THE IMPACT OF ACCELEROMETER USE IN OVERWEIGHT AND OBESE ADOLESCENTS: A LONGITUDINAL STUDY

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by

Shannon Eileen Hutton, MSNc, RN

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THE IMPACT OF ACCELEROMETER USE

ABSTRACT

THE IMPACT OF ACCELEROMETER USE IN OVERWEIGHT AND OBESE ADOLESCENTS: A LONGITUDINAL STUDY

by

Shannon Eileen Hutton

Statement of Problem
Adolescents comprise the most obese childhood age group in the United States, putting them at greatest risk for short and long-term health consequences. Currently, there is a lack of effective and sustainable strategies that aim to reduce and prevent obesity in teens. This grant proposal intends to study the impact of wearable physical activity monitoring devices, called accelerometers, on overweight and obese 14-year-olds during an 8-month period using a repeated-measures design. The dependent variables being examined include body mass index, waist circumference, physical activity output, and self-efficacy levels. This study is significant to nursing since the use of wearable technology, such as accelerometers, as an effective and sustainable tool that monitors and fosters physical activity could create additional clinical strategies for advanced practice nurses to use in health promotion and disease prevention.

Pamela Kohlbry, Ph.D., RN, CNL
Committee Chair

Date

4/23/2016
DEDICATION

I dedicate this work to my mom and dad who have taught me the value of education, staying healthy, and the importance of never giving up on my goals.

This work is also dedicated to Toni McCoy, a wonderful friend and mentor who has always encouraged me to continue learning and growing as both a nurse and person.

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The Impact of Accelerometer Use in Overweight and Obese Adolescents: A Longitudinal Study

CHAPTER ONE: INTRODUCTION

Adolescents comprise the most obese childhood age group in the United States, putting them at risk for short-term and long-term health consequences. According to the Centers for Disease Control and Prevention (CDC) (2014a), 17% of young people aged 2 to 19-years-old are obese in America. When divided by age groups, 12 to 19-year-olds have the highest rate of obesity (20.5%), compared to 2 to 5-year-olds (8.4%) and 6 to 11-year-olds (17.7%) (CDC, 2014a). The cause of obesity amongst young people is multifactorial and influenced by both modifiable and non-modifiable risk factors. Individual characteristics such as genetics and ethnicity are non-modifiable, however factors such as physical activity (PA) can be altered to reduce a young person’s predisposition for obesity and its associated comorbidities. This grant proposal will focus on PA as a primary strategy to reduce obesity in teens.

Background

In the last decade, the use of PA-monitoring devices that can be worn on the body, called “wearables”, have emerged as a popular and valuable tool in promoting lifestyle PA in both teens and adults (Lubans, Morgan, Tudor-Locke, 2009; Lyons, Lewis, Mayrsohn, & Rowland, 2014). These devices comprise important data-gathering technology called pedometers or accelerometers. The accelerometer device, in particular, has proven to be the most accurate wearable technology monitor since it can detect human motion on several planes.

Fitbit Incorporated, represents the industry leader in wearable accelerometer technology, making Fitbit devices potentially strong interventions for use in research settings to alter PA behavior. Wearable accelerometers, such as those made by Fitbit, provide valuable, real-time feedback to their users about their PA performance. This is a critical component to the
sustainability and motivational properties of wearable accelerometers (Lubans et al., 2009). Albert Bandura’s Social Cognitive Theory (1982) will be used in this grant proposal as the underlying theoretical framework supporting the concept of self-efficacy through accelerometer use. The purpose of this study is to determine if long-term use of accelerometers in obese adolescents will lead to improvements in health conditions such as body mass index, waist circumference, and PA levels. In this study, the phrase “long-term” is used to describe as a period lasting eight months.

**Significance to Nursing**

Obese adolescents are 75% more likely to become obese adults and to suffer from obesity-related health complications (Klish, 2014a). These complications include, but are not limited to, heart disease, high blood pressure, diabetes, stroke and mental health disorders (Klish, 2014a; Suchindran, North, Popkin, & Gordon-Larsen, 2010). The cost of obesity related healthcare costs for preventable diseases amounted to $23.9 billion dollars in 2014, and is projected to reach $50 billion in 2050 (State of Obesity, 2014). This notion represents a critical subject matter that nurses at all levels and in all fields of healthcare delivery need to be cognizant of. Specifically, advanced practice nurses (APNs) working in pediatric and family practice settings are in key positions to help mitigate early-age obesity.

Advanced practice nurses are on the frontlines of patient-care delivery, serving as clinicians, educators, advocates, and collaborators in the effort to reduce obesity and obesity-related preventable diseases (ANA, 2014). Understanding the potential uses of wearable technology, such as accelerometers, as an effective and sustainable tool that monitors and fosters PA could create additional clinical strategies for APNs to use in health promotion and disease prevention. Early application of wearable activity monitors by APNs on their patients could
serve as a motivational instrument to increase patients’ PA and to prevent obesity. Additionally, PA monitors could be used as a diagnostic tool, offering timely identification of inactive patients. Using PA monitoring devices, APNs could prescribe step-based goals and provide clinical counseling, that would be “personalized according to [patients’] baseline values, specific health goals and sustainability” (Lubans et al., 2009, p. 310). The possibilities from this proposed research study are significant, including findings that could potentially be used to inform evidence-based practice, which is at the crux of delivering optimal patient care.

The Problem

Adolescents represent the most obese childhood age group, putting them at greatest risk for acute and chronic obesity-related health complications. Research-based evidence indicates a lack of effective and sustainable strategies that aim to reduce and prevent obesity in teens. Further investigation is needed to examine the long-term impact of using PA-monitoring devices, such as accelerometers, as strategies to reduce obesity in teens. To date, there are no known studies that use the Fitbit Charge accelerometer, a waterproof, wrist-worn, triaxial accelerometer, to evaluate the long-term impact of wearable PA-trackers on overweight and obese teens.

Intent of Research

The purpose of this study is twofold. First, it is to examine if the use of a wrist-worn triaxial accelerometer (called the Fitbit Charge) on obese and overweight adolescents, over an 8-month period, will change participants’ PA levels as measured by steps taken, and change the severity of obesity in adolescents as measured by body mass index (BMI) and waist circumference (WC). Second, it is to examine if the use of the Fitbit Charge on obese and overweight adolescents, over an 8-month period, will change reported levels of self-efficacy related to engagement in PA.
Research Question

This study proposes two research questions: (1) Will use of the Fitbit Charge over an 8-month period in overweight or obese 14-year-olds, residing in San Diego County, lead to increased PA behavior, and decreased BMI and WC? And, (2) Will use of the Fitbit Charge improve adolescent’s reported levels of self-efficacy related to participation in PA?

Research Variables

The independent variable in this proposed study is PA level as measured by the Fitbit Charge accelerometer, the primary intervention of this study. The dependent variables in this study are PA, BMI, WC, and self-efficacy related to engagement in PA.
CHAPTER TWO: LITERATURE REVIEW

An extensive literature review was conducted using four primary databases, CINHAL, PubMed, UpToDate, and Google Scholar. Key search terms included, but were not limited to, adolescence, adolescent, teens, obesity, overweight, physical activity, risk factors, health, disease, pedometers, accelerometers, fitness tracker, Fitbit, BMI, waist circumference, and self-efficacy. Literature was collected and organized using Zotero where over-arching themes were established including, defining and measuring obesity, comorbid complications of adolescent obesity, etiology of obesity in adolescents, and use of accelerometers in research.

The inclusion criteria for selecting literature were: (1) publications in the English language, (2) primary research papers evaluating PA interventions using wearable technology, (3) publications in peer reviewed journals, government-based domains or non-profit domains, and (4) the target audience for the intervention was \( \leq 18 \) years old and of any ethnicity. Exclusion criteria included articles in non-English languages, literature greater than 10 years old unless it contributed foundational information, and case studies. Randomized controlled trials were not required in this literature review due to the relatively new area of research that wearable technologies have cultivated, and because of the relatively small amount of studies targeting this specific population with this specific intervention.

Over 400 articles were identified using the established inclusion and exclusion criteria. Once duplicates articles were removed, 133 articles remained for independent screening. Of those articles, 43 full-text articles were utilized in the discussion regarding the use of accelerometers as an intervention for PA in obese teens, as well as the concept self-efficacy as a foundation for change in the research aims.
Defining and Measuring Obesity

The term “overweight” implies an excess of body weight whereas “obesity” denotes an excess of fat (Klish, 2014b). Directly measuring body fat (adiposity) is not feasible in daily practice, therefore body mass index (BMI) serves as an accepted standard of measure for defining obesity in children (Klish, 2014c). BMI has a positive correlation with adiposity and medical complications, and should be calculated annually and trended in all adolescents (Barlow, 2007). When using English measurements, BMI is obtained by dividing weight in pounds by height in inches squared and multiplying by a conversion factor of 703 (CDC, 2014b). In children and adolescence, BMI is plotted on a gender and age-specific growth chart to obtain percentile rankings (CDC, 2014b). For example, <5th percentile = underweight, 5th to 85th percentile = normal weight, ≥85th to <95th percentile = overweight, and ≥95th percentile = obese (Klish, 2014c).

BMI, as a measurement of adiposity severity and as a predictor for obesity-related comorbidities, has limitations (Aeberli, Gut-Knabenhans, Kusche-Ammann, Molinari, & Zimmermann, 2013). BMI measurements alone do not depict fat distribution such as intra-abdominal obesity, and BMI does not distinguish between changes in fat and fat-free mass (Aeberli et al., 2013). For example, a young person with greater body fat mass may be misclassified as having a normal BMI, whereas a young person with greater muscle mass may be misclassified as being overweight or obese (Aeberli et al., 2013, p. 247). In an effort to mitigate these limitations, waist circumference (WC) should be used in addition to BMI (Aeberli et al., 2013).

