THE ACCURACY OF TECHNOLOGY IN ITS ASSESSMENT OF PHYSICAL ACTIVITY AND ITS EFFECT ON AN INDIVIDUAL'S BEHAVIOR: A CASE STUDY

By

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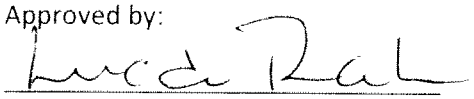

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The Accuracy of Technology in its Assessment of Physical Activity and its Effect on Individual's Behavior: a Case Study

By: Philip Ruiz

Abstract

Given the obesity epidemic, it is essential to find effective ways to modify behavior and reduce associated long-term health issues. Mobile technology is being used to provide feedback to individuals about both activity and consumption, but accuracy and effectiveness are still unclear. In this study, accuracy of the popular Fit Bit device was assessed along with correlations to behavioral changes. Initial calibration of steps taken, distance traveled on a track and on a treadmill, calories burned and floors climbed revealed errors of 0.5%, 12%, 26%, 21.3% and 0% respectively, indicating the Fit Bit is a reasonable tool for assessing activity in relative terms and providing feedback to users. Three subjects then utilized Fit Bits for 28 days to gain insight into whether technology-based feedback can affect behavior. Over the study, there was an average decrease in calories consumed, body weight, and percent body fat. The correlation between calories burned, activity score, and rating of perceived exertion suggested accuracy in subjects' self-assessment of physical activity. No correlation was found between rating of perceived consumption and calories consumed suggesting inaccuracy in self-assessing consumption and/or that external factors were involved. In sum, this technology appears promising for providing individualized feedback to optimize health.

Introduction

Proper exercise and diet can offer numerous physiological benefits and prevent many diseases such as diabetes or heart disease. However, according to Adler et al. (2009), 34.3% of Americans are obese, with a trend shifting the average Body Mass Index or BMI toward extremely obese. In fact 16% of children and 66% of adults are overweight or obese, and it is predicted that by 2015, 75% of adults will be overweight or obese (Adler et al. 2009). These trends lend themselves to a future with increasing obesity related diseases resulting in an increase in the already excessively high healthcare costs in the United States.

Given that over one third of United States adults are obese (35.7%), many otherwise preventable conditions are likely to surface in our population (CDC.gov). According to the CDC, obesity can cause diseases such as coronary heart disease, stroke, high blood pressure, atherosclerosis, type two diabetes, cancer, dyslipidemia, liver disease, gallbladder disease, sleep apnea, respiratory complications, joint damage, infertility and mental health conditions. These ultimately result in 147 billion dollars in healthcare costs associated with obesity, with the average obese person paying $1,429 more in healthcare costs per year than a person of normal weight (CDC.gov). These additional health care costs however are considered underestimated by many sources. For example according to Cawley and Meyerhoefer (2012), obesity raised annual medical costs by 2,741 dollars in 2005. This value does not even account for inflation, the increased complications associated with obesity, and the trend for increasing average BMI.

Childhood obesity has also more than tripled over the past thirty years, contributing to the trend in increased levels of adult obesity, healthcare costs, and occurrence of associated preventable diseases (CDC.gov). Increased obesity at such a young age can result in

atherosclerotic vessels earlier in life leading to myocardial infarction in younger and younger age groups compounding the long-term effects.

According to Canoy and Buchan (2006), obesity is an excess of body fat that leads to health complications. Currently the test used in society that can cheaply assess an individual's adiposity is the body mass index (BMI) which considers an individual's height and weight to determine their BMI (Canoy, Buchan 2006). It is important to note that an individual's BMI is an approximation of adiposity and merely a heuristic in suggesting unhealthiness associated with higher BMI's. Adiposity varies with many factors such as gender, ethnicity, and genetic predisposition; however BMI correlates "reasonably well with body fat mass and the risks of obesity related diseases" (Canoy, Buchan 2006).

Though obesity is prevalent in the United States it has become a global epidemic. In England and Scotland more than half of adults are overweight or obese and the number of individuals with BMI's that classify them as lean are diminishing (Canoy, Buchan 2006). This shift to the right in BMI and increase in adiposity are observed globally with both high and low income countries being affected (Canoy, Buchan 2006).

There is a consensus among many groups about the demographics of those who are obese. Though all ethnicities and classes have high levels of obesity, it is the consensus that obesity is more prevalent in individuals with less education and from families with lower occupational status (Canoy, Buchan 2006). It is important to note that in the past obesity was a problem associated with wealthier individuals (Canoy, Buchan 2006). However, it has been noted that as a country's income rises, obesity increases the most in the lower classes (Canoy, Buchan 2006). Though many minority groups in the United States have higher levels of obesity (except those of Chinese descent who demonstrate a lower proportion of obese individuals) the

groups that suffer the most are African Americans and Mexican Americans (Canoy, Buchan 2006). This trend is not just observed in the United States but is rather a global occurrence.

An important distinction must be made that increases in BMI in active populations are not always indicative of increases in adiposity (Canoy, Buchan 2006). Active and/or very physically fit populations often times are categorized as overweight or in some cases obese based upon their BMI, however, their increased weight is a result of a higher percentage by weight of lean mass (Canoy, Buchan 2006). This must be considered when using BMI as a tool for assessing populations since higher BMI's could merely be indicative of individuals with high amounts of lean mass.

Based upon current trends the obesity epidemic is only getting worse, lending itself to a future with increased healthcare costs and diseases that are preventable. However, there also exists considerable research exploring different approaches for dealing with obesity. Surgical approaches such as bariatric surgery or other forms of intervention may offer success; however there are increased costs, risks, and limitations to invasive surgical techniques. The best approach to this epidemic is a modification in an individual's behavior since it has been changes in behavior over time that have led to the obesity epidemic. This sort of behavioral change is not only more cost effective but also healthier for the individual and has less associated risks.

Obesity is defined by the CDC as a "caloric imbalance," where, "too few calories are expended for the amount of calories consumed," and is affected by, "various genetic, behavioral, and environmental factors." According to Canoy and Buchan (2006), obesity is a result of excess intake of calories, reduced energy expenditure, or a combination of both. Considering that obesity is increasing across all groups regardless of age, gender, or ethnicity, it seems that "pervasive environmental and/or behavioral changes underlie the epidemic" (Canoy, Buchan

2006). This is not to ignore the genetic component of obesity which can explain the "variation of the adiposity phenotype" observed across individuals (Canoy, Buchan 2006). However, manipulating an individual's genetics is not plausible, and often times an individual's environment may be too expensive to change; therefore, modification of behavior is a plausible and affordable approach and is the central focus of this thesis.

Despite the numerous scientific discoveries, and the general knowledge about health, many American's are still not practicing a healthy lifestyle. Individuals from poorer communities, from certain racial backgrounds, and those less educated tend to suffer more from obesity (Adler 2009). Many lack proper information or motivation, while others may simply lack a quantitative understanding of what they are consuming, or how much they are truly exercising.

Another problem is that many individuals begin regimens to lose weight yet end up quitting their program and returning to their previous lifestyle despite knowing that this previous regimen was clearly unhealthy. The Plutchik Impulsivity Questionnaire is a tool that determines aspects of an individual's personality based upon their responses to questions and has been adapted as a tool to assess the likelihood that individuals follow through with efforts to engage in healthier eating and more exercise (Tur 2013). According to Tur et al. (2013), this survey is a successful method of determining if an individual will follow through with their diet and exercise regimen suggesting that there is a psychological aspect in weight loss that extends beyond environment, income, or genetics when it comes to obesity.

There are two classical models that attempt to explain and resolve the epidemic of obesity (Adler 2009). The medical model approaches obesity by analyzing both genetics and lifestyle; however it is widely understood that the genetic aspect does not have as great an impact on an

individual's body mass and composition as their lifestyle does (Adler 2009). The public health model focuses on the external circumstances of an individual's environment which may include the physical structure of the environment, the information available, the food available, and the socio-spatial dialectic of the area which could affect an individual's behavior (Adler 2009). In this thesis, the public health approach will be taken in an attempt to curb this growing problem in the form of providing information about exercise and nutrition through technology, with the grand plan of creating a digital environment based on this information.

It has been documented that in younger age groups intervention has been successful in reducing adiposity (Waters et al. 2011). The review conducted by Waters et al. (2011) suggests that said interventions involved education, increased time for physical activity, and healthier nutrition options made available to children. It is important to note that this study also suggested that improvements were seen when children engaged in fewer "screen based activities," highlighting some of the inherent problems within our own culture of children spending too much time engaging in activities on computers, televisions, and cell phones. However, if technology, one of the key problems causing obesity, were to be used to engage individuals in physical activity with the use of applications for cell phones and computers then perhaps "screen based activities," could be used to actually combat the problem. For example these technological devices could be a source of engaging children (or adults) in physical activities as it integrates a portion of our culture (heavy use of electronics) with physical fitness.

"The use of self-monitoring as a tool to facilitate behavioral modification is common in many lifestyle-based weight loss interventions," and can be assessed by various forms of technology (Anton et al. 2012). One of the benefits of these forms of technology is that they provide, "direct feedback about… physical activity adherence levels, and thereby assist" the

individual "in real time decision making," (Anton et al. 2012). The benefits of this sort of technology is that it seeks to modify behavior and change unhealthy habits by allowing individuals to see firsthand whether they are actually adhering to the exercise regimen they believe they are following. According to Anton et al. (2012), all groups that used a computerized tracking system with greater frequency lost more weight (8.7 percent rather than 5 percent of initial body mass) than groups that did not use a computerized tracking system. This study also revealed that during the two year intervention period, use of computerized tracking systems was very high during the first year, and declined steadily over time revealing a loss of enthusiasm associated with either the weight loss plan or the technology (Anton et al. 2012).

