CELL PHONE-BASED PHYSICAL ACTIVITY RECALL FOR MEASURING PHYSICAL ACTIVITY AWARENESS AND CHANGE IN BEHAVIOR IN SEDENTARY ADULTS

By

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With Honors in

Nutritional Sciences

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ABSTRACT

This study was aimed at evaluating sedentary individuals abilities to recall duration and intensity of moderate physical activity (MPA) before and after an 8-week physical activity intervention. Participants were 41 adults (35 female and 6 male) aged 18-40 years, enrolled in the Tailored Intervention Promoting Physical Activity project, were analyzed through photo recall of physical activity, the International Physical Activity Questionnaire Short Form (IPAQ-SF), and an ActiGraph accelerometer. Paired t-tests were performed to find the mean differences between ActiGraph and self-reported IPAQ-SF MPA before and after photo recall for both pre and post-intervention measurements. The mean differences found between ActiGraph and IPAQ-estimated MPA minutes were not significant ($p > 0.05$), although ActiGraph minutes were observed to be less than self-reported estimations. Only a marginally significant difference ($p = 0.085$) was found between after photo recall post-intervention ActiGraph-recorded minutes of MPA and participants' self-reported minutes, suggesting that participants' self-reporting accuracy declined after photo recall and intervention. Also, the difference between ActiGraph pre-intervention and post-intervention MPA levels was not significant.

ActiGraph-Recorded MPA levels in all participants at pre- and post-intervention were 38.6±21.5 and 37.0±30.0 minutes ($p > 0.05$), suggesting that the participants did not change their duration of MPA following an 8-week intervention.

DISTRIBUTION OF TASKS

Prior to the writing of the thesis, all three of us volunteered as undergraduate researchers in the nutrition and physical activity lab under the guidance of Dr. Nobuko Hongu. Our thesis was derived from a larger study known as Tailored Intervention Promotion Physical Activity (TIPPA). We all aided in data collection, participant intervention, weekly follow-up meetings with participants, and communication with participants via text message, email, and the TIPPA website. There were 43 total sedentary participants in the study that were being observed for changes in physical activity.

Throughout the writing of the thesis, writing assignments were delegated amongst the three of us. Joe Fisher was responsible for the construction of the introduction and the abstract. Richard Young was responsible for the gathering and organization of the data. Angela Kim was in charge of the methods. All three of us collectively worked on the discussion and the analysis of the results. Additionally, we all kept in contact with our assigned participants for the duration of the study.

In the fall semester we recruited participants through the distribution of flyers and in-class announcements. Data was gathered from participants 1-22 using a device called an ActiGraph, which is an accelerometer that measures three dimensional movement to calculate intensity of physical activity. Follow-ups were performed to ensure that the physical intervention was done appropriately and that the participants were properly engaging in the right physical activity. As the intervention period (8 weeks) for the first group of participants neared conclusion, we helped to prepare for the subsequent group of participants (23-43) and began to draft our thesis. Recruitment for these new participants started at the end of the fall semester, in which the same recruitment methods were conducted (flyers, in-class announcements). At the start of the spring semester, the newly recruited participants began their intervention. We repeated the same procedures conducted in the fall and continued to expand and write the body of our thesis.

Cell Phone-Based Physical Activity Recall for Measuring Physical Activity Awareness and Change in Behavior in Sedentary Adults

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ABSTRACT

This study was aimed at evaluating sedentary individuals' abilities to recall duration and intensity of moderate physical activity (MPA) before and after an 8-week physical activity intervention. Participants were 41 adults (35 females and 6 males) aged 18-40 years, enrolled in the Tailored Intervention Promoting Physical Activity project, were analyzed through photo recall of physical activity, the International Physical Activity Questionnaire Short Form (IPAQ-SF), and an ActiGraph accelerometer. Paired t-tests were performed to find the mean differences between ActiGraph and self-reported IPAQ-SF MPA before and after photo recall for both pre and post-intervention measurements. The mean differences found between ActiGraph and IPAQ-estimated MPA minutes were not significant ($p > 0.05$), although ActiGraph minutes were observed to be less than self-reported estimations. Only a marginally significant difference ($p=0.085$) was found between after photo recall post-intervention ActiGraph-recorded minutes of MPA and participants' self-reported minutes, suggesting that participants' self-reporting accuracy declined after photo recall and intervention. Also, the difference between ActiGraph pre-intervention and post-intervention MPA levels was not significant.