The most important feature of WC is its estimation of central obesity. Studies with pediatric populations show consistently strong associations between WC and metabolic
syndrome, a dangerous myriad of risk factors for heart disease and diabetes. This notion has validated WC as an important adjunct to BMI in predicting health risks related to obesity (Aeberli et al., 2013). In a study of 2,303 six to 14-year-olds, Aeberli et al. (2013) used regression and receiver operating characteristic curves to examine the combination of BMI and WC in predicting percentage body fat against WC or BMI alone. Aeberli et al. (2013) found that a composite score of BMI and WC was a more reliable predictor of percentage body fat in primary school children, concluding that BMI and WC together serve as a more effective tool for clinical studies of pediatric adiposity (Aeberli et al., 2013).

The National Obesity Forum (n.d.) reports that a WC of ≥ 94 cm in men and ≥ 80 cm in women is associated with an “increased risk” for health consequences, while a WC ≥ 102 cm in men and ≥ 88 cm in women is associated with a “substantially increased risk” for coronary artery disease, metabolic syndrome, and other obesity-related health complications. Unlike adults, the WC cutoffs for adolescents are less definitive due to a lack of research. A general consensus for WC in 12 to 19-years-olds is that a measurement of 66.8–87.5 cm and greater for boys is associated with increased risk for cardiovascular disease, and a WC measurement of 71.5–87.2 cm and greater for girls is linked to an increased health risk (Messiah, Arheart, Lipshultz, & Miller, 2008). The ranges are larger due to age and ethnicity differences (Messiah et al, 2008).

**Comorbid Complications of Obesity**

The health consequences of adolescent obesity are profound. Teenagers who are overweight or obese are at higher risk for concurrent and imminent systemic complications, including adverse effects on cardiovascular, endocrine, gastrointestinal, orthopedic, pulmonary, and psychological functioning (Daniels, 2009; Klish, 2014a). An examination of these comorbid
complications provides a rationalization and validation for more preventative-focused research studies such as the one proposed in this paper.

**Cardiovascular comorbidities.** An elevation in plasma cholesterol occurs in obese and overweight adolescents (Klish, 2014a). Specifically, adolescents with central abdominal obesity have elevated serum low-density lipoprotein (LDL) cholesterol and triglycerides, and decreased serum levels of high-density lipoprotein (HDL) cholesterol (Harel, Riggs, Vaz, Flanagan, & Harel, 2010). These increased levels of LDL cholesterol and decreased levels of HDL cholesterol in childhood stimulate atherosclerosis which is progressive throughout adolescences and adulthood (Daniels, 2009). Pathology studies have demonstrated that overweight children have an increased presence of atherosclerotic lesions in their coronary arteries and aorta (Daniels, 2009). Daniels (2009) stated that being overweight or obese in childhood is the strongest predictor of coronary calcium later on in life, a marker for plaque formation that is associated with a higher risk of having a myocardial infarction.

Hypertension is more prevalent in adolescents who are overweight and obese. Studies have shown that the risk of having hypertension as an obese or overweight teen is 2.5 to 3.7 times higher than their non-obese counterparts (Daniels, 2009). Further research has indicated that the occurrence of hypertension during youth positively predicts the presence of hypertension during adulthood (Klish, 2014a). One predictive model estimated that the prevalence of coronary heart disease will increase in the U.S. from five to 16% by 2035, with 100,000 additional cases attributable to obese youths (Bibbins-Domingo, Coxson, Pletcher, Lightwood, & Goldman, 2007).

**Endocrine comorbidities.** Obese adolescents are also at risk for multiple endocrine complications including abnormalities in puberty and growth, decreased insulin sensitivity,
impaired glucose tolerance, and diabetes mellitus (Daniels, 2009). Glucose intolerance is a common complication in obese and overweight adolescents, and is associated with insulin insensitivity and ultimately type II diabetes (Daniels, 2009). In a large-scale longitudinal study of 17-year-old males, elevated BMI in adolescence had a distinct relationship with diabetes and coronary heart disease in young adulthood (Tirosh et al., 2011). This clustering of metabolic risk factors for type II diabetes and cardiovascular disease (e.g. abdominal obesity, dyslipidemia, hyperglycemia, and hypertension) is known as metabolic syndrome (Klish, 2014a). Studies estimate that approximately 10% of adolescents living in the U.S. have metabolic syndrome with a majority of them being obese (Klish, 2014a; Steinberger et al., 2009).

**Gastrointestinal comorbidities.** The leading cause of cholelithiasis in adolescents is obesity (Klish, 2014c). The risk for gallstones increases with BMI and is a likely diagnosis in an overweight or obese teen complaining of an intolerance to fatty food, epigastric pain, nausea, vomiting, and/or right upper quadrant abdominal pain (Klish, 2014c). Adolescent obesity is also associated with a spectrum of liver abnormalities known together as nonalcoholic fatty liver disease (NAFLD), the most common cause of liver disease in youth (Welsh, Karpen, & Vos, 2013). In a post-mortem study of 742 adolescents and children, the occurrence of fatty liver was 38% in obese youth (Klish, 2014c). Additionally, NAFLD is associated with elements of metabolic syndrome, including dyslipidemia, insulin resistance, and hypertension (Klish, 2014c).

**Orthopedic comorbidities.** Obese adolescents are also at increased risk for orthopedic complications due to increased weight on the developing skeletal system (Daniels, 2009). The most well documented disorders include slipped capital femoral epiphysis (SCFE) and tibia vara, also known as Bount’s Disease (Daniels, 2009). In SCFE, the capital femoral epiphysis from the femoral neck is displaced externally from the growth plate (Daniels, 2009). SCFE usually occurs
in early adolescence with obesity being a significant risk factor (Klish, 2014c). Teens with SCFE have pain and difficulty walking and require a referral to an orthopedic surgeon and obesity specialist (Daniels, 2009; Klish, 2014c). Tibia vara affects the growth of the medial proximal tibia growth plate due to excessive weight bearing or weight-bearing under an increased load such as in the condition of obesity (Klish, 2014c). This can result in progressive and severe bowing of the legs in adolescence (Klish, 2014c). The primary treatment of tibia vara is through reversal of exacerbating factors such as weight management during childhood, otherwise surgical intervention is necessary to correct severe tibia vara (OrthoPediatrics, 2012).

**Pulmonary comorbidities.** Obese adolescents are also at greater risk for sleep-disordered breathing such as obstructive sleep apnea (OSA) and obesity hypoventilation syndrome (OHS) (Klish, 2014a). Obstructive sleep apnea is a complete obstruction of the upper airways during sleep, resulting in an absence of air movement despite respiratory effort (Klish, 2014a). In a study of 27 overweight and 64 obese nine to 14-year-olds, Verhulst et al. (2007) found that eight percent of participants had moderate to severe OSA. In the same study, 17% of participants had central sleep apnea (the effort to breathe is absent or diminished), resulting in severe oxygen desaturation to $\leq 85\%$ in over half of the subjects (Verhulst et al., 2007). Overweight and obese adolescents with any sleep-disordered breathing require prompt diagnosis and referral to specialty care for treatment with aggressive weight loss interventions (Klish, 2014a).

**Psychological impact.** The psychological repercussions of adolescent obesity can be debilitating. These include poor self-esteem, depression, alienation, and poor peer relationships (Klish, 2014a). Several studies have shown that obese adolescents experienced decreased health-related quality of life, including physical, emotional and social functioning (Klish, 2014a). Obese
adolescents have reported being targeted and bullied by their peers for being overweight, both in free-living settings and during PA while at school (Klish, 2014a). This leads to a negative association with PA and a weak self-image that continues with them into adulthood (Klish, 2014a).

**Etiology of Obesity in Adolescence**

Examining the causes related to adolescent obesity is crucial to proposing effective treatment and prevention strategies to promote healthier weight levels and lifestyle behaviors. Adolescence marks a crucial time period in which youth make “choices about their health and develop attitudes and health practices that affect their current safety and wellbeing as well as influence their risk for future serious chronic disease” (Healthy People 2020, 2013). Almost all obese and overweight adolescents are influenced by one or more environmental factors. Two of the most important factors include the increase of glycemic index in foods and sugar-sweetened beverages (SSBs), along with the concurrent increase in sedentary lifestyles due to more time spent at school, watching television, or playing on digital devices (Demory-Luce & Motil, 2014; Klish, 2014b). Other important factors related to the cause of obesity in young peoples is related to poor parental role modelling, low familial socioeconomic status, decreased family presence at meals, and lack of access to healthcare, affordable healthy foods, and safe, appealing place in the community for children and teens to play or be active (Demory-Luce & Motil, 2014; Klish, 2014b). This section of the literature review will focus specifically on the nutrition and PA factors that influence obesity in adolescence.

**Food choices and eating behavior.** Early assessment and identification of poor food choices can greatly impact an adolescent’s propensity toward being overweight or obese. A meta-analysis of 20 pediatric studies examining the relationship between SSBs, such as soda, and
body weight found that intake of SSBs played a contributing role in the development of obesity (Malik, An, Willett, & Hu, 2013). In the U.S., consumption of SSBs adds an additional 270 calories per day, or 10-15% of total caloric intake for teens (Klish, 2014b). National societies such as the American Heart Association (2013) and the U.S. Department of Health and Human Services (2015) have called for a reduction in the consumption of SSBs to prevent childhood and adolescent obesity.

In addition to SSBs, studies indicate that fast food consumption has become a mainstream activity in the life of adolescents. For teens, fast food is familiar, inexpensive, easily accessible, and associated with peer socialization (Demory-Luce & Motil, 2014). Most fast food choices have poor nutritional value as they are low in vitamins and minerals, and high in saturated fat and sodium (Demory-Luce & Motil, 2014). The National Institutes of Health reports that consumption of fast food has contributed to the 250% increase in teenage obesity seen between 1980 and 2008 (CDC, 2011; Demory-Luce & Motil, 2014).