Overall this study demonstrates that use of computerized tracking systems does have an effect. However there exists the problem of making the applications of these systems entertaining and competitive so individuals use them regularly. The ultimate goal of this thesis is to determine if computerized tracking systems when utilized by individuals and synched with smart phone applications, and social network sites such as Facebook can maintain high levels of usage by utilizing existing environments to foster adherence to use of these tracking systems. Such use of the tracking systems could be a potential way to connect individuals in a community hopefully reducing the drop off in use of these systems. Such a study could have applications to public health in reducing obesity.

To enable such a study there must be a device that is both reliable and convenient to use in assessment of an individual's activity. Also if it is to be useful to the general population, it needs to be affordable as well. The Fit Bit, produced by Fitbit Inc. is a widely used and seemingly convenient device (or set of devices) that costs 100 dollars and tracks steps taken, distance traveled, floors climbed, calorie expenditure, weight, and body composition. The Fit Bit

has many components that allow it to approximate physical activity. According to the producers of the Fit Bit, the Fit Bit comes with a built in barometer to determine the pressure, and uses this information to determine altitude to determine how much work an individual has done in climbing vertical distances. In addition the device utilizes an accelerometer to detect motion in three dimensions. Using an approximation based on information input by the individual (weight, height, and age) it also calculates the amount of calories burned.

The device also allows individuals to set weight goals and then approximates how many calories per day the individual can eat to reach that goal based on how quickly they want to lose weight (which can be selected by the individual when they create their profile). The Fit Bit adjusts the amount of calories that can be consumed for the day based on the individual's activity as detected by the Fit Bit. This device gives constant feedback, and alerts individuals when they are falling short of their goal for the day. In addition, the online site allows individuals to track other activities they have done that were not measured by the Fit Bit (such as weight lifting) and also enter the food that they have consumed. The site offers approximations of common foods for simple entrance of meal information, and also approximates calories burned for a myriad of activities. Combined with the Fit Bit scale, an individual can also monitor their body mass and percent body fat over time. In addition anytime the Fit Bit devices are brought within range of the home computer all of the data collected is uploaded to the individual's profile.

It is clear that the Fit Bit has the potential to offer excellent feedback to individuals, which is why this device was chosen for testing. By using a series of case studies, the goal of this thesis is to test the device and see if it is a suitable, accurate, and convenient tool for assessing individual's activity levels and consumption.

Materials & Methods

Case Studies

The Fit Bit was first calibrated in its measurement of steps taken, floors climbed, distance traveled, and calories burned. The Fit Bit Aria Scale was not calibrated in its measurements of weight and percent body fat. Three college age (21-24 years) male subjects were then given Fit Bits and received a tutorial on how to use them, and how to use the online Fit Bit tools. The subjects were then instructed to use the Fit Bit for the 28 day testing period. The subjects were to enter the food they consumed, and the Fit Bit site would then utilize a database of common foods and approximate calories consumed, as well as how many grams of protein, fat, fiber, carbohydrates and sodium were consumed. This data was collected to assess any trends and to determine the viability of the Fit Bit as a tool to assess activity and consumption. Finally activities not assessed by the Fit Bit (swimming, anaerobic exercise such as weight lifting) were recorded in the Fit Bit activity journal. These activities affected the Fit Bit's activity score for the day. All of the collected data was maintained in a spreadsheet for each subject. Throughout the study subjects received verbal encouragement to continue utilizing the technology and entering information in the online site.

Fit Bit Data Collection Calibration

The following describes the data which was collected by the Fit Bit, and the test methods used to assess the accuracy of the data collected. For the following assessments it was assumed that a walk is roughly 2 miles per hour, a jog is 4 miles per hour and a run is 6 miles per hour. Each test (for steps taken, distance traveled, floors climbed and calories burned) was completed at least 3 times each at a different pace. Prior to and after each test the Fit Bit was synched (i.e.

current information assessed by the Fit Bit was uploaded to an online profile) and the difference in information was used to determine the data for the testing periods. The Fit Bit was clipped on the waistband on the left side for each test.

1. Steps Taken

   The number of steps taken were counted and compared to those reported by the Fit Bit. For each trial a short distance (to minimize counting error) of .37 miles was traveled. A percent difference and an average percent difference were calculated in order to assess the Fit Bit's ability to count steps.

2. Floors Climbed

   According to the producers of the Fit Bit, a floor is ten feet. In order to assess the accuracy of floors climbed, the stair cases of Koffler at the University of Arizona were used. Ten stairs were measured using a meter stick and an average stair height was calculated. The number of stairs were then counted and multiplied by the stair height in order to determine the vertical distance traveled. This measurement was converted to feet, and divided by ten feet in order to determine the number of floors climbed. This value was compared to the number of floors climbed according to the Fit Bit and a percent deviation and average percent deviation was calculated.

3. Distance Traveled

   Distance traveled was assessed by using the indoor track at the University of Arizona Recreation Center. Each lap on the outside lane of the track at the University of Arizona Recreation Center is $1/11^{th}$ of a mile. Eleven laps (1 mile) were traveled and compared to the distance the Fit Bit determined was traveled. In addition three more trials (each trial at the aforementioned paces) were completed on the treadmill ergometer at the University of Arizona's exercise physiology lab in Gittings. The distance traveled was recorded and compared to the distance traveled according to the Fit Bit. Percent deviation and average percent deviation were calculated.

4. Calories Burned

   Calories burned were assessed using the treadmill ergometer in the exercise physiology lab at the University of Arizona. This treadmill had been verified as being within 2% accurate of caloric expenditure as determined by a metabolic system during experimentation in the PSIO 425 course (Keen, Measurement and Evaluation of Physiological Function). The calories burned according to the treadmill were calculated and compared to the calories burned according to the Fit Bit. Percent deviation and average percent deviation were calculated.

5. Body Fat Composition (Fit Bit Scale)

   The Fit Bit Aria Scale determined weight and the percent body fat of the subject, collecting this information every day in the morning after the subject woke up from sleep. This information was correlated for the 28 day test period.

Behavioral Data

Behavioral data was collected during this time period. This included a rating of perceived exertion, and rating of perceived consumption, which could then be compared with the actual levels of both activity and consumption collected through use of the Fit Bit. Perceived exertion for the day was rated on a scale of 1-10 with the different ratings defined as follows:

1: Subject believes they did no physical activity that day.

2: Subject only engaged in incidental physical activity

3: Subject engaged in much less than usual physical activity that day

4: Subject engaged in less than usual physical activity that day

5: Subject engaged in a moderate level of physical activity that day

6: Subject engaged in slightly more physical activity than a normal day

7: Subject engaged in a fair amount of physical activity that day

8: Subject engaged in more than usual physical activity that day

9: Subject engaged in a great amount of physical activity that day

10: Subject was extremely physically active

Perceived consumption was rated on a 1-10 scale as follows.

1: Subject believes their consumption was extremely unhealthy

2: Subject believes their consumption was much more unhealthy than usual

3: Subject believes their consumption was more unhealthy than usual

4: Subject believes their consumption was slightly more unhealthy than usual

5: Subject believes their consumption was about as healthy as usual

6: Subject believes their consumption was slightly more healthy than usual

7: Subject believes their consumption was fairly more healthy than usual

8: Subject believes their consumption was more healthy than usual

9: Subject believes their consumption was much more healthy than usual

10: Subject believes their consumption was extremely healthy

The subjects were instructed to rate their exertion and consumption in relative terms based on what their goals were.

Results

Part I: Case Study Information

The subjects chosen for the case study were those available at the University of Arizona which were college age males. The subjects had similar heights and varying body weights. Each subject had a very different background from strength enthusiast to bodybuilder to fitness enthusiast. The information collected for every subject over the 28 day study period is available in Appendix I.

Table 1: Case Study Individual Data

Subject	Age (Years)	Starting Wt. (lbs.)	Height (in.)	Goal	Description
1	21	172.2	69	Maintain Weight	Very active male weightlifter attempting to gain strength
2	21	159.7	69	Maintain Weight	Fitness enthusiast attempting to get in better shape
3	24	255.5	71	Gain Weight	Bodybuilder attempting to gain lean mass

Table 1 depicts basic information about each subject prior to the study including age, weight, height, goal and a description of the subject and their background in terms of activity.

Summary for Part I: Case Study Information

Table 1 depicts basic information about the subjects in this case study. The subjects are all college age males (ages 21-24) with fair to extensive backgrounds in physical fitness and training. None of the subjects have goals of losing weight which may mean their responses and changes in behavior in response to the Fit Bit may not represent those changes that would occur in the general population.

Part II: Field Tests Assessing the Accuracy of the Fit Bit

Tables 2 through 6 and Graph 1 depict the calibration data of the Fit Bit. The accuracy of the Fit Bit in terms of steps taken, distance traveled on a treadmill, distance traveled on a track, floors climbed and calories burned were tested at paces of a walk (2 miles per hour), a jog (4 miles per hour), and a run (6 miles per hour). Percent deviation and average percent deviation were calculated for each test. For steps taken, distance traveled on a treadmill, distance traveled on a track, floors climbed and calories burned there was an average percent error of .49, 26, 12, 0, and 21.3 respectively.