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INTRODUCTION

The development of persisting improvements in regular physical activity among sedentary individuals, through deliberate physical activity or other lifestyle modification, is a principal objective in physical activity intervention studies. The United States Center for Disease Control (CDC) has annually reported an upward trend in adult onset obesity over the last two decades, with as many as 35.7% of adults 18 and older currently being classified as clinically obese [16]. Sedentary individuals are more likely to become obese [11] and develop diseases associated with increased adipose tissue and decreased lean body mass [20]. Scientific evidence shows that physically active adults are at lower risk for developing chronic disease, such as coronary heart disease, stroke, type 2 diabetes, colon, and breast cancers [15]. In combination with diet, the positive effects of increased physical activity can be seen through an overall decrease in disease risk and in some cases disease reversal [21].

Discovering new ways to track and record physical activity should be regarded as an important element in combating the rising rates of obesity and many diseases related to a sedentary lifestyle. Accurate monitoring of both duration and intensity of an individual's physical activity habits allow for powerful insight that can be applied to intervention and lifestyle modification recommendations [6]. Physical activity can be assessed using subjective (questionnaires, diaries) or objective (motion sensors, heart rate monitors, pedometers, or doubly labeled water) methods [3]. The International Physical Activity Questionnaire (IPAQ) is an established self-report instrument, developed by the International Consensus Group in 1998-1999 [4]. The IPAQ is used as a standardized measure to estimate habitual physical activities of populations from different countries. There are two forms of the IPAQ: a 7 question short form (IPAQ-SF) (Appendix I) and a 31 question long form (IPAQ-LF). Both forms involve a 7-day recall of physical activity [12]. The IPAQ-SF classifies physical activity as four levels of intensity; vigorous, moderate, walking, and sedentary [12,13]. Generally the IPAQ-SF has been widely accepted as a valid source for assessing physical activity [12], and as a result, the questionnaire has been used in a multitude of studies. Despite its reliable reputation, the IPAQ-SF has been shown to often overestimate duration of physical activity when compared to objective measurements [12,13].

Several objective methods exist for tracking physical activity such as heart rate monitors, doubly labeled water (DLW), and motion sensors. Heart rate monitors assess changes in an individual’s heart rate over a period of time. Although there is a strong correlation between heart rate and energy expenditure [2], heart rate monitors are limited in their capability to assess physical activity due to their inability to dissociate changes in heart rate from actual physical movement. The use of DLW provides precise information on total daily energy expenditure and can be used to determine physical activity energy expenditure when compared to an individual’s estimated resting energy expenditure [24]. Despite its accuracy, and recognition as the gold standard method for energy expenditure assessment, DLW is prohibitively expensive for use in large studies. Furthermore DLW provides solely a measure of energy expenditure and not physical activity or movement [19]. Nonetheless, DLW has been useful for the validation of other objective and subjective methods suitable for large-scale or free living use, such as motion sensors [14,19]. Motion sensors, such as pedometers and accelerometers, assess actual physical motion over time. Pedometers are essentially step counters that measure one dimension of physical activity; an individual’s accumulated movement over a given amount of time [23]. Accelerometers detect an individual’s acceleration in a programmed plane and relay the movement as counts over a specific time interval [7] Accelerometers are capable of measuring timing and duration of activity and have defined cut points which are related to the intensity of movement. Expectedly, accelerometers are often regarded as the standard for comparing self-reported physical activity to objective data [12]. However, accelerometers have been found to underestimate various forms of physical activity and are incapable or relaying information in regards to the type of activity performed [6]. Eighteen different accelerometers have been validated through research, of which the ActiGraph is the most highly regarded in its capability to assess physical activity [19]. The ActiGraph accelerometer is a measurement tool and assessment monitor widely used in physical activity research today [25]. The ActiGraph is an indicator of physical activity and an assessment of diseases and collects data objectively in order to ensure accuracy. The system allows for recording of the intensity and quantity of human activity for investigation of an individual's behavioral patterns. The amount of energy expenditure along with the individual's activity intensity is calculated by the system's developed and validated algorithms. These algorithms include cut-off points, which can then classify human activity as sedentary, lifestyle, light, moderate, and vigorous, and very vigorous.