**Physical activity and entertainment media.** Physical activity and its relationship with adolescent obesity generates the foundation for this proposed study. In addition to healthy eating, exercise is imperative to adolescents as it helps to promote and maintain physical and mental health, resulting in healthy behaviors and outcomes that teens carry with them into adulthood. The U.S. Department of Health and Human Services recommends that adolescents participate in at least 60 minutes of PA a day (CDC, 2014c). Despite this recommendation, a 2013 national survey conducted by the CDC of 21 large urban school districts across 42 states, found that only 27.1% of 13,583 students in grades nine through 12 participated in the recommended 60 minutes per day of PA (CDC, 2014c). This lack of activity is attributed to teens’ growing interest and access to entertainment media such as use of smartphones, tablets, computers, and social media.
sites like Facebook and Twitter. According to a report from the Pew Research Center for Internet, Science, and Technology, “88% of American teens ages 13 to 17 have or have access to a mobile phone of some kind, and a majority of teens (73%) have smartphones” (Lenhart, 2015, para. 2). According to the CDC (2013), children and adolescents aged eight to 18-years-old report using entertainment media for an average of 7.5 hours per day. This amount of time spent using entertainment media highlights a significant discordance from the American Academy of Pediatrics’ (AAP) recommendation that youth should participate in less than two hours of non-educational screen time a day (Strasburger, 2011). The proliferation of entertainment media use has led to a growing prevalence of inactive teens resulting in an imbalance of energy expenditure with energy consumption and ultimately leading to obesity.

Watching television, in particular, is the greatest established environmental cause for inactivity and the development of overweight and obese adolescents (Klish, 2014b). An international cross-sectional study of 207,672 adolescents aged 12 to 15-years-old from 37 countries, found that the number of hours spent watching television was positively correlated with BMI (Braithwaite et al., 2013). Specifically, adolescents who watched one to three hours of television per day had a 10 to 27% increased risk of being overweight or obese, and those who watched greater than five hours a day had up to a 45% increased risk (Braithwaite et al., 2013).

Researchers have suggested several reasons for the correlative relationship between watching television and BMI. First, watching television displaces potential time spent doing PA (Klish, 2014b). Second, watching television is a sedentary behavior that depresses metabolism and reduces caloric expenditure (Klish, 2014b). Third, food advertisements on television stimulate increased consumption of calorie-dense snacks such as SSBs thereby decreasing consumption of nutritionally-rich foods such as fruits and vegetables (Klish, 2014b; Strasburger,
2011). Also, teens who spend prolonged periods of time watching television tend not to participate in healthy household routines such as eating at regular family meals, as well as tend not to get enough nighttime sleep (Anderson & Whitaker, 2010; Klish, 2014b). Watching television before bed can make it difficult for youths to fall asleep and stay asleep, an important notion since insufficient sleep increases the prevalence of teenage obesity by 40% (Anderson and Whitaker, 2010; Klish, 2014b).

**Use of Accelerometers in Research**

As demonstrated, it is imperative that adolescents spend less time watching television and more time engaging in PA. This presents a considerable challenge since even when adolescents are presented with various opportunities to engage in PA, they choose sedentary activities (KidsHealth, 2014). Opportunities such as school sports (e.g. soccer, football and volleyball), recreational activities (e.g. yoga, swimming, skateboarding and Frisbee), and general daily routines (e.g. doing chores, walking to school, and working an active part-time job), are often last priorities for teens who prefer technology-based play such as surfing the internet, playing video games, watching television, or listening to music (KidsHealth, 2014).

Janz et al. (2002) recognized the challenge of researchers and parents to develop and implement effective long-term strategies that accurately measure and promote PA in youth. In a cross-sectional study of 467 children that examined fatness, leanness, and PA, Janz et al. (2002) demonstrated that there was a lack of methods that resulted in accurate reporting of the quantity and intensity of PA in young people. Traditional parental observation of their child’s PA frequently yielded significant reporting bias and an over-estimation of the actual activity being performed (Janz et al., 2002). Janz et al.’s (2002) findings were reflective of the foundational need for future research that used wearable technology activity monitors such as pedometers and
accelerometers to gain objective and real-time reporting of PA quantity and intensity (Janz et al., 2002). This insight was paralleled by the support of the Centers for Disease Control (CDC) who concluded at that time that “electronic monitoring is the best choice for detecting and assessing patterns of physical activity, especially in measures of intensity, over an extended period” (p. 564).

In 2003, the National Institutes of Health supported the use of accelerometers to measure PA in the National Health and Nutrition Examination Survey (NHANES), a large ongoing program of the National Center for Health Statistics, a division of the CDC (CDC, 2003-2004). Troniano et al. (2008) used the NHANES in a cross-sectional study of 6,329 participants who provided at least one day of accelerometer data and 4,867 participants who provided at least four days of accelerometer data, to describe PA in the United States. Troniano et al. (2008) discovered that only 42% of children aged 6 to 11 years old met the recommended 60 minutes per day of PA, and only 8% of adolescents achieved this goal. These objective findings were taken from an accelerometer and compared to self-reporting from national surveys (Troniano et al., 2008). In the surveys, participants estimated they were adhering to the PA recommendations approximately 51% of the time (Troniano et al., 2008). Troniano et al. (2008) suggested that a likely possibility for discrepancies between objective and self-reporting outcomes were that the “accelerometer provides an estimate close to truth, and that respondents greatly overestimate their physical activity” (p. 186). An additional possibility presented by Troniano et al. (2008), was that self-reporting overestimates could have resulted from misclassifying sedentary activity as moderate activity, as well as activity duration could may have been overestimated.

Basset and John (2010) supported Troniano et al.’s (2008) findings in a validity and reliability comparison study of accelerometer-based activity monitors (n=9). Basset and John
(2010) found that accelerometers and pedometers were advantageous over conventional self-reporting instruments such as diaries, logs, and questionnaires, since they did not rely on subjective reporting. Basset and John (2010) acknowledged that wearable technology monitors have become more sophisticated, accurate, and feasible for recreational users and for use in research. The memory capacity of the accelerometer computer often allows for up to several days of minute-by-minute data storage (Basset & John, 2010). Basset and John (2012) also noted the importance of the digital display screen on the wearable monitors which allowed participants to receive immediate visual feedback about their PA.

Traditional behavioral-change PA interventions can be costly and require professional experts to implement. In contrast, wearable monitors can provide low cost, wide-reaching benefits that have proven effective in their ability to promote increased PA (Lyons et al., 2014). In a systematic content analysis by Lyons et al. (2014), electronic activity monitors (n=13) such as those manufactured by Fitbit, Jawbone, and Nike, were found to enforce important behavior changes through techniques such as feedback, self-monitoring, and environmental change. Other prevalent behavior change concepts utilized by these manufacturers included use of social support, social comparison, prompts, and rewards (Lyons et al., 2014). These technology-based techniques embrace the foundation of self-efficacy and the social cognitive theory, as well promote a natural integration of accelerometers into adolescents’ technology-driven lifestyles.

**Selecting an accelerometer.** There are several important factors to consider when utilizing PA monitors for research purposes. Concerns such as the placement site of the monitor (e.g. waist, chest, ankle or wrist), the number of internal monitoring axes (e.g. uniaxial, biaxial, triaxial), and the type of activity being performed (e.g. walking, swimming, biking, or yoga), can all influence the accuracy of the device. For example, in a study of 60 participants who
completed a series of 10 to 12 semi-structured activities in outdoor and laboratory settings, Zhang, Rowlands, Murray, & Hurst (2012) demonstrated that specific proprietary algorithms are necessary to achieve accurate outcomes based on device location and the activity being performed. Zhang et al. (2012) found that the accuracy for waist-worn devices was marginally higher (0.99) when compared to wrist-worn devices (right wrist = 0.97, left wrist = 0.96). Zhang et al. (2012) stated that obtaining precise measurements of PA is crucial for evaluating the efficacy of interventions and being able to appreciate the relationship between PA and health.

Older generation activity monitors such as spring-level pedometers have been outpaced by newer technology accelerometers that aim to eliminate known limitations and inadequacies of pedometers. Spring-level pedometers that attach to the waist are inaccurate in obese persons and pregnant women since the spring-level pedometers records movement on vertical planes; if the device is tilted forward due to an obese or protuberant abdomen, the results are inaccurate (Basset & John, 2010). Modernized internal technology such as in piezoelectric accelerometers, allows the device to be tilted at any angle and to still accurately record data (Basset & John, 2010). Accelerometers are capable of measuring accelerations in human movement from the extremities or the trunk on multiple planes, and these devices are not affected by body adiposity (Basset & John, 2010).

In a literature review pertaining to research design and conduct using accelerometers (n=9), Murphy (2009) summarized a list of recommendations to consider when selecting an accelerometer for research purposes. First, Murphy (2009) stated that the accelerometer should be selected based on its ability to accurately measure the primary outcome variable in the proposed study. Second, the selected monitor should facilitate wearable ease for study participants including considerations of size, location, and water resistance (Murphy, 2009).
Third, the selected monitor should be appropriate for the length and scope of study, considering battery life and warranty (Murphy, 2009). Finally, the accelerometer should meet the cost restraints and expertise of the research team (Murphy, 2009). Murphy (2009) concluded that careful consideration of these recommendations would improve the accuracy and quality of the results, as well as allow for future research comparison and replication.

**Wrist-worn accelerometers in adults.** While the literature supports the validity and reliability of accelerometers worn on the waist, upgrades in technology have led to a growing popularity of accelerometers worn on the wrist. Wrist-worn PA-tracking devices are preferential for many reasons including vanity, feasibility, and their increasing accuracy for use in both free-living and research settings.