Table 2: Steps Taken According to the Fit Bit and Those Measured Experimentally

Trial (Speed)	Actual Steps Taken	Fit Bit Steps Taken	Percent Deviation
1 (Walk)	685	681	0.58
2 (Jog)	552	553	0.18
3 (Run)	431	434	0.69
		Average % Deviation	0.49

Table 2 depicts the steps taken according to the Fit Bit and the actual steps taken for 3 trials completed at a walk, jog, and run. The steps the Fit Bit determined were taken were compared to the actual steps taken, and an average percent deviation was determined to be .49% for all 3 trials.

Table 3: Distance Traveled According to the Fit Bit and Those Measured Experimentally Using the Treadmill Ergometer

Trial (Speed)	Distance Traveled (Treadmill)	Fit Bit Distance Traveled	Percent Deviation
1 (Walk)	0.5	0.43	14
2 (Jog)	0.5	0.35	30
3 (Run)	0.5	0.67	34
		Average Percent Deviation	26

Table 3 depicts the distance traveled on the treadmill ergometer (.5 mile) and the distance traveled according to the Fit Bit. Percent deviation was calculated and an average percent deviation was determined to be 26% between distance traveled on the treadmill ergometer and distance traveled according to the Fit Bit for all 3 trials.

Table 4: Distance Traveled According to the Fit Bit and Those Measured Experimentally Using the University of Arizona Track

Trial (Speed)	Distance Traveled (miles)	Fit Bit Distance Traveled	Percent Deviation
1 (Walk)	1.0	0.87	13
2 (Jog)	1.0	0.94	6.0
3 (Run)	1.0	0.84	16
4 (Run)	1.0	0.87	13
		Average Percent Deviation	12

Table 4 depicts the distance traveled on the University of Arizona recreation center track (1 mile) and the distance traveled according to the Fit Bit. Percent deviation was calculated and an average percent deviation was determined to be 12% between distance traveled on the track and distance traveled according to the Fit Bit for all 3 trials.

Table 5: Floors Climbed According to the Fit Bit and Those Measured Manually

Trial (Speed)	Actual Floors Climbed	Fit Bit Floors Climbed	% Deviation
1 (Walk)	6	6	0
2 (Jog)	6	6	0
3 (Run)	6	6	0
		Average % Deviation	0

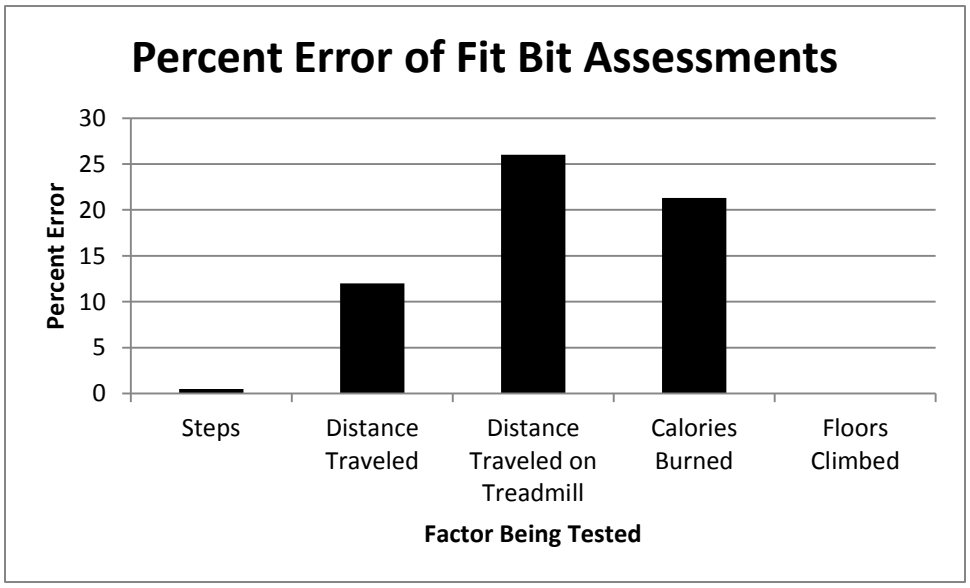
Table 5 depicts the floors climbed according to the Fit Bit, and the actual floors climbed. Actual floors climbed were calculated by manually counting the steps and multiplying this value by step height and then dividing by 10 feet. Percent deviation and average percent deviation were calculated and determined to be 0% over the three trials.

Table 6: Calories Burned According to the Treadmill Ergometer and According to the Fit Bit

Trial (Speed)	Calories Burned Treadmill	Calories Burned Fit Bit	Percent Deviation
1 (Walk)	45.5	53	14.2
2 (Jog)	41.2	60	31.3
3 (Run)	71	87	18.4
		Average Percent Deviation	21.3

Table 6 depicts the calories burned according to the treadmill ergometer (accuracy verified to be within 2% by a metabolic system) and the calories burned according to the Fit Bit. The average percent deviation was calculated and determined to be 21.3% across the three trials.

Graph 1: Percent Error of the Fit Bit for All Tests



Graph 1 depicts the average percent error of the Fit Bit in its assessments. The assessments tested were steps taken, distance traveled on a track, distance traveled on a treadmill, calories burned, and floors climbed which demonstrated average percent errors of .49, 12, 26, 21.3, and 0 respectively.

Summary for Part II: Field Tests Assessing the Accuracy of the Fit Bit

Tables 2 through 6 and Graph 1 depict the calibration data of the Fit Bit. Overall for steps taken, distance traveled on a treadmill, distance traveled on a track, floors climbed and calories burned there was an average percent error of .49, 26, 12, 0, and 21.3 respectively. This data suggests that though the data the Fit Bit provides may not always be accurate, it is at least reliable and can give relative feedback to the user about trends in distance traveled (on a treadmill or track) or calories burned. For steps taken and floors climbed the data was quite accurate and precise suggesting the ability of the Fit Bit to assess these variables.

Part III: Data Collected from the Case Study Subjects

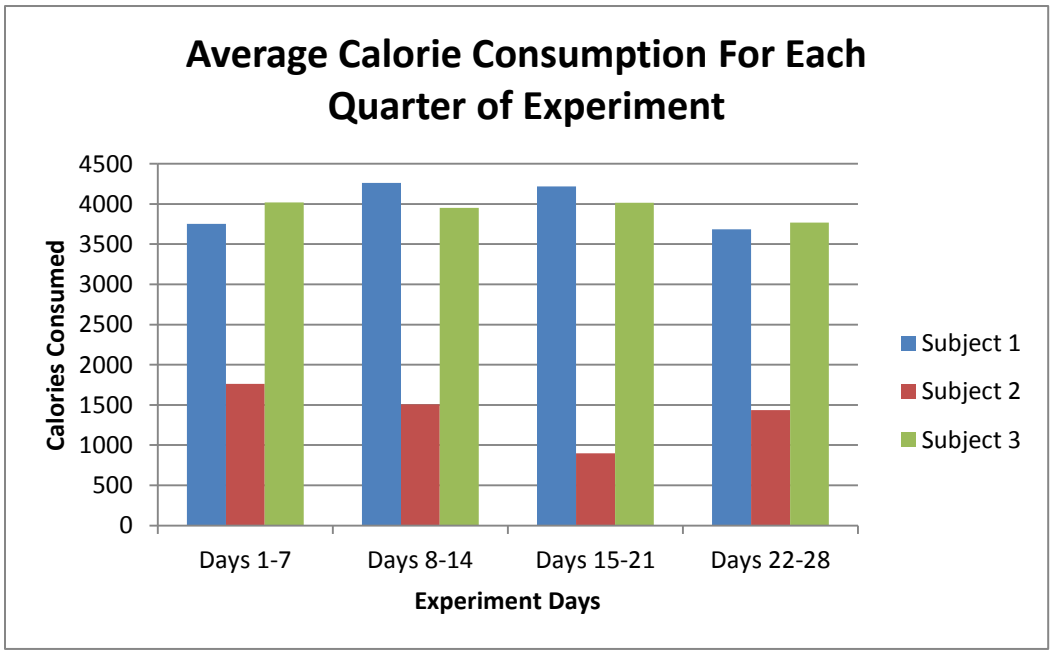
Table 7 and Graphs 2 through 8 depict the data collected from the subjects throughout the 28 day case study. On average subjects had a decrease in body fat of .6% and weight of .8%. Across all subjects when comparing the first and fourth quarter of the experiment there was a decrease in overall consumption of calories for each subject. A weak correlation was seen between rating of perceived exertion, the Fit Bit determined activity score, and calories burned. There was no correlation seen between rating of perceived consumption and calories consumed.