In order to fully grasp why many individuals are incapable of sustaining long-term fitness goals and reaching the minimum recommendations for daily physical activity (150 minutes per week) [8], accurate data collection methods must be assessed and further developed. Previous research has illustrated how photographic recollection (photo recall), in combination with objective data collection, can be used to analyze length and intensity. Photo recall has been shown to analyze the context and type of physical activity as well, allowing for in-depth analysis of exercise [6]. As a result of technological advances and popular use of smartphones, the future of accurate objective data collection in conjunction with photo recall can be made both easy and accessible to a large population.

How much should an individual exercise to maintain a healthy lifestyle?

The American College of Sports Medicine [8] recommends that all healthy adults maintain a minimum of 150 minutes of physical activity each week at moderate intensity. American Heart Association recommends at least 150 minutes per week of moderate exercise or 75 minutes per week of vigorous exercise [17]. The American Diabetes Association recommends about 30 minutes a day, at least 5 days a week [6]. The Physical Activity Guidelines for Americans recommends all adults should avoid inactivity. For substantial health benefits, at least 150 minutes a week of moderate-intensity or 75 minutes a week of vigorous-intensity aerobic physical activity or an equivalent of moderate- and vigorous-intensity aerobic activity are recommended. The Physical Activity Guidelines for Americans also recommends muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups on 2 or more days a week, as these activities provide additional health benefits [18]. The Physical Activity Guidelines for Americans and the IPAQ-SF defines MPA as any physical activity similar to walking briskly such as playing tennis (doubles) or bicycling at a pace slower than 10 miles an hour.

How much do most people actually exercise?

Data from 2005 revealed that less than 50% of U.S. adults (49.1%) met the CDC/ACSM recommendation of physical activity. The data also showed that 59.6% of younger individuals (18-24 yrs.) met the recommendation, higher than the mere 39.0% of older adults (>65 yrs.). Individuals who possessed a college degree had the highest percentage (53.2%) in terms of meeting the CDC/ACSM recommendation [10].

Photo Recall and Accelerometers Potential to Promote Exercise and Increase Self Awareness of Physical Activity

Research has identified that individuals who are not aware of their lack of engagement in physical activity are less likely to adhere to exercise intervention and subsequently increase their overall physical activity. Research has also identified awareness of physical activity as an important motivational factor in increasing exercise frequency [22]. Photo recall and accelerometers provide for irrefutable data in regards to an individual's intensity, type and duration of physical activity. This objective data can then be compared to the individual's self-report of physical activity in order to determine their awareness of physical activity and to develop an appropriate intervention.

Objective:

The objective of this study was to determine if the participants' self-report of their moderate physical activity (MPA) using IPAQ-SF corresponds with the data collected from the ActiGraph accelerometer. Furthermore, this study is aimed at assessing the potential for photo recall to increase one's ability to accurately recall MPA.

Hypothesis:

1. It is hypothesized that most sedentary individuals misinterpret their length and level of physical activity, with sedentary meaning those who do not regularly engage in moderate-vigorous activity at a minimum of 150 minutes each week.

2. With photo recall, individuals may become more aware of their physical activity, which may lead them to alter their physical activity habits.

3. Participation in the Tailored Intervention Promoting Physical Activity (TIPPA) project and using the FitBit website, which displays physical activity in numerical and graphical form, will help sedentary individuals to be more aware of their physical activity.

METHODS

The TIPPA study was carried out in the Nutrition and Metabolic Testing Lab under the Department of Nutritional Sciences at University of Arizona from September 2012-April 2013. The study was approved by the Human Subject Protection Program at the university.

Participants

Forty-three individuals from the age of 18 to 40 (37 females and 6 males, mean age 22±5.5 years) participated in the study. All eligible participants provided written informed consent (Appendix II). A total of two participants dropped out of the program during the eight-week intervention. Post-intervention data for these participants were not collected. The reasons for the discontinued intervention (n=2) were lack of time and interest.

Recruitment

Participants were recruited using IRB approved flyers, holding recruitment sessions, and inviting classmates and friends to participate in the study. Participation in the study was completely voluntary but required participants to have a mobile phone with the capability of receiving text messages and access to a computer with Internet.