In a study by Esliger et al. (2011), 60 sedentary male and female adults aged 40-63 years old were given three GENEa triaxial accelerometers to be worn at different locations on the body (made by Activinsights Ltd., Kimbolton, United Kingdom). One GENEa device was placed on participants’ right wrist, one device was placed on the left wrist, and one device was worn at the waist using an elasticized belt (Esliger et al., 2011). Each participant underwent VO$_2$ (volume of oxygen consumed) testing so their metabolic rate could be measured while they performed different tasks in the study such as lying down, working on a computer, washing dishes, walking slowly on a treadmill walk, running on a treadmill, etc. (Esliger et al., 2011). This allowed the researchers to establish cut points for metabolic equivalents of tasks (METs).

Esliger et al. (2011) converted participants’ VO$_2$ to METs using “the standard conversion of 1 MET = 3.5 mL x kg$^{-1}$ x min$^{-1}$ and then coded into one of four absolute-intensity categories: sedentary (<1.5 METs), light (1.5–3.99 METs), moderate (4.00–6.99 METs), or vigorous (7+ METs) activity” (p. 1088). Cut points were important in this study since it allowed Esliger et al.
(2011) to identify and categorize the intensity of physical activity. Esliger et al. (2011) concluded that although the accuracy of the GENECA was greatest at the waist, “it also performed well at the wrist, with the left wrist being more accurate than the right” (p. 1091). The researchers suggested that the diminished accuracy found in the right wrist might be due to participants’ right-handedness, since it was more likely to engage in extraneous movements such as hand gestures, adjusting clothing, eating, drinking, etc. (Esliger et al., 2011). Esliger et al. (2011) proposed that the non-dominant wrist would be a better estimate of true PA.

Zhang et al. (2012) supported Esliger et al.’s findings in their study using a similar research design using three GENECA accelerometers, one worn at the waist, one worn on the right wrist and one worn on the left wrist. Zhang et al. (2012) recruited 60 participants, 23 males and 37 females, who aged 40-65 years old. The difference was that Zhang et al. (2012) examined the use of algorithms based on raw acceleration data instead of MET cut-points for monitoring PA intensity. Zhang et al. (2012) found that the “algorithms based on the waist-worn GENECA had slightly better results (98.2%-99.1%) than algorithms based on the right wrist-worn GENECA (95.3%-97%) or the left wrist-worn GENECA (95.3%-96.4%)” (p. 746). However, since these findings were comparable to each other, Zhang et al. (2012) concluded that the GENECA accelerometer, whether worn at the wrist or waist, demonstrated high accuracy for classifying sedentary activities, walking, household activities, and running (Zhang et al., 2012). Zhang et al. (2012) further stated that the wrist-worn accelerometer validity findings were particularly encouraging as “there is potential for greater compliance to activity monitoring protocols” with a monitoring device in the wrist location (p. 747).

Another study by Rosenberger et al. (2013) examined the accuracy of activity energy expenditure (AEE) in 37 healthy adults, aged 18 to 74 years old, using a Wocket triaxial
accelerometer (a device custom made by the researchers). A Wocket was positioned on the participants’ hip and was compared to a Wocket positioned on the participants’ dominant wrist (Rosenberger et al., 2013). Participants engaged in 20 different activities which were classified into four categories. The categories included sedentary activities such as lying, sitting, reading a book, sorting paper and working at a computer, cycling activities such as outdoor and indoor biking, ambulation activities such as walking, running, and carrying a box, and lifestyle activities such as painting a wall, sweeping the floor, and folding laundry (Rosenberger et al., 2013). Rosenberger et al. (2013) found that accelerometers worn on the wrist detected movements of small mass such as actions made by the forearm when sitting, as well as actions made by large body mass such as in running and walking as long as the wrist with the accelerometer was not inhibited such as carrying a cup of coffee, carrying a briefcase, talking on a cell phone, or pushing a grocery cart or stroller (Rosenberger et al., 2013). The hip-worn accelerometers had a greater sensitivity and specificity score (71% and 96%) for estimating AEE when compared to the wrist-worn accelerometer (53% and 76%) (Rosenberger et al., 2013). These findings underlined the challenges in classifying PA intensity using a wrist-worn device based on the potential for misclassification related to wrist inhibition or excessive wrist movement (Rosenberger et al., 2013). However, Rosenberger et al. (2013) acknowledged the greater acceptability and compliance amongst users with the wrist-worn devices versus hip-worn devices and called for more research concerning accelerometer data accuracy.

**Wrist-worn accelerometers in youth.** As mentioned throughout the literature review, several studies have supported the notion that the wrist location for PA-tracking devices has improved in accuracy and is more convenient and comfortable than devices worn at the waist
THE IMPACT OF ACCELEROMETER USE

(Esliger et al., 2011; Murphy, 2009). These concepts are key for promoting adherence amongst young participants in research studies that occur over a prolonged period of time.

In a qualitative study by Schaefer, Van Loan, and German (2014), 24 children aged seven to 10 years old were asked to give their acceptability and compliance of four different wearable activity monitoring devices. Each week for four weeks, the participants wore a different device: 1. Phillips Actical uniaxial, non-waterproof, accelerometer worn on the wrist, 2. SenseWear dual-axial, non-waterproof, accelerometer worn on the upper arm, 3. Polar Active uniaxial, waterproof, accelerometer worn on the wrist, and 4. Polar Heart Rate Monitor, waterproof device worn on the wrist and chest (Schaefer et al., 2014). Schaefer et al. (2014) found that children had the greatest preference for the Polar Active (ranked 3.9 out of 4, by 23 of 24 children) based on the device’s comfort, feedback feature, as well as it was “cool” and displayed the time. The SenseWear ranked the lowest of all the devices as participants stated “it was uncomfortable to wear, it was embarrassing to wear, and it made a lot of noise” (Schaefer et al., 2014, p. 3). Factors for not liking the other devices included having to remove the device to change clothes, bathe, shower or swim (Schaefer et al., 2014).

While acceptability and adherence of using wearable PA-tracking devices is important, so is the validity and reliability of the wrist-worn location. Phillips, Parfitt and Rowlands (2012) compared wrist and waist-worn accelerometers in 44 children, aged eight to 14-years-old. Each participant was fitted with a triaxial accelerometers at three locations: one on the right wrist, one on the left wrist, and one on the hip. Participants were asked to perform eight different activities of varying intensity such as watching a movie, using Nintendo Wii, walking, running, etc. (Phillip et al., 2012). Phillip et al. (2012) found that the hip-mounted monitors had marginally outperformed their wrist-mounted counterparts, but determined that the wrist-worn
accelerometer demonstrated good criterion validity at both wrist locations (right: r = .900; left: r = .910, both p < 0.01), and concurrent validity (right: r = .830; left: r = .845; hip: r = .985, all p < 0.01) across each age category. Phillips et al. (2012) also concluded that “the potential for increased feasibility and compliance that may be associated with wrist-worn monitors, may compensate for the slightly lower validity scores observed” (p. 127).

**The Fitbit.** Fitbit Incorporated, based out of San Francisco, California, represents one of the industry leaders in wearable accelerometer technology. Fitbit commands 22.2% of the wearable market, making it the number one vendor for activity-tracking gadgets (Silbert, 2015). With this notion in mind, a Fitbit device was chosen for the proposed study since it would be most likely preferred by prospective participants for use in free-living settings.

Fitbit has integrated custom-built features into its fitness-tracking devices that enhances accuracy and personalization. Before activation of a Fitbit device, the user must input their demographic characteristics such as height, weight, gender, and age (Basset & John, 2010). This demographic information allows the device to calculate steps based on stride length, and uses the data to establish resting metabolic rates and to calculate calorie expenditure (Basset & John, 2010). Fitbit utilizes this triaxial technology along with proprietary algorithms to convert accelerations into step counts and energy expenditure (Basset & John, 2010; Takacs et al., 2014). For the wrist-worn Fitbit devices, there is a dominant and non-dominant wrist setting to enhance the accuracy of step counting (Fitbit, 2016a). The non-dominant wrist setting is the default setting for all wrist-worn Fitbit devices (Fitbit, 2016a). This setting increases the step-count sensitivity to reduce under-counting, whereas the dominant-wrist setting decreased the step-count sensitivity to prevent over-counting (Fitbit, 2016a). Fitbit encourages all its user to verify their wrist-dominance settings prior to use.
In a study by Takacs et al. (2014), the Fitbit One device underwent rigorous testing to assess the validity and reliability of the internal triaxial accelerometer technology. Thirty volunteer participants (15 males and 15 females) were fitted with three Fitbit One monitors in various locations: one on the right hip, one on the left hip, and one in the front pocket of the dominant leg (Takacs et al., 2014). The participants were then asked to walk at five randomly assigned speeds on a treadmill (0.90, 1.12, 1.33, 1.54, and 1.78 m/s) (Takacs et al., 2014). Participants’ mileage travelled on the treadmill was recorded on their Fitbit One devices and was compared to the treadmill’s recorded distance (Takacs et al., 2014). The Fitbit One devices also recorded the number of steps taken by participants on the treadmill and was compared to the step count manually recorded by two researchers using video motion data (Takacs et al., 2014). All three Fitbit One monitors demonstrated strong inter-device reliability at all treadmill speeds (Takacs et al., 2014). The step-count function on the Fitbit One device was regarded as valid, with no significant difference (p < 0.05) between the researchers’ manual step count and all three Fitbit devices at different positions and at all five treadmill speeds (Takacs et al., 2014). Additionally, the inter-device reliability of the Fitbit One monitor was calculated using intra-class correlation coefficients (ICC). An ICC > 0.8 was defined as an acceptable level of agreement; Takacs et al. (2014) reported that the “inter-device reliability was excellent for all treadmill speeds, ICC ≥ 0.90” (p. 497).

