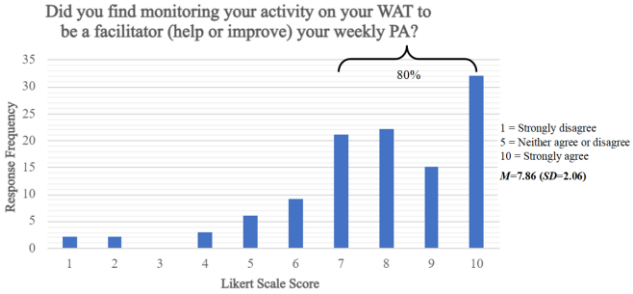


Figure L12.

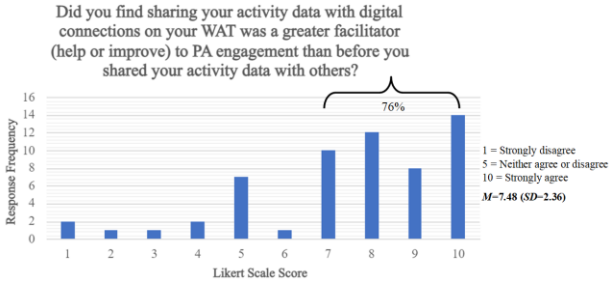


Figure L13.

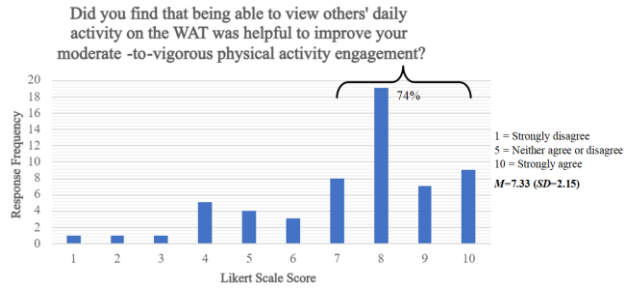
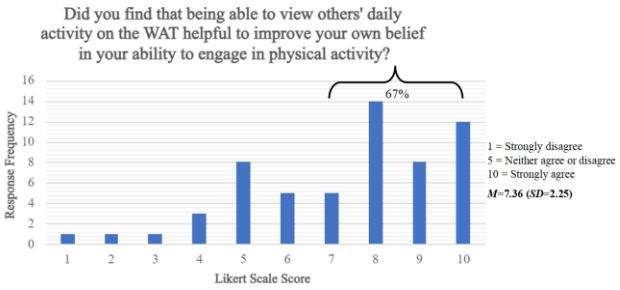


Figure L14.



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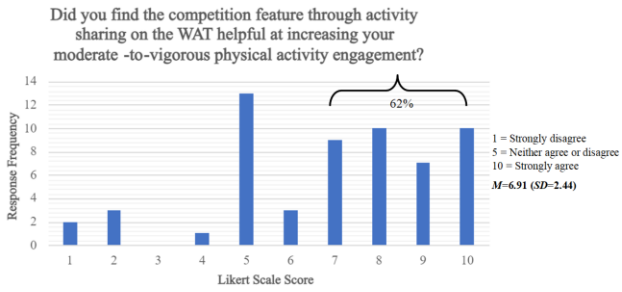

Figure L16.

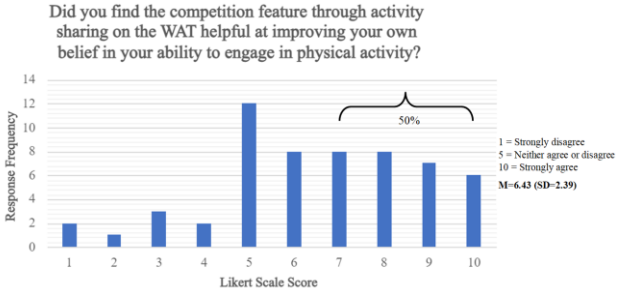

Figure L17.

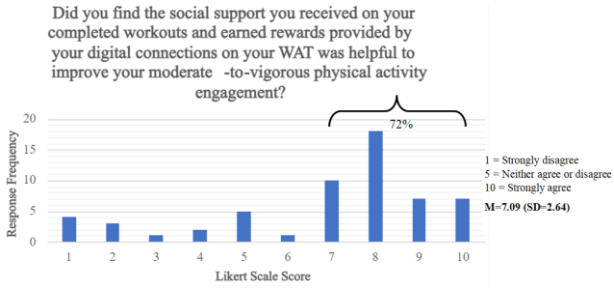

Figure L18.