Study Design

The 8-week long TIPPA program is a study testing the effect of communication technologies, such as the Internet and text messaging, on individuals' awareness of their physical activity. This study consisted of participants wearing accelerometers for the first week (baseline period) and either meeting with a personal trainer every week for eight weeks or receiving emails about topics regarding physical activity, nutrition, exercise, and health-related topics. The subjects were randomized into either a control or experimental group in order to test whether the use of information and communication technologies provided benefits for promoting change in physical activity levels and behavior in sedentary adults.

Control Group

The control group met with a personal trainer (qualified member of the research team) for approximately 15 minutes to go over weekly lesson plans (Appendix III) for a period of eight weeks. These meetings were done in small groups or one-on-one, depending on the participant's preference. After the completion of the eight-week intervention, participants in the control group were asked to meet with the trainer and have post-intervention measurements.

Experimental Group

The experimental group participants received the same weekly lesson plans for eight weeks except the lessons were delivered via email. These participants were signed up for and encouraged to interact with one another through a provided TIPPA website (http://tippa.arl.arizona.edu/). Participants and personal trainers were allowed and encouraged to share messages, photos, and videos relating to physical activity on the website. During the eight-week intervention, weekly text messages were sent to the experimental group participants in order to encourage them to stay active throughout the week and reach their step goals.

Pre-Intervention

At the beginning of the first week of the study, participants met with the research team to receive baseline measurements, including height, weight, and blood pressure, and fill out surveys and questionnaires regarding their daily life patterns and current involvement in physical activity. Any individual that did not reach the minimum of 150 minutes of MPA each week was regarded as physically sedentary for the purposes of this study. During this initial meeting, the participants also received an ActiGraph accelerometer and asked to wear the accelerometer for a week and then return the device to the lab (physical activity baseline measurement). When the participants returned the accelerometer to the lab after a week, the data was downloaded from the device by the research team. The participants were also asked to complete a 3-minute step fitness test for assessment of their physical ability (data not included). During this second meeting, the participant's weight and body composition were measured with a scale, and each participant was also assigned to either the control or experimental group.

8-week Intervention

Lesson plans were delivered either in person to the control group participants by the personal trainer or via email to the experimental group participants. The first three lesson plans covered general topics in health, such as physical activity, nutrition, and forms of exercise. The fourth lesson was on hydration, basic nutrition, and their benefits. The research team helped set new goals for participants after a 25-minute presentation. The last three weeks of the 8-week intervention covered health, nutrition, and physical activity lessons, similarly to the first few weeks of intervention.

FitBit

The FitBit is a relatively new fitness tool with the capability to track steps, floors climbed, calories burned, and sleep activity. The FitBit website provides an online community for users to keep track of their physical activity along with features, such food logs and weight trackers. The online forums also provide the opportunity for individuals to connect with other

FitBit users and encourage one another to maintain their weekly goals and strive for improvements in physical activity.

Post-Intervention

The participants were asked to visit the lab after their eight-week intervention to repeat the surveys, questionnaires, and tests done during pre-intervention.

Questionnaire

IPAQ-SF was used during pre-intervention and post-intervention assessment and measurement procedures for the participants (Appendix I). The questionnaire was provided based on the rationale that it yielded data of personally estimated physical activity by the participating population. A total of seven questions were asked on the questionnaire. Questions considering the participant's involvement in vigorous, moderate, and low levels of activity were included to observe each participant's self-evaluation of physical activity. Participants were asked to complete the survey based only on the last seven days and to include only physical activities done for at least 10 minutes at one time. Vigorous activities were described as those that require difficult physical effort and are much more aerobic than normal. Moderate activities were referred to those that take medium physical effort and are somewhat more aerobic than most activities. Walking activities included those done at home, work, or any other traveling done for whatever purpose. Low-level or sitting activities were described as sedentary and requiring minimal physical effort. The participants were asked to fill out how much time they spent doing each level of activity during the past week. This questionnaire with the same exact questions was given again to the participants following their completion of the eight-week intervention. The purpose of this was to discover any change or improvement in the participants' self-assessment of their physical activity after eight weeks of intervention. The questionnaire administered twice at both the pre and post-intervention stages for photo recall participants in order to discover any influence of the 24-hour recall (see below) on the participants' self-reporting accuracy.