In 2015, Diaz et al. investigated the validity and reliability of the Fitbit One (waist-worn) versus the Fitbit Flex (wrist-worn) for use by primary care physicians to monitor patients’ PA. Twenty-three adult participants, 10 males and 13 females, were fitted with three hip-worn Fitbit Ones, and two wrist-worn Fitbit Flexes (Diaz et al., 2015). Estimated energy expenditure and step counts from the Fitbit trackers were compared to gas exchange indirect calorimetry (Ultima
CPX, MedGraphics) and manual counting with video recording in minute epochs (Diaz et al., 2015). Diaz et al. (2015) found that the observed step count strongly correlated with estimated step counts from the hip-mounted Fitbit One (0.97 - 0.99) and wrist-worn Fitbit Flex (0.77 – 0.85). The measured energy expenditure also strongly correlated with the Fitbit One (0.86 – 0.87) and Fitbit Flex (0.88) (Diaz et al., 2015). Diaz et al. (2015) concluded that:

With the capability to wirelessly inter-face with mobile devices and the growing number of platforms/apps that provide patients a means to share health information with their physician, the Fitbit may be an accurate, reliable, and efficient tool for physicians to track the adoption/maintenance of physical activity programs and support their patient's attempt at an active lifestyle. (p.139)

The Fitbit Charge. After the production of the waist-worn Fitbit One and the wrist-worn Fitbit Flex, Fitbit Incorporated has developed several other wrist-worn devices, such as the Fitbit Charge (Figure 1). While there are no studies that have used the Fitbit Charge for purposes of research, the Fitbit Charge has the same triaxial accelerometer technology as the Fitbit Flex, and it is also worn on the wrist. With this notion in mind, the Fitbit Charge has the same validity and reliability competence as the Fitbit Flex regarding measuring step counts and possess the same feasibility standards. The advantage of the Fitbit Charge over the Fitbit Flex is the size and capability of the organic light emitting diode (OLED) display. In the Fitbit Charge, the OLED display is larger and equipped to display the time, step count, number of floors climbed, distance traveled, energy expended, battery life and caller ID. In the Fitbit Flex, the OLED is smaller and only displays five dots of lights which communicates the user’s progress to their PA goal. The Fitbit Flex does not display specific PA data such step count, distance travelled, or energy expenditure.
The Fitbit devices produced after the Fitbit Charge, such as the Fitbit Charge HR, the Fitbit Surge, and the Fitbit Blaze, were not considered for use in this study since their existence was either not known about or the device was not available at the time of the study’s design. The newest generation Fitbits are also costlier and have additional features that do not add to the purposes of the proposed study.

<table>
<thead>
<tr>
<th>Fitbit Zip</th>
<th>Fitbit One</th>
<th>Fitbit Flex</th>
<th>Fitbit Charge</th>
<th>Fitbit Charge HR</th>
<th>Fitbit Surge</th>
<th>Fitbit Blaze</th>
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<tr>
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<td>Everyday (waist)</td>
<td>Everyday (wrist)</td>
<td>Everyday (wrist)</td>
<td>Active (wrist)</td>
<td>Performance (wrist)</td>
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<tr>
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<td>Disposal button battery</td>
<td>10-14 days</td>
<td>up to 5 days</td>
<td>7-10 days</td>
<td>up to 5 days</td>
<td>up to 7 days</td>
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<tr>
<td>Charging time</td>
<td>Replace in 6 months</td>
<td>1-2 hours</td>
<td>1-2 hours</td>
<td>1-2 hours</td>
<td>1-2 hours</td>
<td>1-2 hours</td>
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<tr>
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<td>Clock</td>
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<td>Sleep tracker &amp; alarm</td>
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<td>Floors climbed</td>
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<td>Active minutes</td>
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<td>Continuous heart rate monitoring</td>
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<td>Music &amp; text notifications</td>
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<tr>
<td>GPS tracker</td>
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</table>

Figure 1. Seven generations of Fitbit devices with a list of their features and capabilities.

Theoretical Framework

Overweight and obese adolescents require significant support, education, and motivation to become more active. In a meta-analysis report, Lubans, Foster and Biddle (2008) found that
PA interventions that target self-efficacy to increase exercise, such as accelerometers, were amongst the most successful strategies to positively change behavior in youths. Accelerometers not only foster self-efficacy but they also promote teens’ developmental stage of seeking autonomy and identity (KidsHealth, 2014; Lubans et al., 2008). Using wearable technology like an accelerometer allows the adolescent to maintain control over when, where, and what type of PA they engage in. This is important since a teen may want to exercise in private if they are concerned with how they are perceived by their peers or if they are bullied during PA (Trout, 2009). Additionally, many wearable PA-tracking devices utilize smartphones and computers as the interface for receiving data. This facilitates a natural integration of the accelerometers into the technology-centered lives of adolescents.

The last 10 years of research conducted with PA monitoring devices has shown that the most effective PA interventions are those founded on theories of health behavior change (Lee, Kuo, Fanaw, Perng, & Juang, 2012; Lyons et al., 2014). The underlying premise for the use of accelerometers to monitor PA is based on the theory of self-efficacy, a central concept of Albert Bandura’s (1982) Social Cognitive Theory (SCT). The SCT has become one of the most predominantly utilized theories for understanding and predicting health behavior, as well as provides a foundation for implementing behavioral modifying strategies (Lee et al., 2012).

Self-efficacy alludes to the confidence level of an individual to participate and carry out a specific behavior (Bandura, 1982). Bandura (1982) suggests that a person’s perceived self-efficiency is directly related to their effort and persistence to embrace a particular health promoting behavior. Bandura (1982) explains that intrinsic and extrinsic sources of self-efficacy originate from feedback and information that a person acquires through performance of a behavior. For example, self-efficacy may emerge in an individual when they experience self-
perceived improvement of a physical or psychological state related to a performance behavior
(Lee et al., 2012). Individuals may also obtain self-efficacy after receiving encouragement to
execute a certain behavior, after observing others perform a similar behavior, after having a
positive experience related to a behavior, or after adopting a behavior in a comfortable way (Lee
et al., 2012).

Accelerometers have proven to be a significant source of self-efficacy in their ability to
provide instant visual feedback and provoke self-monitoring of the users’ cumulative step count
(Lubans et al., 2009). Today, many accelerometer brands offer associated software applications,
called “apps”, along with their devices that allows individuals to monitor their PA progress,
receive cyber awards for their PA behavior, and communicate and compete with other device
users (see Appendix A) (Fitbit, 2014a). Visualizing this information increases the individuals’
awareness and confidence level regarding how their health behavior decisions impact their PA
(Lubans et al., 2009). Thus, self-efficacy is referred to as a mediator of PA, defined as an
“intervening causal variable necessary to complete the pathway from an intervention to the
targeted behavioral outcome” (Figure 2) (Lubans et al., 2008, p. 464).

![Figure 2. Self-efficacy as a mediator between theory-based treatments or interventions, such as physical activity trackers, and an outcome, such as changes in activity level. Figure used with permission from Lubans et al. (2008) (see Appendix B).](image-url)
Summary

Preventing obesity amongst adolescents is critical to reducing the large financial and resource burden obesity places on the healthcare system. A reduction in obesity is also detrimental to individuals’ quality of life not only during youth but also as an adult. The literature review emphasizes how physical activity is an essential component to decreasing obesity and lessening obesity-induced comorbidities. Physical activity habits are especially important to establish during adolescences when teens are adopting behavior they will carry with them into adulthood. Wearable activity monitors may serve as an effective long-term strategy that promotes healthy PA behavior in youth. Specifically, the Fitbit Charge is a waterproof, wrist-worn accelerometer that has the technology and design to accurately measure PA while promoting user compliance. The Fitbit Charge also provides real-time valuable feedback to its user through an OLED display and the Fitbit smartphone application and website. This feature is a key component to the theory of self-efficacy, the notion that using fitness tracking devices may increase awareness and confidence levels pertaining to PA. This makes the Fitbit Charge a valuable research tool and the primary intervention of this proposed study. The results from this study would help to fill a gap in research since, to date, there are no known longitudinal studies that utilize the Fitbit Charge as a tool to change PA and adiposity in overweight and obese adolescents.
CHAPTER THREE: METHODOLOGY

The previous chapter highlighted important concepts from the literature review including the need for an accurate and feasible intervention that will increase physical activity (PA) in teens. At present, there are no studies that utilize wrist-worn, waterproof accelerometers in obese teens over an extended period of time to enhance PA and reduce adiposity. Research using PA-tracking devices on the wrist in adolescents offers a promising, sustainable method for obesity reduction and prevention in teens. Implementation of accelerometers within the context of self-efficacy and the social cognitive theory, heightens the potential for increasing reported self-efficacy and increasing overall PA. This chapter will discuss the research question and hypothesis, operationalization of research variables, research design, research setting, research instruments, data collection process and management, biases and limitations, and ethical considerations.

Research Question and Hypothesis

There are two research questions for this study:

1. Will 8-months use of the Fitbit Charge accelerometer by overweight (body mass index $\geq 85$th to $< 95$th percentile) or obese ($\geq 95$th percentile) 14-year-olds, residing in San Diego County, lead to a statistically significant increase in PA behavior and statistically significantly decrease in body mass index (BMI) and waist circumference (WC)?

2. Will 8-months use of the Fitbit Charge by overweight or obese 14-year-olds show a statistically significant increase in levels of reported self-efficacy when compared to levels found in the beginning of the study?

The hypotheses for this study are theory driven and directional. The hypothesis for the first research question is: Long-term use of the Fitbit Charge accelerometer will lead to
statistically significantly increased PA, and statistically significantly decreased BMI, and decreased WC in overweight and obese 14-year-olds. The hypothesis for the second research question is: Long-term use of the Fitbit Charge accelerometer will show a statistically significant increase in self-reported scores of self-efficacy.