Table 7: Body Fat Percentage and Weight of Subjects at Beginning and End of Experiment With Average Percent Changes

Subject	% Body Fat Start	% Body Fat End	% Body Fat Change	Weight Start (lbs.)	Weight End (lbs.)	Percent Change in Wt.
1	9.8	9.1	-0.7	172.2	177.4	3.0
2	13.5	13.1	-0.4	159.7	157.4	-1.4
3	25.6	24.8	-0.8	255.5	245.1	-4.1
		Average % Change	-.6		**Average % Change**	-.8

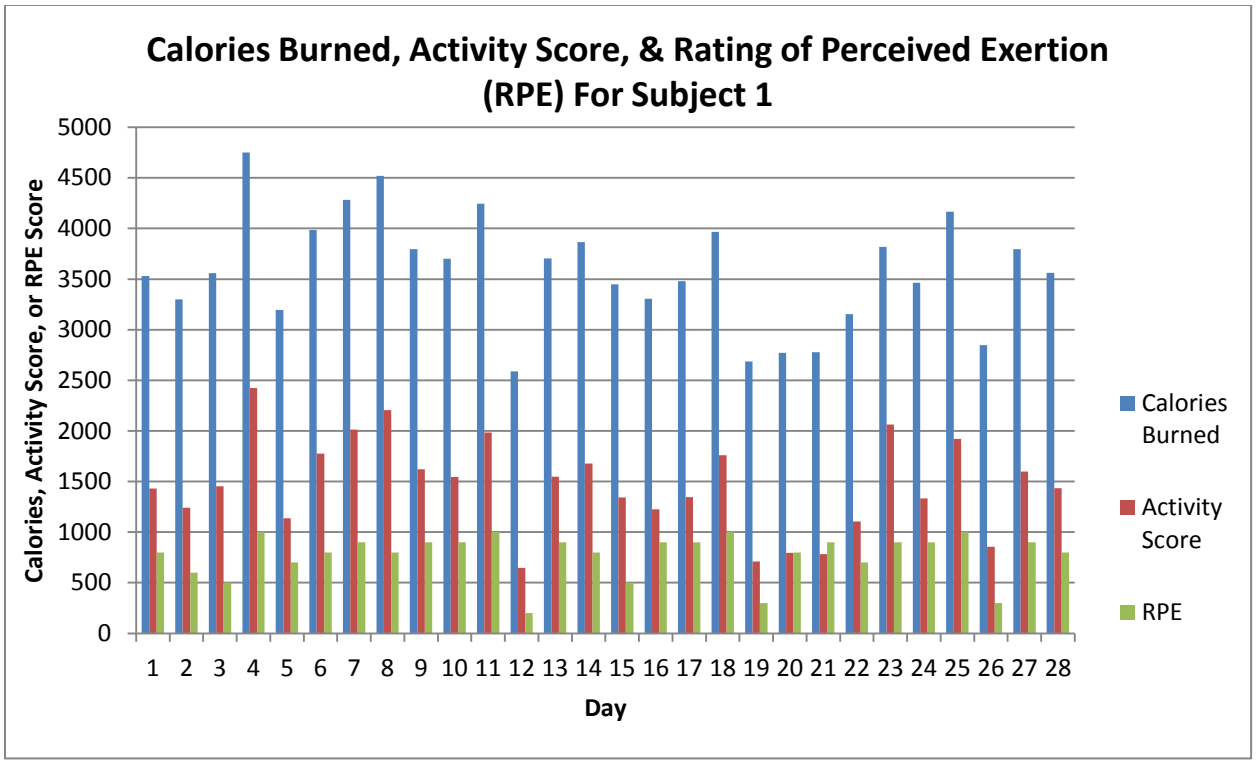
Table 6 depicts the percent body fat and weight of each subject at the beginning and end of the study, as well as the average percent change for each of these variables. Body fat had an average percent decrease of .6% and weight had an average percent decrease of .8%.

Graph 2: Average Calorie Consumption for Each Quarter of the Experiment



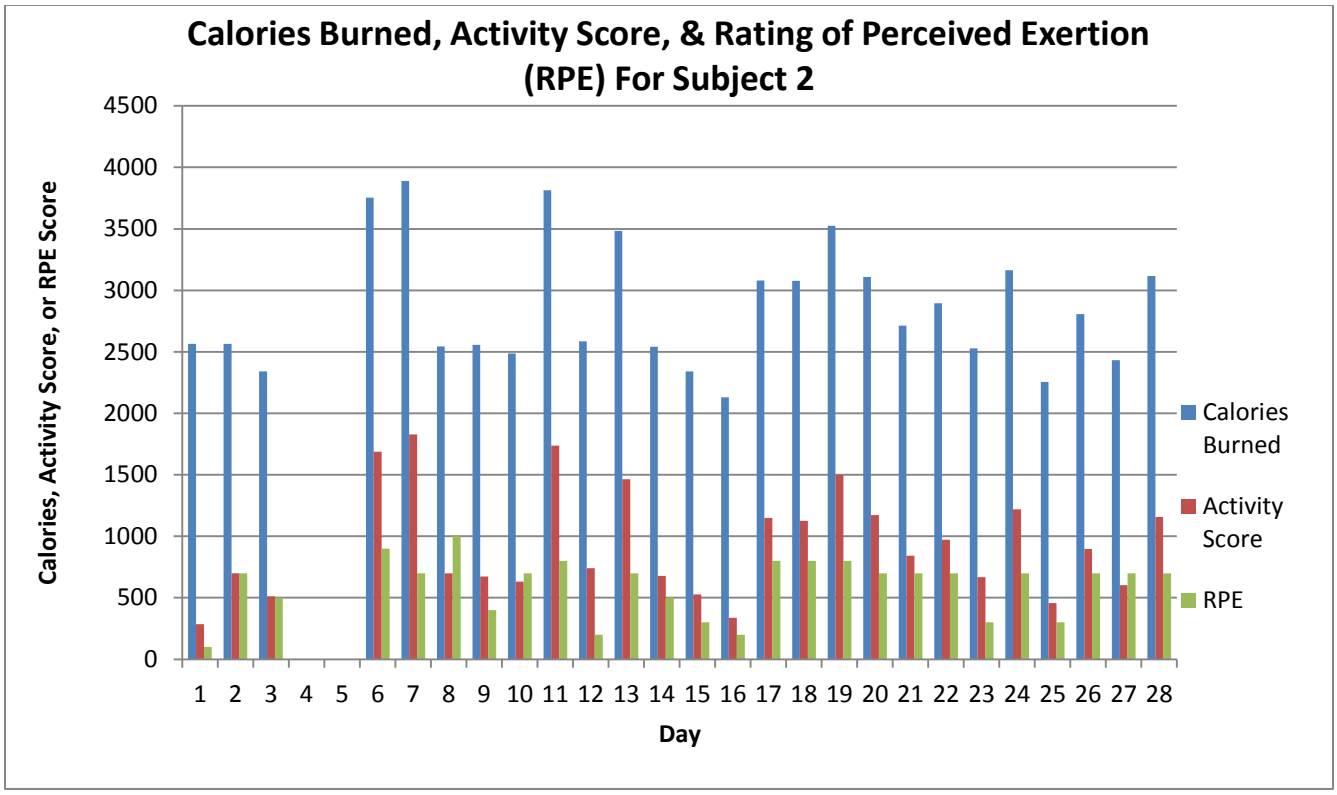
Graph 2 depicts an average of the calories consumed for each quarter of the 28 day experiment for each subject.

Graph 3: Calories Burned, Activity Score and Rating of Perceived Exertion over the 28 Day Period for Subject 1



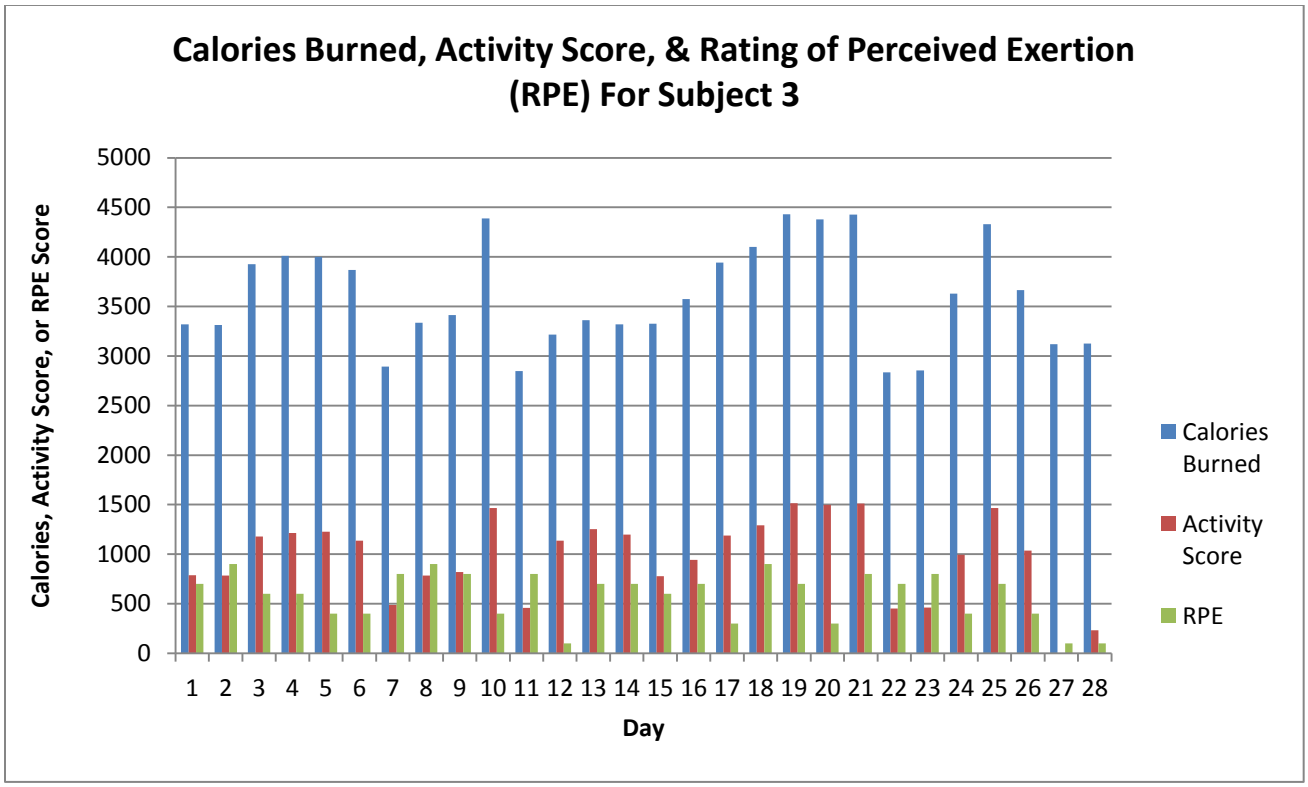
Graph 3 depicts the calories burned, the Fit Bit determined activity score (a compilation score based on steps taken, distance traveled, floors climbed, and activities recorded on the Fit Bit site) and the rating of perceived exertion over the 28 day period for Subject 1.