24-Hour Recall

Photographic recalls were used as an assessment tool in measuring the participants' awareness and estimations of their physical activity levels. A qualified member of the research team met with participants who were randomly selected to have the opportunity to participate in the 24-hour recall. These participants used their cellphone camera to capture images of physical activity they participated in the span of 24 hours. It was hypothesized that taking pictures with their cellphones allowed participants to keep track of their activities. The pictures were sent to the research team and evaluated during a one-on-one meeting the following day to assess the participants' ability to recall their physical activities. The meeting consisted of very specific and detailed questions asked to the participants regarding their activity from the previous day to discover a correlation (or lack thereof) between the participant's recall and the pictures taken with the cellphone camera. The reported duration of MPA (measured in minutes) per day before taking pictures, the duration of MPA after taking pictures, and the reported minutes of MPA from the photo recall during the pre and post-intervention were statistically compared.

ActiGraph

The ActiGraph's data analysis software, *ActiLife,* was used to collect data from the ActiGraph devices and to download and process the collected data in this study. *ActiLife* allowed for the determination of cut-off points to categorize activities. The ActiGraph measures the participants' activity level and intensity, which can be quantified using the Freedson Adult VM3 2011 cut points ActiGraph; light (0-2690 CPM), moderate (2691-6166 CPM), vigorous (6167-

9642 CPM) and very vigorous (9643- ∞ CPM) [1].The self-reported minutes obtained from the IPAQ-SF were compared against the ActiGraph-measured minutes to determine the accuracy of participants' self-assessments of physical activity.

Statistics

Statistical analysis was performed using STATA, data analysis and statistical software, version 11.2. Means and standard deviation (SD) were calculated. The significance level was set at 5%. Paired t-test was used to examine participants' weight and BMI. The difference in total MPA minutes recorded ActiGraph and self-reported IPAQ-SF was compared by a paired t-test and a Wilcoxon rank-sum test.

RESULTS

Anthropometric measurements were taken at both the pre and post-intervention stages. Paired t-test procedures were used to examine any significant differences between pre and post-intervention weights and BMIs. For weight, the t-statistic of 0.15 ($p=0.88$) reveals that there was not enough evidence to show a significant difference between pre and post-intervention weights of the participants. A similar result was found for the BMIs of the participants. It was concluded that there was not enough evidence of a significant difference between participants' pre and post-intervention BMIs, as supported by the t-statistic of 0.19 ($p=0.85$) (Table 1).

Table I. *Demographic characteristics of participants*

	Pre-Intervention/Baseline	*Post-Intervention*	*T-statistic*	*P-value*
Age				
Mean ± SD	22 ± 5.5			
Sex				
Male/Female	6/37	6/35		
Weight (kg)				
Mean ± SD	74.3 ± 20.9	75.0 ± 21.7	0.15	0.88
BMI				
Mean ± SD	26.6 ± 6.7	26.9 ± 7.2	0.19	0.85