**Operationalization of the Research Variables**

The independent variable in this proposed study is PA level as measured by the Fitbit Charge accelerometer, the intervention of this study. At the beginning of the study, a baseline measurement of participants’ PA will be obtained over a seven-day period while the Fitbit Charge display screen is sealed from participants’ viewing. During this period, the Fitbit Charge will be used as a measuring instrument only. Once the device is unsealed, the Fitbit Charge remains the primary instrument to measure PA, as well as assumes the role as the study’s primary intervention to examine the effects of the device on PA, BMI and WC. The dependent variables in this proposed study are PA, BMI, WC, and self-efficacy.

**Physical activity.** The Fitbit Charge will operationalize the PA variable using internal triaxial technology that converts accelerations of body movement into digital data that continuously tallies steps 24 hours a day, 7 days a week. The data collected by the Fitbit Charge automatically and wirelessly uploads to the Fitbit smartphone app where individuals can view their average daily step count and PA output. The primary investigator (PI) will access this information from each participant’s smartphone device on data-collection days and record the step-data in a composition notebook. All data points will be transcribed electronically into SPSS on the PI’s password-protected laptop, which is kept in a locked office. The Fitbit should be worn at all times by participants, including during all activities such as physical education class and during any sports. The Fitbit should only be removed at night to charge the device. If the
participant is asked to remove the device for a specific activity, the participant should notify the PI immediately.

**Body mass index.** BMI is an interval-level variable and calculated based on age, gender, height, and weight. Age and gender will be obtained through participants’ self-report. Participants’ height and weight will be obtained using methods recommended by the CDC (2014d). For height, adolescents will remove their shoes and any bulky clothing such as sweatshirts (CDC, 2014d). Participants will then stand with their feet together, look straight ahead and their height will be measured using a height rod stadiometer and recorded in feet and inches to the nearest 1/8th inch (CDC, 2014d). Weight will be measured using a digital scale that is calibrated before each use. Participants will stand on the scale with their shoes off and with their feet in the center of the scale; their weight will be recorded in pounds to the nearest decimal (CDC, 2014d). Age, gender, height and weight will then be entered into the CDC’s (n.d.) BMI calculator (formula= weight (lb.) / [height (in)]² x 703) for children and teens to obtain the final BMI percentile. All data points will be transcribed electronically into the PI’s password-protected laptop, which is kept in a locked office.

**Waist circumference.** Waist circumference (WC) will be measured using a non-stretchable tape measurer on bare skin measured just above the iliac crest (Aeberli et al., 2013; Jago, Mendoza, Chen, & Baranowski, 2013). WC will be measured to the nearest 0.1cm (Aeberli et al., 2013; Jago et al., 2013). All data points will be transcribed electronically into the PI’s password-protected laptop, which is kept in a locked office.

**Self-efficacy.** The participants’ self-efficacy score will be operationalized by the adolescents’ Self-efficacy to Overcome Barriers to Physical Activity Scale. The participants’
scores will be transcribed electronically into the PI’s password-protected laptop, which is kept in a locked office.

**Demographic variables.** Demographic variables will include participants’ first name and last name initial, age, gender, ethnicity, home phone number, cell phone number, and email address if available. This information will then be transcribed electronically onto a spreadsheet; paper remnants will be destroyed. Participants’ names will be assigned an identification (ID) number. The PI will retain the names and corresponding ID numbers on a password-protected laptop computer. Collecting age and gender information is to ensure inclusion/exclusion criteria are met, and for calculation of BMI. Collecting ethnicity information is to distinguish any disparities of health outcomes related to ethnicity. Phone numbers and email addresses are necessary to remind participants of data-collection meetings every 6-weeks.

**Research Design**

In consideration of the length of time to conduct the proposed research study, other comparable studies were examined. According to a systematic review by Lubans et al. (2009), the length of time of previous similar studies varied from 20 minutes to six months. Of the 14 studies that were included in the systematic review, 12 resulted in increased PA amongst youth (Lubans et al., 2009). Of the two studies that did not report significant findings, one study was three weeks in duration and the other was 20 weeks in duration (Lubans et al., 2009). Lubans et al. (2009) concluded overall “since there are so few studies at this time, there is ample need and opportunity to contribute to the knowledge base” (p. 307). Given Lubans et al.’s (2009) findings, the proposed research study was not confined to a specific period of time. In fact, to gain a better understanding of the long-term sustainability of PA monitoring devices as an intervention to
increase PA, this study is designed to last 8-months. As a result, the novelty in length of this study will help to bridge a gap in research regarding sustainability of accelerometer use.

A longitudinal repeated measures design will be employed to examine the effects of accelerometers worn by participants for an 8-month period. A total of six measurements will be made over 8 months in 6-week intervals (Figure 3). Six-week data collection intervals were recommended in this longitudinal design to decrease likelihood of attrition by the adolescent participants (L. Axman, personal communication, December 2, 2014). Incentives will be provided on these days, as well as any needed re-education pertaining to device usability or compliance (L. Axman, personal communication, December 2, 2014). The first data set or pre-intervention measurements, will be collected over a 7-day period and serves as the baseline PA data for the study.

\[ \text{Figure 3. Timeline of repeated measures ANOVA longitudinal research design} \]
Research Setting

The proposed study will be conducted in a high school in San Diego, California that is representative of the target population. The PI will meet with participants every six weeks to measure their BMI, WC, and PA output. These data-collection meetings will occur at the selected high school, during participants’ physical education (PE) class, as pre-arranged with their PE teacher. Physical education classes are a requirement for all 14-year-olds in the 9th grade, unless exempt per California Education Code (California Department of Education [CDE], 2015a).

Sampling

Recruitment strategy. The participants for this study will be recruited over a one-month period using convenience sampling (Polit & Beck, 2012). According to Shrewsbury et al. (2009) and Nguyen et al. (2012), the strategic areas to recruit overweight and obese adolescents is through schools, media, health professionals and community organizations. Distributing recruitment flyers in the school will be used since that method was deemed most successful and cost-effective in previous research (see Appendix C) (Nguyen et al., 2012; Shrewsbury et al., 2009). The flyers will instruct potential participants and their legal guardian(s) to attend the selected school’s “Fall Open House” night at the beginning of the school year. The study will be explained at that time and any interested parents and participants will be given informed consent and assent forms to sign. IRB approval from the research university will be obtained.

Target population. The target population for this study includes any overweight and obese 14-year-olds entering the 9th grade in San Diego County, or potentially 8,558 teens (see Appendix D). This target population represents the entire group by which this study aims to
make generalizations about its findings. One selected high school in San Diego County will serve as the accessible population for which the PI will conduct convenience sampling.

The rationale for targeting 14-year-old participants for this study is multifactorial. First, Fitbit requires all its users are 13-years of age or older (Fitbit, 2014f). Second, California Education Code Section 51225.3 states that all high school students are “required to complete two years of PE in order to be eligible to graduate” (CDE, 2015a). Therefore, the 14-year-olds entering the 9th grade in the selected high school for this study will be required to take PE class; the PE class will serve as a supportive backdrop for the participating students, as well as allow the PI an appropriate time and place to collect the 6-week interval data.

When selecting the most appropriate high school for the proposed study, the PI used the most recent fitness and wellness data collected by California public school districts for grades 5th, 7th and 9th, as mandated by California Education Code Section 60800 (Corcos, Kong, Sampson, Cooke, & Ray, 2011). Utilizing a database called the FITNESSGRAM Aerobic Capacity Atlas, all 9th grades in the San Diego Unified School District were analyzed to locate the most representative school for the proposed study that was also feasible distance to the primary investigator (see Appendix E). FITNESSGRAM® uses objective criteria to evaluate adolescents’ performance in six fitness areas: body composition, abdominal strength/endurance, trunk extensor strength/flexibility, upper body strength/endurance, and flexibility (CDE, 2015b; Corcos et al., 2011). The goal for each school is to have as many students as possible qualify as healthy individuals, or in the “Healthy Fitness Zone” (HFZ) (CDE, 2014). If the fitness goals are not met, the student is either categorized as “needs improvement” (NI), or “needs improvement and has a health risk” (NI-HR) such as obesity (CDE, 2014). The chosen public high school for this study has 1,200 students in grades nine through 12. The school’s 2013-2014 California
FITNESSGRAM® report for 9th graders included 63.5% of students in the HFZ, 16.1% of students in the NI zone, and 20.4% of students in the NI-HR zone (CDE, 2015c). This school is reflective of the CDC’s (2014a) national report of adolescent obesity at 20.5%. This school is also reasonable distance to the PI’s residence. Approval by the school district, principal and physical education teacher will be obtained.

**Sample size.** The required sample size for this study was determined by a power analysis using G-power software for $f$-test with repeated measures ANOVA design, within factors. According to the literature review, an effect size for this type of intervention and research design was high, approximately 0.60 due to the strength of the relationship between the research variables (Lee et al., 2012). However, to account for the novelty of implementing a new accelerometer device, and based on the recommendations of Polit and Beck (2012) to use an effect size in the range of 0.20 and 0.40, the G-power calculation was performed with an effect size of 0.30. An alpha level of 0.05 was used based on conventional standards, and a power equal to 0.80 (Polit & Beck, 2012). Factoring in the six measures in this study, the G-power calculation is $n=14$ (see Appendix F). An attrition rate of 50% was applied to the G-power calculation of $n=14$, resulting in a final total group size of $n=21$.

**Inclusion and exclusion criteria.** In order to partake in the proposed study, participants must meet the following inclusion criteria:

1. Participant is 14 years old.
2. Participant is enrolled in the 9th grade at the selected high school.
3. Participant is overweight (BMI $\geq$85th to <95th percentile) or obese (≥95th percentile).
4. Participant is inactive (i.e., no physical activity) or insufficiently active (i.e., some PA but does not meet guidelines) (Carlson, Fulton, Pratt, Yang & Adams, 2015).
5. Participant is able to read and speak English.