Graph 4: Calories Burned, Activity Score and Rating of Perceived Exertion over the 28 Day Period for Subject 2



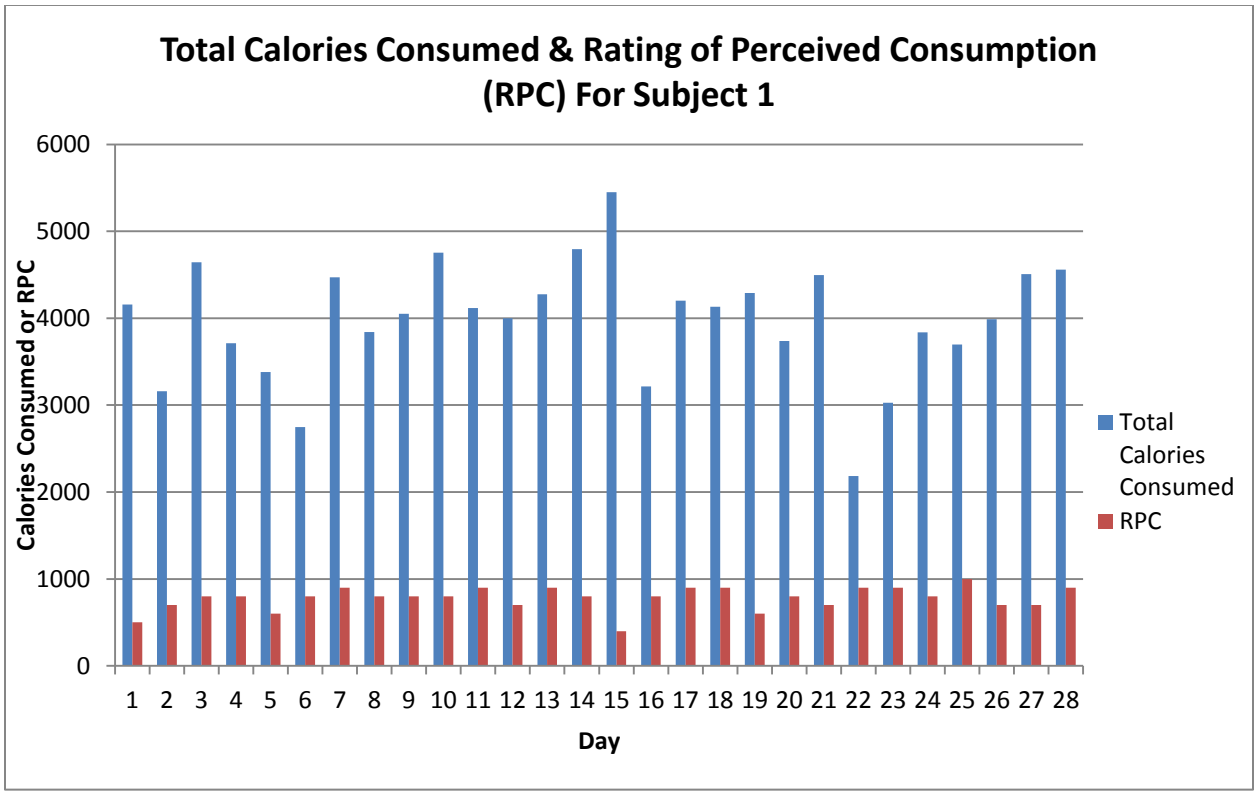
Graph 4 depicts the calories burned, the Fit Bit determined activity score (a compilation score based on steps taken, distance traveled, floors climbed, and activities recorded on the Fit Bit site) and the rating of perceived exertion over the 28 day period for Subject 2. No data was collected on days 4 and 5 for Subject 2 due to a misplacement of the equipment.

Graph 5: Calories Burned, Activity Score and Rating of Perceived Exertion over the 28 Day Period for Subject 3



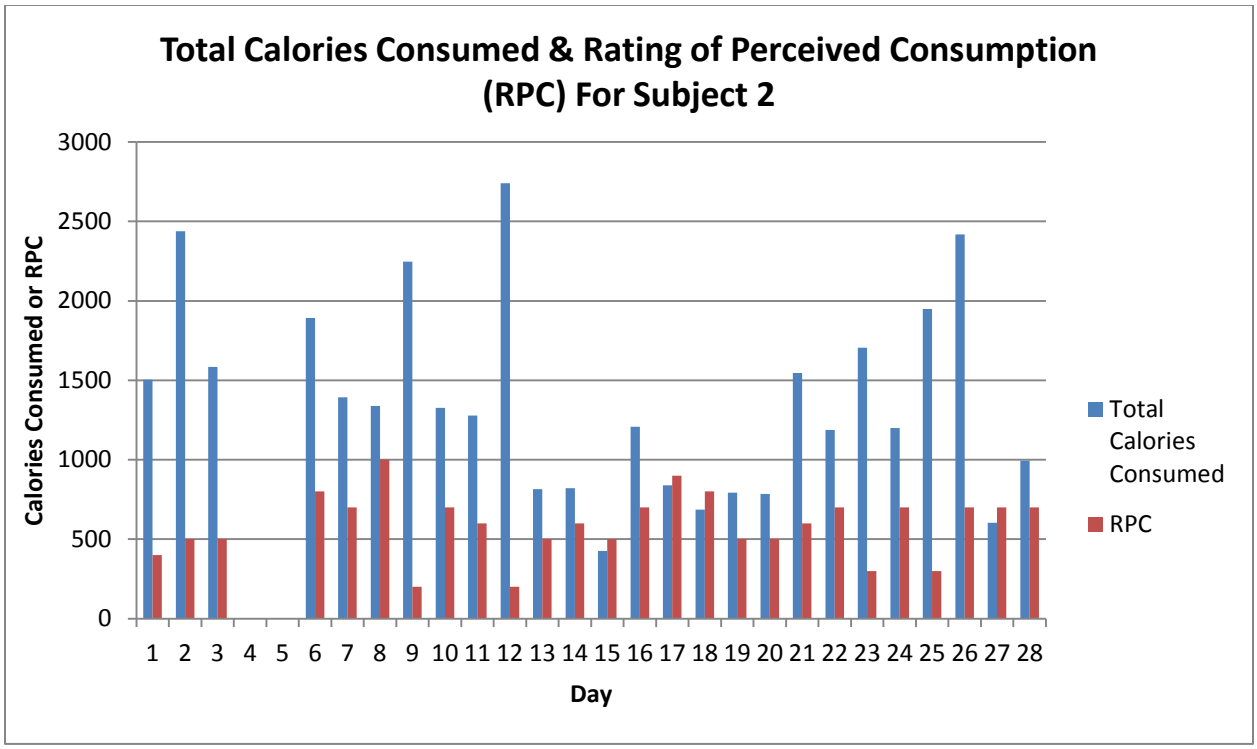
Graph 5 depicts the calories burned, the Fit Bit determined activity score (a compilation score based on steps taken, distance traveled, floors climbed, and activities recorded on the Fit Bit site) and the rating of perceived exertion over the 28 day period for Subject 3. On Day 27 the subject did not wear the Fit Bit and thus there is no associated activity score, and the calories burned reflect those burned only at basal levels.

Graph 6: Calories Consumed and Rating of Perceived Consumption over the 28 Day Period for Subject 1



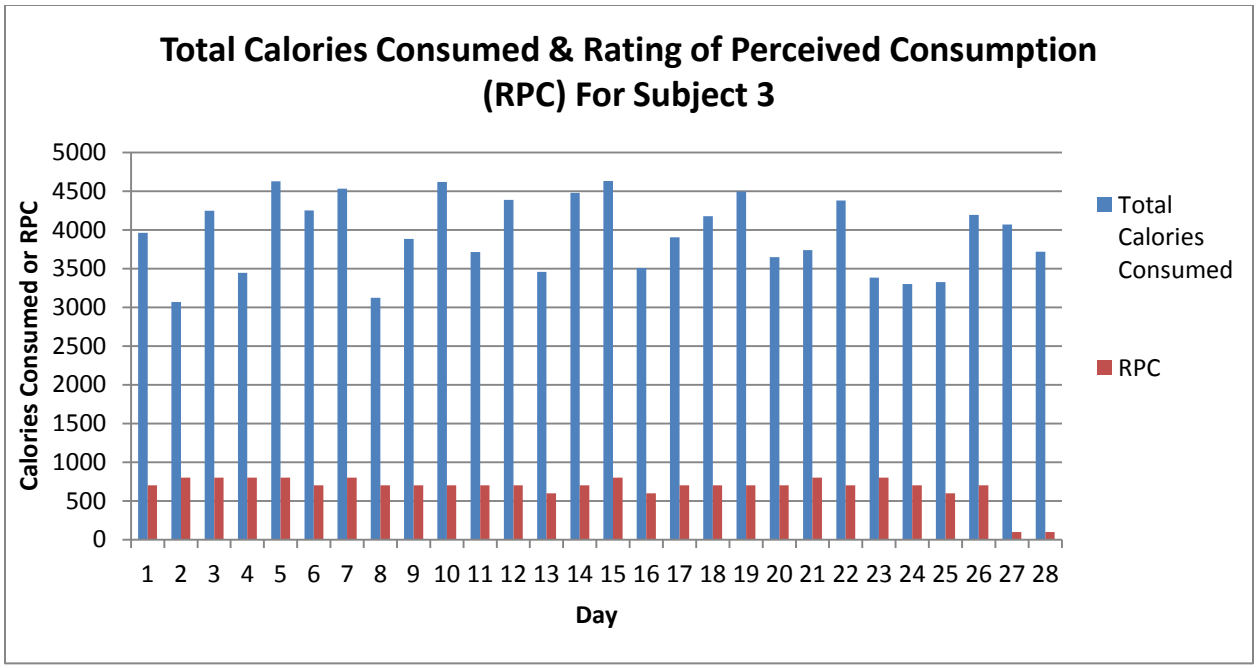
Graph 6 depicts the calories consumed and rating of perceived consumption (RPC) over the 28 day period for Subject 1.