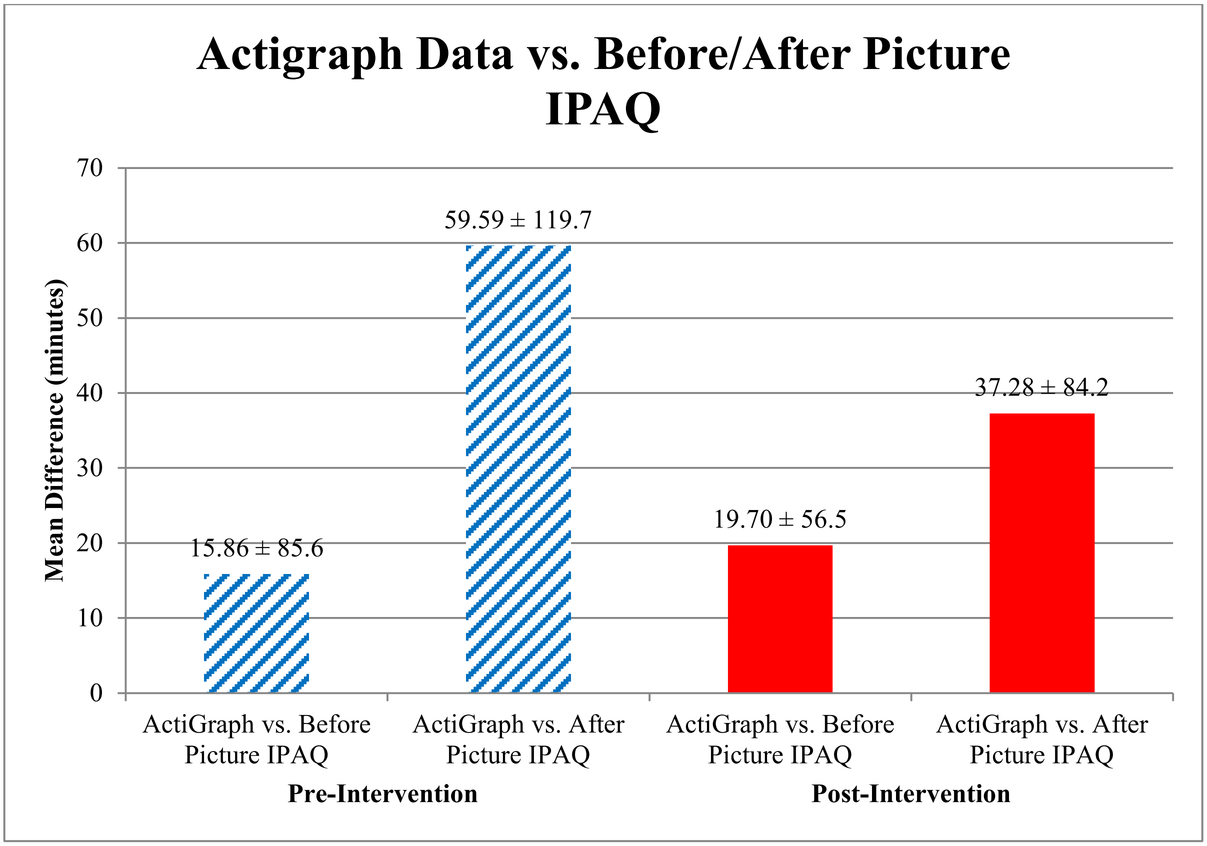
Comparison of the ActiGraph-measured minutes versus the IPAQ-estimated minutes

Table II describes the statistical results that were compared the ActiGraph-measured minutes and the IPAQ estimated minutes. As stated before, an IPAQ questionnaire was administered to every photo recall participant before and after the 24-hour recall to look for effects of this procedure. This process was done at both the pre and post-intervention of the study in order to identify the effect of the 8-week long physical activity intervention. A mean difference of zero served as the null hypothesis of the performed paired t-test. The alternate hypothesis was that the true difference in means was not equal to zero. If the p-value retrieved from the t-test was less than 0.05, the null hypothesis could be rejected. Before the photo recall at the pre-intervention stage, a t-statistic of -0.97 was obtained (p=0.34). The p-value, being larger than the significance level of 0.05, allowed for the conclusion that the null hypothesis could not be rejected. There was not enough evidence to state that the mean difference was not zero. In other words, the difference between the ActiGraph-recorded minutes and IPAQ-estimated minutes was not found to be statistically significantly different and could have been due to random variation. The confidence interval explained that there was a 95% chance that the true mean lied in the interval from -49.59 to 17.87. In the last analysis of after recall post-intervention, a marginally significant difference ($p=0.085$) was found between ActiGraph-recorded minutes versus IPAQ-estimated minutes. A marginally significant difference indicates that if the significance level were set at 10%, the result would be significant. At 5%, however, the result would not be significant. Thus, depending on the significance level, the post-intervention and after recall mean difference could be accepted as either significant or insignificant.

