Title: A Study to Test the Effectiveness of Different Interventions to Improve Physical Activity in Adults.
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Background

Physical Activity (PA) and Health

According to the Centers for Disease Control and Prevention (CDC), adults (≥ 18 years) should participate in at least 150 minutes (two hours and thirty minutes) moderate-intensity physical activity (MPA) per week, or 75 to 150 minutes of vigorous intensity physical activity (VPA) per week, or some combination of both.[1] This level of PA is associated with substantial health benefits including improvements in cardiovascular health, muscular fitness, and cognitive function.[1] More than two third of U.S. adults do not meet these guideline and have a 67% higher risk for all-cause mortality and contribute to the $117 billion dollars in health care costs associated with physical inactivity.[14]

Self-Determination Theory and Physical Activity

Behavior-change theory-driven interventions and in particular those based in Self-Determination Theory (SDT) have been successful in improving PA participation in a variety of populations, in part due to a focus on intrinsic motivation.[12,39-43] Behaviors that are intrinsically motivated are undertaken for the sake of the behavior itself; inherent satisfaction is the reward.[10] In contrast, extrinsic motivation is associated with motivation by external factors and at its extreme, motivation by coercion.[10] More autonomous, or intrinsic motivation, is correlated to long-term PA engagement while extrinsic motivation has been shown to be effective in PA initiation, but not sustainability.[9,17]

Wearable Fitness Trackers to Improve Physical Activity Engagement

A promising tool to enhance PA participation is the use of a wearable fitness tracker (WFT) such as a Fitbit or Apple Watch. The small, relatively low-cost, and user friendly WFTs have been developed to support sedentary or under-active individuals in increasing their PA

engagement.[18] Short term studies have indicated that WFT use increases both self-reported PA and objectively measured PA in adults.[44,45] However, this improvement is not sustained in a majority of individuals.[46-51] Furthermore, it is known that most WFT consumers discontinue tracker use within six months of purchase.[52] Therefore, it continues to be relatively unknown whether or not WFT impact motivation for PA or PA behavior in the long-term.[50]

Multiple Behavior Change Techniques Are Better Than One

One potential method to improve the effectiveness of WFTs is to combine them with other interventions. According to a review by Sullivan and Lachman,[13] the most effective strategy to increase PA and sustain that increase is to employ multiple behavior change techniques. Several studies have combined wearable tracker use with other interventions such as cash incentives for hitting goals,[48] challenges sent to participants via email,[47] and a mobile application loaded with an exercise program.[44] Specifically, we propose combining WFT use with a Self-Determination theory driven Motivational Interviewing (MI) intervention to improve PA motivation and engagement.

Motivational Interviewing and Physical Activity

MI is a person-centered form of engagement that encourages people to assess their own position on the motivation continuum, explore the reasons behind their position, and determine how to best shift from amotivation or ambivalence to a more autonomous position. While MI was not developed with SDT in mind, Deci & Ryan[53] point out that SDT and MI have historically been congruent, particularly with their emphases on autonomy support to make health-related decisions and changes. Specifically, both SDT and MI are focused on the central ideal of motivation and the development of internal motives, and the exposure and consideration of externally imposed goals or pressures to act which have no personal meaning to the

individual.[54] SDT constructs and MI, both on their own and combined, are effective in improving both motivation for PA and PA behavior in a range of age groups. A number of studies measuring changes in PA in response to an SDT-based intervention or MI, or a combination of the two saw statistically significant increases in PA.[39,43,55-58] Research has also indicated that SDT-based MI is a powerful intervention to shift motivation for PA from mostly extrinsic to mostly intrinsic.[39,59,60]

WFTs and MI: A Powerful Combination

Two pilot studies[61,62] found that combining SDT-based MI interventions with wearable tracker use significantly improved self-reported PA, body weight, and HDL cholesterol in African American men[61] and increased the likelihood of meeting daily step goals in adolescent-parent dyads.[62] These results present an encouraging possibility for improving PA in sedentary adults: WFTs and SDT based MI. Given the popularity of wearable fitness trackers and the effectiveness of SDT based MI in increasing PA motivation and behavior, the combination of the two shows promise to improve the overall health of adults. Therefore, the purpose of this study is to assess the impact of a self-determination theory motivational interviewing intervention in combination with wearable fitness tracker use on motivation for PA and PA behavior.

Methods

Participant Recruitment and Health Screening

Participants aged 18 and over will be recruited through a variety of means including flyers on the Colorado State University campus, flyers in local fitness centers, physician referrals, social media, and mass emails. In order to detect difference between groups with 95% confidence in repeated measures analyses, we will seek to recruit 40 total participants in order to allow for attrition. We aim to have 32 participants complete the study. To be included in this

study, participants must be over the age of 18 and must not meet physical activity guidelines of at least 150 minutes of moderate physical activity per week. They must own an Android or iPhone smartphone device and be willing to download a mobile application onto that device for use during the intervention. They also must be willing to potentially wear a WFT and/or attend bi-weekly remote MI. Participants must not have a history of heart disease or diabetes, and must not have limiting conditions like concurrent cancer treatment, peripheral artery disease, orthopedic injury, or pain limiting arthritis. They must also not seek to participate in other structured PA programs for the duration of the study, must not be pregnant or seek to become pregnant, and must not have been diagnosed with alcohol or substance abuse during the previous twelve months.