Graph 7: Calories Consumed and Rating of Perceived Consumption over the 28 Day Period for Subject 2



Graph 6 depicts the calories consumed and rating of perceived consumption (RPC) over the 28 day period for subject 2. No data was collected on days 4 and 5 due to a misplacement of the equipment by the subject.

Graph 8: Calories Consumed and Rating of Perceived Consumption over the 28 Day Period for Subject 3



Graph 6 depicts the calories consumed and rating of perceived consumption (RPC) over the 28 day period for Subject 3.

Summary for Part III: Data Collected from the Case Study Subjects

Table 7 and Graphs 2 through 8 depict the data collected from the subjects throughout the 28 day case study. On average subjects had a decrease in body fat of .6% and weight of .8% suggesting that subjects lost weight based on use of the Fit Bit or based on some external factor. To verify this conjecture control groups and a larger sample would be needed. Across all subjects, when comparing the first and fourth quarter of the experiment, there was a decrease in overall consumption of calories which could have been a result of use of the Fit Bit food journal.

A weak correlation was seen between rating of perceived exertion, the Fit Bit determined activity score, and calories burned suggesting that subjects have a vague idea of how much activity they are actually engaging in. There was no correlation seen between rating of perceived consumption and calories consumed. This could reveal that subjects do not understand what they are consuming quantitatively, or that they utilize a different method (not based on calories consumed) of determining healthy consumption.

Discussion

Part I: Accuracy of the Fit Bit

Overall the Fit Bit demonstrated its usefulness as a tool, and its limitations in assessing an individual. In terms of accuracy it seems that the Fit Bit has a great enough level of accuracy to give feedback to the individual. In terms of steps taken the Fit Bit demonstrated extremely low percent deviations between the actual number of steps taken, and the steps taken according to the Fit Bit. As seen in Table 1 the average percent deviation across all trials was .49%. This low value reveals the accuracy of the Fit Bit, and it can be seen in Table 1 that this low percent deviation was seen across all trials suggesting that the Fit Bit can accurately count the number of steps taken regardless of the pace of exercise.

In terms of distance traveled, the data in Table 2 and Table 3 suggest that the accuracy of the Fit Bit is a bit lower. In Table 2 (the treadmill data) and 3 (the track data) the average percent deviation was 26% and 12% respectively. The large difference between these two values could be due to the fact that using a treadmill affects the Fit Bit's ability to determine the distance traveled since one is not actually moving but staying relatively in place while using this piece of equipment. This assertion is supported with the data in Table 2 as the Fit Bit tended to

underestimate to a greater extent distance traveled for every trial on the treadmill. Regardless, the large difference of 12% makes the Fit Bit not the best tool for determining distance traveled, however it can give a general approximation that could be used for trends in distance traveled which could give valuable feedback to the user. Perhaps the overall error in this measurement could be based upon how the Fit Bit calculates distance traveled. If the Fit Bit is using the number of steps taken (which are accurately counted) and multiplying it by an average stride length this could lend itself to error since no individual has a standardized stride length. It also seems that the Fit Bit can determine distance traveled more accurately for walking paces. As seen in Tables 2 and 3 there is a larger percent difference between actual distance traveled and the distance traveled according to the Fit Bit for the jog and run trials suggesting that the Fit Bit is a better tool for assessing everyday activities that involve walking, but not more strenuous activities that require a faster pace of movement.

The most accurate aspect of the Fit Bit is determining floors climbed. As seen in Table 4 the Fit Bit had a zero percent deviation between actual numbers of floors climbed and the Fit Bit determined number of floors climbed. This reveals its accuracy in determining the vertical distance traveled when ascending stairs. The Fit Bit also does not count descending stairs as climbing a floor, further promoting its accuracy in assessing floors climbed. One possibility for such a high accuracy could be that the Fit Bit only reports floors climbed to the nearest whole number. In this way it is not possible to determine if the Fit Bit was off by a fraction of a floor. Regardless at each speed the Fit Bit had a zero percent deviation between measured floors climbed and actual floors climbed suggesting its accuracy in this assessment.

The Fit Bit's ability to determine calories burned seems relatively accurate for such a difficult assessment. It was assumed that the treadmill ergometer was accurate in its assessment

of calories burned as this piece of equipment was tested by the exercise physiology laboratory at the University of Arizona, and demonstrated only a 2% difference from the metabolic system in terms of calories burned (Keen, Measurement and Evaluation of Physiological Function). As demonstrated in Table 5, the Fit Bit demonstrated an average percent deviation of 21.3% between its measure of calories burned, and the treadmills measure of calories burned. Though this value seems rather large, assessing calories burned is a highly complex calculation that requires a metabolic system for accurate values. For this reason, and for all the approximations that must be taken in order to approximate calories burned, it seems that the Fit Bit is a reasonable tool for demonstrating at least trends in energy expenditure (burned calories). The Fit Bit overestimated calories burned for each trial suggesting a systematic error in its method of determining calories burned. However, the Fit Bit was able to acknowledge exercise intensity and adjust the number of calories burned based on the pace of exercise as demonstrated in Table 4. Overall it seems that though the data may not be completely accurate, it does give trends in calories burned which would be valuable to users of this piece of equipment. For greater accuracy this portion of the experiment could be repeated, but instead the number of calories burned according to the Fit Bit could be compared to the number burned according to a metabolic system although this would be time consuming and costly.

For all tests that assessed the accuracy of the Fit Bit, improvements could be made. The primary improvement could be an increase in the number of trials for more certain assertions to be made. It must also be acknowledged that the paces of walk, jog, and run were approximated. Overall though it seems that the Fit Bit is accurate enough to provide feedback to the user about their daily activities, even in the less accurate assessments such as distance traveled and calories burned. The important aspect is that the Fit Bit observes trends in behavior, and the Fit Bit was

able to reveal increases in calories burned for more intense exercise, and roughly accurate distances traveled. The detailed yet not accurate nature of the Fit Bit is useful in providing data to the individual to demonstrate trends in their behavior, yet not useful for exact values (except in the instances of floors climbed and steps taken). For this reason it would be appropriate to use this device for additional experiments since it can give repeatable and detailed feedback to individuals.

Part II: Subject Behavior

It is first important to discuss the subjects' attitudes toward the Fit Bit. Initially it was observed that each subject had great enthusiasm toward the piece of technology. During the first quarter of the study subjects meticulously used the Fit Bit and the online tools to record what was consumed and the activities that the Fit Bit could not rate. This was completed without constant verbal reminders, and it was observed that there was a competitive nature among the subjects for who could travel the largest distance and take the most steps in a week. In fact the Fit Bit site connected the subjects and ranked them so that they could observe the "leaderboards" in steps taken furthering this competitive aspect. There was clear enthusiasm and competition amongst the subjects. The nutrition information entered seemed reasonable and was always entered in a timely manner (at least before the end of the day) at the beginning of the study.

Towards the end of the study there was a complete lack of enthusiasm for using the Fit Bit and its online tools. Constant verbal encouragement was necessary to get the subjects to use the online tools. For the most part the subjects wore the Fit Bit, however occasionally they would forget and needed additional reminding and encouragement. In the food diary it seems that some of the recorded food was unreasonable and recorded a day or so later based off of the

subject's memory. There is a major limitation of the Fit Bit's approximation of the nutrition profile of certain foods as well. The subjects in this study tended to cook their own food, and the approximations that the Fit Bit site used were often values based on food from fast food restaurants resulting in exaggerated values of calories consumed and inaccurate nutrient profiles. Individuals that prepared their own home made food (which is typically healthier than fast food alternatives) would be unable to maintain an accurate food diary with the Fit Bit's approximations. This created distrust toward the Fit Bit since the approximations that the subjects believed were incorrect in calorie consumption made them suspicious of the accuracy of the other measurements. This could have possibly led to the decline in enthusiasm for the Fit Bit as the subjects demonstrated attempts to consume healthier foods and were disappointed with the approximations the Fit Bit gave.