Table II. *Comparison of the ActiGraph-measured minutes versus the IPAQ estimated minutes*

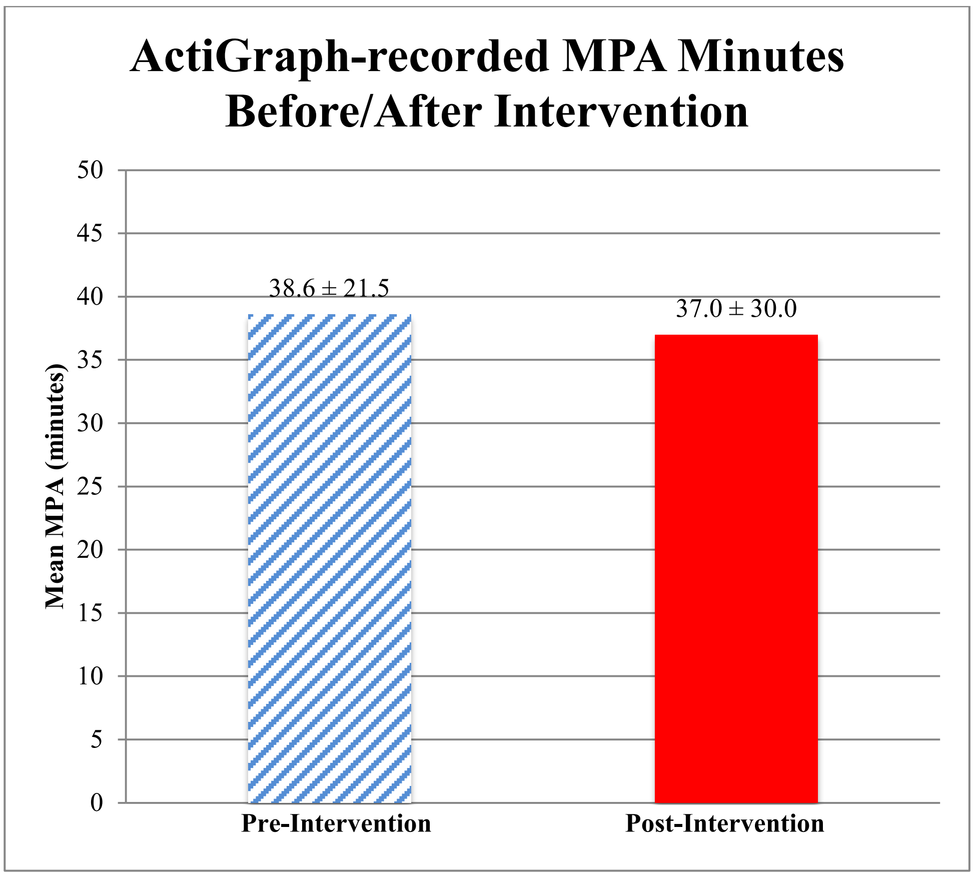
	Pre-Intervention	*Post-Intervention*
Before photo recall		
T-statistic	-0.97	-1.46
Degrees of freedom	23	21
P-value	0.34	0.16
Mean difference	-15.86	-19.70
Confidence interval (95%)	(-49.59, 17.87)	(-47.80, 8.41)
After photo recall		
T-statistic	-2.31	-2.19
Degrees of freedom	22	17
P-value	0.14	0.085
Mean difference	-59.59	-37.28
Confidence interval (95%)	(-113.00, 6.18)	(-73.23, -1.33)

Figure I. *Comparison of the mean differences of the ActiGraph-measured minutes versus the mean differences of the IPAQ-estimated minutes*



The striped-blue columns represent pre-intervention data comparing the mean differences between the minutes of MPA recorded by the ActiGraph with the before/after photo recall IPAQ data. The red columns represent the same comparisons except with the post-intervention data. There was only a marginally significant difference found between the post-intervention ActiGraph-recorded minutes of MPA and the post-intervention participants' self-reported minutes of MPA after the photo recall. The ActiGraph-recorded minutes were observed to be less than all four self-reported estimations (before/after photo recall for both pre/post-intervention), suggesting that the participants overestimated their duration of MPA. However, these overestimations were not considered significant, according to the performed paired t-test *analyses (Table II). Photo recall is not associated with any significant improvement in the participants' self-reported perception of MPA. For the pre-intervention portion, the mean difference between the ActiGraph-recorded MPA and before-picture IPAQ minutes was 15.86 minutes. This increased to 59.59 minutes after photo recall, showing an insignificant decrease in self-reported perceptual accuracy. For the post-intervention segment, the mean difference increased (marginal significance) from 19.70 minutes to 37.28 minutes after the photo recall was performed.*