After having established the eligibility of a potential participant via a screening form, participants will be consented and will complete baseline assessments. This session will involve the administration of all self-reported measures, as well as instruction on accelerometer use Participants will wear the accelerometer for the subsequent7 days to provide baseline data on their baseline level of PA. Researchers will collect the ActiGraphs after the 7-day period.

Participants who complete the baseline PA assessment invited to a remote session to general physical activity guidelines education and will take approximately 1 hour. Prior to this meeting, participants will have been randomly assigned to one of the four study groups (i.e., WFT, MI, WFT+MI, or PA Education Control) using a randomized number generator. To control for age and sex, participants will be age- and sex-matched in each group. During this remote meeting, participants will be inform as to which group they have been randomized into.

Description of Intervention:

The duration of the study will be twelve weeks. The four study conditions are as follows:

WFT: Individuals assigned to this experimental condition will be given a wrist-worn WFT and will be instructed to wear it for the duration of the study. They will also be instructed to download the corresponding mobile application on their smartphones to be used for the duration of the study. They will be trained by a member of our team on how to utilize the WFT and mobile application. The intended WFT tracks daily steps, miles traveled, kcals expended, and daily activity time. This device provides these data to the wearer via a small screen. Participants will be instructed to try and complete at least 150 minutes of PA per week. Researchers will have the capability to track participant daily PA via the WFT mobile application account created for each participant. These individuals will be asked to set biweekly PA goals, which will be emailed to the study coordinator. These participants will also receive general physical activity guidelines education and information on strategies to reach the recommended amount of activity per week during the initial baseline assessment meeting. Participants in this condition will be asked to ONLY wear the WFT provided to them by researchers.

MI: The individuals will be scheduled for and participate in six biweekly remote SDT based MI sessions. These sessions will take place via video calling platforms like Microsoft Teams, Zoom, or Skype. The MI sessions will be conducted by a PhD student who has been trained by a MI practitioner. Participants will be provided a log book and will be asked to log their PA, with the goal of completing at least 150 minutes of PA per week. These participants will also receive general physical activity guidelines education and information on strategies to reach the recommended amount of activity per week during the initial baseline assessment meeting. Participants in this condition will be asked to NOT wear a WFT of their own over the course of the intervention.

WFT+MI: These individuals will be given the wrist-worn WFT, be instructed to wear it for the duration of the study AND be scheduled for six SDT based remote MI sessions. These participants will also be trained by a member of our team on how to utilize the WFT and associated application. They will be instructed to try to complete 150 minutes of PA per week. Researchers will have the capability to track participant daily PA via the WFT and associated API. These participants will also receive general physical activity guidelines education and information on strategies to reach the recommended amount of activity per week during the initial baseline assessment meeting. Participants in this condition will be asked to ONLY wear the WFT provided to them by researchers.

PA Education Control: These participants will receive general physical activity guidelines education and information on strategies to reach the recommended amount of activity per week during the initial baseline assessment meeting. Participants will be asked to NOT wear a WFT of their own over the course of the intervention. At the conclusion of the study, these participants will be offered the chance to participate in one MI session.

Outcome measures: The following outcome measures will be collected at baseline, and at the completion of the twelve-week intervention.

- **Objectively measured PA engagement**: PA will be objectively measured by one week of actigraphy using the ActiGraph wGT3-BT activity monitor. Participants will be given the ActiGraph and will be instructed to wear it on a provided elastic belt on their non-dominant hip for one week. They will be given a log to record times that they removed the ActiGraph, which should only be when showering, bathing, or otherwise coming into contact with water. At the conclusion of the week, the ActiGraph data will be downloaded using ActivLife software. Daily PA will be assessed via the WFT

application for individuals in the WFT+MI and WFT groups, and via self-report for the MI group.

- **Motivation for PA**: Motivation for PA will be assessed using the Behavioral Regulation in Exercise Questionnaire (BREQ-3). This instrument is one of the most widely used in PA and exercise motivation research and has been validated in this population.[21,22] This survey will be accessed via a secure online link.
- **Covariates**: Each of the following covariates will be collected pre-intervention: age, race/ethnicity, education level, family affluence, and height/weight (BMI). All, except height and weight will be collected with self-report. Height and weight will be measured by lab personnel during the first visit to the lab.

Data Analysis

Means and standard deviations of the following variables will be calculated: baseline and follow-up MVPA, steps, and energy expenditure, baseline and follow-up scores for PA motivation subscales, and participant age and BMI. Paired t-tests will be used to compare within subjects pre-participation values from post-participation values for PA, and motivation variables by group. ANCOVA will be used to compare between subjects differences in outcome variables by group. Models will be developed based on covariate correlation with outcome variables and other covariates.