Overall though the attitude toward the Fit Bit over time was very similar to that demonstrated in the Pounds Lost Study (Anton et al. 2012). According to this study use of the computerized tracking system declined steadily over time albeit in this study the duration was two years, a much longer period of time (Anton et al. 2012). This seems to be a recurring problem with technology that assesses individual's behavior. Perhaps the additional piece of equipment is deemed burdensome as the subjects lose enthusiasm with their fitness regimens. Towards the end of the present study the subjects reported that they found the information provided by the Fit Bit (in terms of exercise such as steps taken and distance traveled) interesting and relevant in planning their diet, yet not crucial enough to have the Fit Bit charged for every day and worn (in contrast to the beginning of the study). For this reason it seems that the best method of providing feedback to the user would involve integration with something the individual already uses. Integration of the technology with cell phones could be extremely

beneficial as individuals tend to always use their phone and bring it with them everywhere they go. This could minimize the additional burden of using a separate piece of technology to provide this information. Likewise navigation to the Fit Bit site also declined over time according to the subjects. It seems that integration of the reporting mechanism with a site already widely utilized by individuals such as email or social networking sites could improve the frequency of feedback given to individuals. Therefore, it seems that integration with current technology and websites could lead to more successful outcomes and regular use of technology over time.

In terms of behavior in relation to feedback, the Fit Bit did seem to have an effect to some degree. As seen in Table 6 all subjects had a decrease in body fat by the end of the testing period, with an average decrease of 0.6%. Though this value is small, it could suggest that the subjects adjusted their behavior when given feedback about their consumption and energy expenditure. Also seen in Table 6 was an average decline in body weight of 0.8%. Though one of the subjects gained weight, the decrease in body fat coupled with this increase in weight seems to suggest a more favorable body composition over time.

As seen in Graph 2 the average amount of calories consumed decreased from the first to the fourth quarter of the study for all subjects. This could be due to feedback regarding what the subjects were consuming, or it could be coincidental since the decrease was rather small. In addition the amount of calories consumed seemed to fluctuate in the middle portion of the experiment depending on the subject. The data from this group of subjects may not reflect trends that could occur with a population trying to lose weight. The subjects in this study were all college age males looking to increase their lean mass, level of fitness and strength rather than simply trying to lose bodyweight. More information could be obtained from populations looking to lose weight to see if feedback has an effect on their behavior.

Graphs 3, 4, and 5 reveal information about the subjects rating of perceived exertion (RPE), calories burned (according to the Fit Bit), and activity score (a composite score determined by the Fit Bit based on steps taken, distance traveled, floors climbed, and other activities recorded in the activity journal) over the 28 day period. Across all subjects there seems to be a correlation between rating of perceived exertion and calories burned and activity score. Particularly with Subject 1, rating of perceived exertion seemed to track calories burned and activity score revealing accurate self-assessment by this subject. Subject 2's data suggested a weak correlation between these factors, and in Subject 3 the correlation was the weakest. This perhaps reveals differing self-perceptions that can exist within society. Some individuals may have an accurate idea of how much energy they are expending (Subject 1) and others may over or underestimate their energy expenditure. That being said this discrepancy could be based on the activities done for the day. For example, for Subject 3 on two different day's entry in the Fit Bit journal 1.5 hours of weight lifting was recorded on each day, but the energy expended was very different depending on the muscle group trained. The Fit Bit did not offer ways to record intensity for some activities, and as a result on two different days with similar activity scores and calories burned, there may have been very different ratings of perceived exertion. This again is a result of the subjects used for this study as they were already active individuals with training regimens (Subjects 1 and 3). For the general population, the approximation by the Fit Bit of calories burned for a certain amount of weight lifting will likely be more accurate and a larger sample of adults looking to lose weight will reveal more information relative to correlations about self-perception.

In terms of rating of perceived consumption (RPC), there appeared to be no correlation between calories consumed and RPC. This may be due to the fact that calories alone are not the

only factor an individual considers when determining whether they are eating healthy or not. In addition rating of perceived consumption was assessed in relative terms in comparison to an individual's goals meaning that a higher calorie consumption on a day with high levels of endurance training may be considered healthy by that particular subject. There also did not appear to be any correlation between the composition of food consumed (fiber, protein, fat, carbohydrates, sodium) and rating of perceived consumption. This may be a result of the inaccurate approximations of the Fit Bit's software when entering nutritional information for the food the subjects entered.

For more conclusive results this study could be completed with a control group and a greater number of subjects who are interested in losing weight, or a group that has BMI's classifying them as overweight or obese. This would reveal if the feedback that the Fit Bit gives has any effect on success in weight loss. An extended trial period could also be used to see how use of the Fit Bit over time changes. In addition it would be useful to see how individuals would respond to the Fit Bit when it is integrated with current pieces of technology such as cell phones, and when the information provided to the user is depicted through current social networking sites. This could possibly reduce the decline in usage over time and provide a competitive and supportive aspect when users are connected on a social networking site.

In terms of the effect the Fit Bit and its information had on the subjects the data does not suggest significant changes in behavior. Overall the subjects tended to lose weight and body fat, and on average consumed less calories in the final quarter of the study than in the first quarter. In addition there appeared to be a weak correlation between rating of perceived exertion and calories burned and the Fit Bit determined activity score suggesting that subjects may understand approximately how much energy they are truly expending in a day. In contrast there was no

observable trend between rating of perceived consumption and calories consumed which could suggest that individuals do not understand what they are consuming, or that the subjects were assessing what they consumed based on their own personal goals and preferences.

Overall it seems that the Fit Bit is fairly accurate in its assessments. In areas such as steps taken and floors climbed the information provided is very accurate. In contrast when determining calories burned, and distance traveled the Fit Bit is not as accurate in absolute values yet does demonstrate trends in exercise. When providing feedback to the user it is most important that a piece of technology provides accurate trends so that the user can get an idea of the changes that need to be made in their lifestyle to accomplish their goals. For this reason, despite the inaccuracy in some of the Fit Bit measurements, the Fit Bit is a viable tool for assessing basic activities of individuals.

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Appendix I: All Data for Subjects 1, 2, and 3 over the 28 Day Case Study

Subject 1

Date	Weight	% Body Fat	Total Calories Consumed	Fat (g)	Fiber (g)	Carbs (g)	Sodium (mg)	Protein (g)	Steps Taken	Floors Climbed	Miles Traveled	Calories Burned	Activity Score	RPE	RPC
03.09.13	172.2	9.8	4159	179.6	63.8	471.1	3938	255	8133	4	3.32	3530	1430	8	5
03.10.13	171.4	12.9	3160	155.4	35.5	340.7	5259	157.6	7177	6	2.72	3298	1241	6	7
03.11.13	171.4	12.9	4644	180.7	93.6	593.2	5802.3	251.9	9963	28	3.78	3560	1454	5	8
03.12.13	173.5	12	3714	183.3	83.4	384.3	4299.6	194.2	19437	5	7.46	4751	2423	10	8
03.13.13	174.5	8.5	3381	136.6	61.1	373.3	5017.9	172.8	9563	4	3.62	3194	1136	7	6
03.14.13	172.2	8.1	2746	77.4	33.8	410.7	4507	123.9	16364	8	6.55	3985	1774	8	8
03.15.13	173.1	8.3	4471	168.8	69	521.3	6029.6	230.2	15802	8	6.12	4283	2014	9	9
03.16.13	174.3	11.6	3842	146.4	56.4	464.6	4358.7	205.3	19219	2	7.28	4519	2204	8	8
03.17.13	171.9	9.6	4050	172.2	66	426.6	3734.2	183.8	7046	3	2.67	3796	1621	9	8
03.18.13	172.7	10.3	4754	215.8	63.8	493.6	5351.8	223.2	11414	4	4.33	3702	1545	9	8
03.19.13	172.7	10.3	4116	201.6	65.6	414.2	4456.2	180.7	16465	16	6.24	4244	1983	10	9
03.20.13	173.9	10.2	3999	172.7	35.7	434.1	5140.1	188	8475	25	3.21	2587	646	2	7
03.21.13	173.9	10.2	4276	195.8	73.8	467.1	3597.6	200.6	7347	0	2.78	3704	1547	9	9
03.22.13	174.2	10.1	4795	213.4	95.4	594.8	6242.9	180.9	11724	5	4.53	3865	1677	8	8
03.23.13	174.1	10.7	5451	250.7	97.1	571.7	6982.4	243.8	9680	2	3.72	3449	1341	5	4
03.24.13	174.1	10.7	3215	103.5	55.8	423.4	4777.2	161.8	6490	4	2.46	3305	1225	9	8
03.25.13	175.5	10.2	4202	214.9	74.4	395.3	2809.3	202.6	10354	4	3.92	3480	1344	9	9
03.26.13	174.8	10.8	4133	217.8	71.4	353.1	3075.8	210.8	13057	8	4.95	3968	1760	10	9
03.27.13	176.2	10.2	4292	243.2	70.1	343.9	3763.7	195	7014	3	2.66	2687	710	3	6
03.28.13	175	10.9	3737	136	58.4	424	4240.9	216.5	9982	8	3.83	2771	795	8	8
03.29.13	175.5	10.2	4495	228.7	56.8	447.8	2638.7	201.6	8268	1	3.13	2779	783	9	7
03.30.13	173.9	10.9	2185	63.5	35.3	283.2	2282.9	145.8	6004	1	2.28	3155	1104	7	9
03.31.13	177.2	10.3	3029	67.3	57.9	392	4133.9	191.5	6671	2	2.53	3817	2062	9	9