Figure II. *Comparison of ActiGraph-recorded MPA pre and post-intervention*



The difference between pre-intervention ActiGraph-recorded minutes of MPA and post-intervention ActiGraph minutes was small and insignificant. The difference between the two means was less than 2 minutes, and a performed t-test revealed that the mean difference between *pre and post-intervention ActiGraph minutes was not significantly different from zero. This indicates that the participants actually did not change their physical activity levels after the 8-week intervention.*

DISCUSSION

Awareness of physical activity has been previously identified as a factor in helping individual's increase exercise frequency. It has also been found to be an attributing factor in one's ability to adhere to exercise intervention [21]. Of the 43 participants enrolled in this study, two participants dropped out during the intervention; thus, their data was excluded. 24 participants engaged in the photo recall pre-intervention, and 20 engaged in the photo recall post-intervention. According to pre-intervention ActiGraph-recorded activity, participants averaged around 39 minutes of MPA daily, indicating that on average, the participants were not sedentary according to the ACSM recommendation of 150 minutes MPA weekly [8]. The inability to successfully recruit participants that were truly sedentary is one shortcoming of this project. In future cycles of the TIPPA project, participants should be screened based on ActiGraph and IPAQ-SF data at baseline, rather than self-identification, in order to determine if they are eligible for the study. Post-intervention ActiGraph data indicated that participants did not increase their MPA levels and continued to average around 37 minutes of MPA daily after 8 weeks.

Previous research has indicated that the majority of individual's overestimate physical activity in self-assessments [13,14]. Although no significant mean differences were observed between ActiGraph MPA and self-reported IPAQ-SF MPA, participants over-reported MPA. The TIPPA study identified no significant increase in an individual's ability to accurately self-report MPA after photo recall and post-physical activity intervention. Accuracy was determined by comparing the mean difference between self-reported MPA and ActiGraph-recorded MPA minutes. Comparison of ActiGraph data pre-intervention and before and after photo recall determined no significant mean difference, indicating that the IPAQ-SF question 4 was able to accurately assess the participants' MPA levels. No significant mean difference was observed between the post-intervention and before photo recall reported MPA minutes. A marginally significant mean difference was observed between the after photo recall post-intervention ActiGraph and self-reported data, indicating that participants may have become less aware of their physical activity post-intervention and after photo recall. More data is needed in order to assess the potential for photo recall to increase one's ability to accurately recall and report MPA. Testing a larger sample of participants could reduce bias and provide better representation of the study.

Traditionally, ActiGraph cut points are broken down into six categories: sedentary, lifestyle, light, moderate, vigorous, and very vigorous. There are various examples of how these cut points can be redefined to assess different levels of physical activity depending on the model of ActiGraph and age range of participants. The Freedson Adult 2011 defined cut points were utilized in this study because they were tested on the same ActiGraph model and clearly define MPA [1]. However, the variance and wide range of cut point choices should be reevaluated and standardized in order to ensure that future studies all utilize the same cut points. It is important to use accelerometer cut points wisely when surveying physical activity levels in individuals.

Future studies should be aimed at exploring disparities between techniques utilized in photo recall and determining which techniques are capable of yielding the most accurate self-reported physical activity data. Photo recall as a tool to report physical activity is a fairly new idea, and there are various aspects of this data collection method that have not been fully tested or examined. This study looked at one aspect of photo recall—its potential to increase awareness of MPA. Overall, the TIPPA study did not focus on validation of data collection using the photo recall, and participants were simply encouraged to capture images of physical activity throughout the day. In order to more accurately assess MPA, participants should be instructed prior to intervention to capture any MPA that they engage in throughout the day. In conclusion, photo recall is a valuable tool for the assessment of physical activity because it allows for in-depth analysis of type and context of physical activity. Despite these obvious advantages, the ability of photo recall to increase personal awareness of physical activity is still need to be explored in future studies.

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APPENDIX I

The following questionnaire is the International Physical Activity Questionnaire administered to participants as part of pre-intervention and post-intervention data collection.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

APPENDIX II

The following lesson plans were delivered to participants electronically or verbally as part of the 8-week intervention.

Lesson #1

Lesson #2

Lesson #3

Lesson #4

Lesson #5

Lesson #6

Lesson #7

APPENDIX III

The following consent form was provided to and signed by all 43 participants.

Consent form