6. Participant owns a smartphone device (iOS or Android) or has daily access to one.

7. Participant agrees to comply with the demands of the study including wearing the device during wakeful hours and attending seven meetings over an 8-month period.

Exclusion criteria for this study includes participants with any of the following conditions: muscle, bone, or joint problems that limits the participants ability exercise, cardiac problem(s) that requires PA limitations, fainting with exercise in the past six months, blood pressure in the 95th percentile for age and gender (boys ≥132/84, girls ≥129/84) not controlled with medication, uncontrolled asthma, diabetes with frequent very low or very high blood glucose levels, seizures not controlled with medication, thyroid dysfunction not controlled with medication, sickle cell disease, anorexia nervosa, cystic fibrosis, severe kidney problems, or severe liver problems, and any blood condition that increases the risk of bleeding (National Institutes of Health, 2004; Stevens et al., 2005). Further exclusion criteria includes the unwillingness of a parent or guardian to support or assist their adolescent with the device such as charging the device, syncing the device, or encouraging compliance with wearing the device (Farpour-Lambert et al., 2009). Any adolescent that anticipates relocation to another town, city, or state during the study will not be allowed to participate (Farpour-Lambert et al., 2009).

Research Instruments

**Fitbit Charge.** The Fitbit Charge will be used to measure PA in this proposed study. The Fitbit Charge is comprised of the same technology that its predecessor, the Fitbit Flex, uses to track PA. The Fitbit Flex triaxial accelerometer, as an instrument to measure PA, was found valid and reliable by Diaz et al. (2015) in a study of 23 adult participants. Ten males and 13 females were fitted with two wrist-worn Fitbit Flex devices and three hip-worn Fitbit One
devices (Diaz et al., 2015). Estimated energy expenditure and step counts from the Fitbit trackers were compared to gas exchange indirect calorimetry and manual counting with video recording (Diaz et al., 2015). Diaz et al. (2015) found that the observed step count strongly correlated with estimated step counts from both the hip-mounted Fitbit One (0.97 - 0.99) and wrist-worn Fitbit Flex (0.77 – 0.85). The measured energy expenditure also strongly correlated with estimated energy expenditure calculated by the Fitbit One (0.86 – 0.87) and Fitbit Flex (0.88) (Diaz et al., 2015). The inter-device correlation between the left wrist Fitbit Flex and and the right wrist Fitbit Flex was 0.95 (energy expended) and 0.90 (steps taken) (Diaz et al., 2016). Diaz et al. (2015) concluded that the Fitbit Flex devices “reasonably and reliably estimate step counts and energy expenditure during walking and running (two of the most common activities among primary care patients)” (p.138-139).

The Fitbit Charge was soon released after the development of the Fitbit Flex. While there are no validity or reliability studies that exist on the Fitbit Charge, the Fitbit Charge poses the same technological and feasibility means as the Fitbit Flex. The Fitbit Charge also has the appropriate organic light-emitting diode display and therefore, was deemed the most appropriate instrument for this study.

**Adolescent self-efficacy scale.** The adolescents’ Self-efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS) will be used to measure self-efficacy in this proposed study (see Appendix G). Since self-efficacy is a major determinant of PA in teens, tools that measure self-efficacy can help researchers assess the effectiveness of interventions like the proposed use of the Fitbit Charge device. Many scales that assess self-efficacy intend to evaluate individuals’ confidence and motivational levels to engage in PA despite potential personal, social or situational barriers (Dwyer et al., 2012). The SOBPAS was developed specifically for
adolescents by Dwyer et al. (2012). The scale contains 24-items measured on a Likert scale that reflect teenage-specific barriers to engaging in PA such as, lack of time to exercise due to school or work responsibilities, feeling tired, not having friends to work out with, feeling intimidated or stressed due to PA competition, having a preference for watching television or using entertainment media, and feeling self-conscious or being teased when performing PA (Dwyer et al., 2012).

Dwyer et al. (2012) tested the validity and reliability of the adolescents’ SOBPAS in a study of 484 subjects aged 14 to 18-years-old in Toronto, Ontario, Canada. The authors found that the Cronbach’s coefficient alpha for the SOBPAS subscale was .86 for internal barriers, .81 for harassment barriers, .80 for social barriers, and .79 for responsibilities barriers; these values were all greater than the recommended .70 value (Dwyer et al., 2012). The researchers also used structural regression to examine the relationship between PA measures (METs hours/week) and the five SOBPAS subscales, finding that SOBPAS latent factors and PA level were all statistically significant (P< .001). Dwyer et al. (2012) concluded that SOBPAS is a “multidimensional measure of self-efficacy to overcome barriers and has good construct validity, internal consistency reliability, and predictive validity” (p. 520). Permission to use this scale was obtained from Dr. John Dwyer, associate professor in the Department of Family Relations and Applied Nutrition at the University of Guelph, Ontario, Canada (see Appendix H).

Demographic tool. Basic demographic data will be collected via survey form. Demographic information will include participants’ first name and last name initial, age, gender, ethnicity, a reliable home and cell phone number, and email address if available (see Appendix I).
Exit-study questionnaire. An exit-study questionnaire will be administered to participants during the last data-collection meeting (see Appendix J). The purpose of this questionnaire is to gather information on possible confounding variables such as the use of concurrent social media platforms like Facebook and Twitter as possible sources of motivation, as well as the presence of familial support, changes in eating habits, etc. Participants will also be asked about how how often they removed the device or did not wear the device during wakeful hours.

Data Collection Process & Management

The following steps outline the data collection process and management of the proposed study:

1. IRB approval will be obtained from the research university.
2. Permission from the San Diego Unified School District will be obtained for the selected high school.
3. Recruitment of participants will begin on the first day of school in late August.
4. The proposed study will be explained to all interested parents/guardians and participants during the school’s Fall Open House night in late September. Informed consent will be obtained from each parents/guardian and assent forms will be obtained from each participant. The informed consent and assent will outline the purpose of the study, risks and benefits, confidentiality, and incentives (see Appendix K). Basic demographic variables will be collected via survey form with pen and paper during the Fall Open House night.
5. Data collection will begin in early October, at the first meeting (lasting approximately 30 minutes). All meetings will be conducted by the PI and assistant researcher and take place during the participants’ PE class in a private setting, such as in the office of the PE teacher.
At the first meeting each participant will have their BMI and WC measured, and be asked to complete the SOBPAS. Participants will receive their Fitbit Charge and be provided assistance to activate their tracker using the Fitbit app on their smartphone device (see Appendix L). The screen of each Fitbit Charge will be temporarily covered with electrical tape so participants cannot receive visualize feedback from the device (Bravata et al., 2007). For seven days, the participants will be prohibited from accessing their Fitbit app and be asked not to alter their daily activities or routines. The battery life of the Fitbit Charge is from seven to 10 days, however participants will be instructed to remove and charge their Fitbit device every night preferable next to their smartphone (Fitbit, 2016b). This will ensure adequate daily battery life, daily synchronization of data with the smartphone, and help the participants establish a daily habit of putting on the device. Charging time for the device takes 1-2 hours (Fitbit, 2016b). Participants will be provided the PI’s personal contact information with instructions to call the PI immediately for any lost or broken equipment, and for any situations in which the participant is being asked to remove the device.

6. The second meeting (lasting approximately 20 minutes) will take place one week after the first meeting. The electrical tape will be removed from each participants’ device and the baseline PA level will be obtained from the participant’s Fitbit app on their smartphone. This information will be recorded as average steps per day and reflect the first PA measurement. The PI will record the participants’ step data into a notebook and then transcribed the data into Statistical Package for the Social Science (SPSS) software on a password-protected laptop. Any paper remnants will be destroyed. Participants will then receive a 10-minute tutorial on how to use their Fitbit Charge. The tutorial will cover how to charge their device, how to sync the device to their smartphone, and each participant will demonstrate how to
access and read their Fitbit app. Participants will be encouraged to charge their Fitbit battery every night. Participants will also be given an informational brochure (see Appendix M) that summarizes the education covered in the tutorial, as well as the website for Fitbit “help”. Participants will be counselled to notify the PI immediately for any lost or broken equipment, and for any situations in which the participant is being asked to remove the device (e.g. specific sports). Participants will be educated regarding the importance of continuous use of their Fitbit Charge throughout the duration of the study.

7. After the second meeting, the PI will meet with participants every six weeks at school during their PE class. These meeting days will be scheduled around school holidays and breaks. Each meeting will take 10-15 minutes per participants. At each meeting, participants will continue to have their BMI, WC and PA level measured. This data will be obtained in privacy with the PI and the assistant researcher presents.

8. At the last data-collection meeting (lasting approximately 20 minutes), the participants will have their BMI, WC and PA level measured, retake the SOBPAS, and take an exit-study questionnaire.

9. All data will be recorded and stored in a password-protected laptop computer belonging to the PI. Statistical Package for the Social Science software, version 20, will serve as the statistical analysis program for the study data, which will also be on the PI’s password-protected laptop.

**Data coding.** To maintain confidentiality and to limit data-entry errors, participants’ names will be coded in SPSS as an identification (ID) number (Polit & Beck, 2012). For example, a participant named Brittany will be assigned ID #1, a participant named Scott will be assigned ID #2, a participant named John will be assigned ID #3, a participant named Michelle
THE IMPACT OF ACCELEROMETER USE

will be assigned ID #4, and so forth. Gender will be coded as 0 for female and 1 for male (Polit & Beck, 2012).