04.01.13	176.7	9.4	3836	128.9	66.8	497.4	4171.3	187.3	13551	4	5.14	3465	1332	9	8
04.02.13	174.8	9.9	3697	102.1	52.3	498.2	4026.3	200.1	15396	5	6.13	4166	1920	10	10
04.03.13	172.6	8.8	3988	144.4	79.8	496	5046.1	190.6	10441	8	3.96	2847	856	3	7
04.04.13	175.8	9.1	4507	197.8	49.1	474	4647.6	176	14914	5	5.65	3796	1597	9	7
04.05.13	177.4	9.1	4559	204.1	78.8	544.4	7120.5	215.2	16270	19	6.26	3563	1433	8	9
Date	**Weight**	**% Body Fat**	**Total Calories Consumed**	**Fat (g)**	**Fiber (g)**	**Carbs (g)**	**Sodium (mg)**	**Protein (g)**	**Steps Taken**	**Floors Climbed**	**Miles Traveled**	**Calories Burned**	**Activity Score**	**RPE**	**RPC**

Subject 2

Date	Weight	% Body Fat	Total Calories Consumed	Fat (g)	Fiber (g)	Carbs (g)	Sodium (mg)	Protein (g)	Steps Taken	Floors Climbed	Miles Traveled	Calories Burned	Activity Score	RPE	RPC
03.09.13	159.7	13.5	1504	52.2	8	151.6	3398.7	109	1563	0	0.62	2566	284	1	4
03.10.13	161.4	14.5	2438	11.6	11.6	233.7	4685.8	115	19464	3	7.14	2566	698	7	5
03.11.13	161.4	14.5	1584	71.6	22.3	169.3	3185.2	74.5	6912	1	2.53	2341	511	5	5
03.12.13	158.9	14.3													
03.13.13	158.9	14.3													
03.14.13	161.9	14.3	1892	79.9	8.3	196.4	3510.3	101.6	12444	5	4.86	3753	1687	9	8
03.15.13	158.8	13.5	1393	56.2	29.8	169.9	3846.4	69.1	11973	7	4.58	3890	1829	7	7
03.16.13	158.4	13.8	1338	35.1	28.7	229	2329.3	55.6	10070	3	3.69	2544	698	10	10
03.17.13	158.8	12.5	2246	50.7	13.3	220.4	2977.2	65.7	10510	10	3.85	2558	674	4	2
03.18.13	159	13.5	1327	30.1	50.5	168.8	2617.8	122	8483	5	3.11	2487	632	7	7
03.19.13	159.8	13.3	1278	58.1	36	127.2	1542	89	16847	8	6.18	3813	1737	8	6
03.20.13	159	13.5	2740	116	3	214	7920	176	11670	10	4.28	2585	741	2	2
03.21.13	159.2	14.6	815	37	2	85	0	41	14204	4	5.21	3484	1463	7	5
03.22.13	159.2	14.6	820	39.5	6.1	81.7	2002	33.3	3532	2	1.29	2540	677	5	6
03.23.13	159.2	15.1	426	14.2	2	51.6	1326.8	23.1	5136	10	1.88	2340	526	3	5
03.24.13	159.9	15.1	1208	41.9	17.9	107.8	3493.1	107.9	3248	1	1.19	2131	336	2	7
03.25.13	159.4	15.5	840	25.5	9.5	109.8	943.2	48.3	13202	7	4.84	3081	1149	8	9
03.26.13	161	15.4	686	19.6	20.4	66.3	2185	67.1	10605	6	3.89	3078	1125	8	8
03.27.13	160	14.2	792	30.3	11	77.1	2118.5	50.8	18636	11	6.83	3526	1498	8	5
03.28.13	159.5	13.8	785	17.5	5.4	112	897.6	45.3	10099	3	3.7	3109	1173	7	5
03.29.13	158.4	13.8	1546	90.4	12.4	98.6	3185.5	86.5	10116	3	3.71	2714	841	7	6
03.30.13	159.8	13.9	1187	54.5	6	110.5	1860.6	52.8	8564	6	3.14	2895	972	7	7
03.31.13	162.1	13.7	1705	61.4	12	198	2366.3	75	5695	5	2.09	2529	667	3	3
04.01.13	157.3	13.7	1200	35.5	11.3	111.4	1928.6	111.9	13190	4	4.84	3164	1219	7	7
04.02.13	159.5	12.9	1948	98.9	26.5	172.3	3865.8	72.2	5939	3	2.18	2256	456	3	3

04.03.13	157.7	13	2418	113	38	263	3900	88	10379	8	3.81	2806	898	7	7
04.04.13	159.3	12.7	603	20.7	2.7	75.2	1040.4	27.7	9712	3	3.56	2431	603	7	7
04.05.13	157.4	13.1	994	35.5	7	77.5	1639.5	85	13988	8	5.13	3117	1157	7	7
Date	**Weight**	**% Body Fat**	**Total Calories Consumed**	**Fat (g)**	**Fiber (g)**	**Carbs (g)**	**Sodium (mg)**	**Protein (g)**	**Steps Taken**	**Floors Climbed**	**Miles Traveled**	**Calories Burned**	**Activity Score**	**RPE**	**RPC**

For Subject 2 on 03.12.13 and 03.13.13 the subject lost the Fit Bit and no data was collected. The subject also did not enter any data that day.

Subject 3

Date	Weight	% Body Fat	Total Calories Consumed	Fat (g)	Fiber (g)	Carbs (g)	Sodium (mg)	Protein (g)	Steps Taken	Floors Climbed	Miles Traveled	Calories Burned	Activity Score	RPE	RPC
03.09.13	255.5	25.6	3961	191.5	9.5	260.7	5750.8	239.3	1432	0	0.57	3320	788	7	7
03.10.13	254.8	22.9	3070	166.4	10.7	169.1	2765.6	227.2	1026	0	0.41	3314	784	9	8
03.11.13	254.8	22.9	4246	193	15	348.7	6284.6	283.5	6362	3	2.52	3926	1177	6	8
03.12.13	254.8	22.9	3446	145	15	332.7	5844.6	207.5	7372	8	2.92	4009	1215	6	8
03.13.13	252.7	23.2	4626	236.1	15.3	390.5	5138.8	271.8	10977	0	4.34	4002	1228	4	8
03.14.13	253.1	22.9	4250	190	14	353	6333	317	6793	0	2.69	3867	1138	4	7
03.15.13	253.6	22.9	4532	234.9	15.6	299.9	5627.5	311.7	102	0	0.04	2892	488	8	8
03.16.13	254.5	22.8	3124	148.6	7.6	250.3	4927.6	207.6	3859	0	1.53	3337	785	9	7
03.17.13	254.3	22.3	3884	199.8	5	234.7	5478.9	292.9	4188	1	1.66	3414	821	8	7
03.18.13	254.3	22.3	4619	201.6	13.6	391.3	6799.6	322.6	12199	0	4.83	4389	1467	4	7
03.19.13	254.3	22.3	3713	184.8	5.6	239.4	4448.9	266.1	0	0	0	2849	459	8	7
03.20.13	251.9	22	4389	222.4	12.5	324.9	4846.6	289.7	7356	0	2.91	3215	1136	1	7
03.21.13	251.9	22	3459	149.9	7	262	4500.6	269.2	9605	0	3.8	3360	1252	7	6
03.22.13	251.9	22	4477	239.1	11.5	283.3	5299.9	309.3	7512	1	2.97	3318	1197	7	7
03.23.13	251.9	22	4633	233.4	15	360	8672.7	283.9	4022	0	1.59	3325	777	6	8
03.24.13	251.8	22.5	3507	175.1	26.7	295.1	5175.4	194.9	4575	0	1.81	3573	942	7	6
03.25.13	253.2	22	3902	190.7	13.5	268.9	4198.4	284.6	9684	1	3.83	3943	1189	3	7
03.26.13	252.4	22	4178	197.6	22.6	367.6	4018	247.1	7600	0	3.01	4100	1293	9	7
03.27.13	251.7	21.8	4493	218.5	10.1	344.3	5924.7	303.8	9598	0	3.8	4431	1514	7	7
03.28.13	251.1	22.1	3646	180	0	216.7	4589.6	295.5	11850	0	4.69	4377	1498	3	7
03.29.13	251.7	22.1	3738	194.5	14.6	244.5	3747.3	260.5	9253	0	3.66	4427	1511	8	8
03.30.13	251.3	22	4377	190.1	15.5	333.5	5928.7	334.7	2462	0	0.97	2836	451	7	7
03.31.13	251.8	22.1	3382	189.7	19.1	245.6	4003.6	188.2	333	0	0.13	2853	462	8	8
04.01.13	248.8	22.5	3300	157	15	258	3018	219	5620	0	2.22	3628	995	4	7
04.02.13	249.6	22.6	3324	148.6	7.6	302.3	4929.6	209.6	9047	0	3.58	4330	1466	7	6

04.03.13	244.5	23.1	4194	183.1	23.5	368	6086.6	275.1	4846	0	1.92	3666	1037	4	7
04.04.13	245.5	24.8	4069	203.3	21.7	293.1	4726.1	273.4	0	0	0	3120	0	1	1
04.05.13	245.1	24.8	3719	174	0	254.1	6002.8	289.7	1587	0	0.63	3126	233	1	1
Date	**Weight**	**% Body Fat**	**Total Calories Consumed**	**Fat (g)**	**Fiber (g)**	**Carbs (g)**	**Sodium (mg)**	**Protein (g)**	**Steps Taken**	**Floors Climbed**	**Miles Traveled**	**Calories Burned**	**Activity Score**	**RPE**	**RPC**

*For Subject 3 on 04.04.13 the Fit Bit was not worn which is why there is no activity data recorded from the Fit Bit.