**Test statistics.** In this proposed study, there will be a total of six measurements over an 8-month period. The repeated-measures ANOVA (RM-ANOVA) to compute the \( f \)-statistic is the most appropriate statistical test for this study. In this single-group longitudinal design, RM-ANOVA assumes that three or more measurements of the same dependent variable for each participant will be calculated (Kellar & Kelvin, 2012; Polit & Beck, 2012). The proposed study also meets the other assumptions for RM-ANOVA testing, including the assumption that the dependent variables are measured at the continuous level, either interval or ratio (PA = ratio, BMI = interval, WC = ratio), the measures constitute an independent sample, the dependent variable is somewhat normally distributed, there is no potential for carryover effects, and there is no compound symmetry (Kellar & Kelvin, 2012, p. 221). RM-ANOVA is also beneficial to this research design because it yields a more sensitive test of the relationship between the independent and dependent variables (Polit & Beck, 2012). A significance level will be defined for \( \alpha = 0.05 \).

In addition to RM-ANOVA, an independent \( t \)-test will be employed to compare the mean self-efficacy scores (SOBPAS) from pre to post-implementation of the Fitbit Charge (L. Axman, personal communication, December 9, 2014). The independent \( t \)-test is appropriate for this dependent variable analysis since the total sample size contains at least 15 or more participants (\( n = 21 \)), also the dependent variable is of interval level and dichotomous, and the data will be evaluated for normality of distribution. In the event the data is not normally distributed, the Wilcoxon signed-rank nonparametric test will be considered (Kellar & Kelvin, 2012, p. 99; L. Axman, personal communication, December 9, 2014). The degrees of freedom (\( df \)) for this \( t \)-test
equals the total sample size minus 2 ($df = n-2$), therefore the $df = 19$ (Kellar & Kelvin, 2012, p. 98). And, for a significance level of $\alpha = 0.05$ and $df = 19$, the critical value for the two-tailed $t$-statistics is 2.093 (Kellar & Kelvin, 2012, p. 98-99, 517).

**Biases and Limitations**

The primary source of bias in this study is related to the use of a convenience sampling technique. Volunteer or sampling bias occurs during convenience sampling because participants volunteer or self-select themselves for the study (Polit & Beck, 2012). Those who volunteer for the study may carry traits such as motivation or have newly found enthusiasm (the novelty effect), which may not reflect the target population and may result in poor generalizability of findings (Polit & Beck, 2012). Also, the Hawthorne effect may exist when participants are aware they are in a study, and as a result may alter their behavior simply based on that notion versus in response to the intervention (Polit & Beck, 2012). Response bias is also a possibility if the participant wants to be a good experimental subject and have things “turn out well” for the researcher (Polit & Beck, 2012).

Expectation or researcher bias is another important concept to discuss since the PI owns a Fitbit device and is a fitness enthusiast. Expectation bias may occur if the PI subtly communicates their expectations to the participants in the study (Polit & Beck, 2012). Thus, cognizance of personal views and attitudes, especially while interacting with participants, will be imperative as to not influence or bias the participants’ behavior. The PI and the research assistant will not wear any accelerometer devices during interactions with the participants.

Limitations of this longitudinal design are primarily related to its longevity. While stability, continuity and normative trends can be better identified through a longitudinal design, it can be expensive and time-consuming for both participants and researchers, and also difficult to
replicate (Polit & Beck, 2012). The study is more vulnerable to internal validity threats such as attrition, history, and maturation (Polit & Beck, 2012). Additionally, the participants being selected for the study may not represent all 14-year-olds, so generalization of findings will be done with caution.

**Threats to internal validity.** History is a naturally occurring internal validity threat to this study due to its longitudinal design (Polit & Beck, 2012). History is the possibility of external events taking place concurrently to the study’s independent variable that causes the dependent variable to be skewed (Polit & Beck, 2014). For instance, if a participant experiences a stressful event such as a death in the family, the participant may lose or gain weight related to this event versus use of the accelerometer device. Maturation is also a naturally occurring threat to the internal validity of this study (Polit & Beck, 2012). For example, as time passes physiologic changes in the adolescents will occur such as alterations in metabolism and growth in height and weight, which will impact the dependent variables like BMI (Polit & Beck, 2012). This will be controlled for by also measuring the WC of each participant as it is less affected by these physiological changes over time. Natural changes in psychological status, such as development of self-determination may also impact the measured outcomes, however this cannot be controlled for (Polit & Beck, 2012).

Other threats such as attrition and nonadherence to the study’s design (i.e. does not wear or charge the device) will be controlled for as much as possible through reminders during data-collection meetings every 6-weeks. Parents will be encouraged to make sure their teen is wearing the accelerometer and using it appropriately (i.e. keeping it charged). Also, participants and their parents will be provided the Fitbit “help” website and the PI’s personal phone number to call if any questions arise or problems with accelerometers occur (i.e. device malfunction). Monetary
incentives in the form of Target® gift cards will be given at each data-collection point to encourage participation and reduce chances of attrition.

**Ethical Considerations**

This study involves adolescents, a vulnerable population in any type of research design (Polit & Beck, 2012). To protect this population, the PI has completed the Collaborative Institutional Training Initiative (CITI) program certification for vulnerable populations, and has filled out the required forms for approval by the California State University San Marcos Institutional Review Board (IRB). Permission will be obtained from the San Diego Unified School District before initiation of the study. The PI will ensure that parents and participants are well informed prior to commencement of the study, and both parent and adolescent have completed an informed consent/assent. The informed consent will outline all the details of the study in easy-to-understand wording, including potential benefits for the participants (e.g., increased PA, decreased BMI and WC, and/or overall acute and long-term improvements in health) and potential risks (e.g., no improvement or worsening PA levels, BMI and WC; emotional disturbances such as stress, anxiety, or embarrassment). Participants and parents will also be made aware that this study is not meant to provoke any stress, anxiety, or injury, and that withdrawal from the study is permitted at any time. Confidentiality and housing of the participants’ personal information will be maintained throughout the duration of the study on the PI’s password-locked personal computer.

**Incentives.** Other ethical considerations like incentives are important to discuss (Frederick, 2009). Attrition rates are higher in adolescents, especially in a longitudinal design, thus many studies utilize incentives as a form of retaining their participants (Demby, Gregory, & Lewis, 2013). This study proposes the use of Target® gift cards, of increasing amounts, as an
incentive to the participants. The gift card will be awarded in modest increasing amounts beginning at the second meeting with the participants and at every subsequent data-collection meeting (Frederick, 2009). The initial incentive amount will be $10 and will increase by $5 at each consecutive meeting: $15, $20, $25, $30, $35. The total gift card incentive will amount to $135 over 8 months. Participants will get to keep their Fitbit Charge ($130 value) upon completion of the study. Theses incentives are pending IRB approval and budgetary considerations.

Summary

A reduction in adolescent obesity and its preventable health-related diseases would decrease the financial burden and resource allocation endured by the healthcare system. By using a sustainable intervention such as the Fitbit Charge to reduce obesity through self-efficacy-mediated PA, adolescents may develop healthy behaviors they can carry with them into adulthood. The findings from this study may have the potential to decrease the prevalence and severity of obesity in teens, as well as may help to fill a gap in research that supports the use of accelerometers by frontline providers in a diagnostic and prescriptive manner that aims to promote health and quality of life in patients of all ages.
CHAPTER FOUR: GRANT ELEMENTS

The final chapter of this proposal will discuss the grant elements of this proposed research study. This includes a description of the final grant selection, as well as an examination of the budget and budget justification. Also, a timeline of events will be outlined in addition to the final dissemination plan.

Final Grant Selection

The National Institutes of Health (NIH) aims to prevent disease and promote health through the collection of data in evidence-supported research. Since the NIH recognizes the difficulty to reverse obesity in America’s youth, the agency has developed a handful of Funding Opportunity Announcements. Amid these opportunities is Research Project Grant (R01) number PA-14-177 titled, Healthy Habits: Timing for Developing Sustainable Healthy Behaviors in Children and Adolescents (National Institutes of Health [NIH], 2014). This research grant allows up to $275,000 in funding for a two-year project (NIH, 2014). This grant opportunity opened in May 2014 and closes in May 2017 (NIH, 2014). The purpose of this funding opportunity is to encourage applicants to employ innovative research to positively influence sustainable health behavior(s) in children and adolescents (NIH, 2014). The applicant’s innovation should target cultural and social factors including, but not limited to, families, schools, communities, food industry, social media, social networking, age-appropriate learning games and tools, technology and mass media (NIH, 2014). Amongst the topics to be addressed in this research project grant PA-14-177, is the need for sustainable and effective processes for promoting positive health behavior choices in youth through the role of technology and new media (NIH, 2014).
## Budget

Program Director/Principal Investigator (Last, First, Middle):

Hutton, Shannon, Eileen

### DETAILED BUDGET FOR INITIAL BUDGET PERIOD

**DIRECT COSTS ONLY**

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**SUBTOTALS**

$57,000

**CONSULTANT COSTS**

Statistician

$2,000

**EQUIPMENT (Itemize)**

Fitbit Charge, dual-USB charger, and charging cable ($4,644)

Digital scale, retractable measuring tape ruler and height rod stadiometer ($301)

Laptop computer, wireless printer, and back-up external hard drive ($2,795)

$7,740

**SUPPLIES (Itemize by category)**

SPSS IBM 21.0 ($1,330)

General office supplies, e.g. copy paper, pencils, pens, copier expenses, postage ($355)

$1,685

**TRAVEL**

Fuel costs for travel to and from research study site

Dissemination of study findings: 9th Biennial Childhood Obesity Conference, 38th National Conference on Pediatric Healthcare, and 10th International Conference on Health Informatics

$5,003
### THE IMPACT OF ACCELEROMETER USE INPATIENT CARE COSTS

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<td>SUBTOTAL DIRECT COSTS (Sum = Item 8a, Face Page)</td>
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<tr>
<td>TOTAL DIRECT COSTS</td>
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<td>0</td>
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TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD $76,263
Shannon Hutton, MSNc, RN will serve as the primary investigator (PI) on this novice study regarding the application of fitness-tracking devices on overweight and obese adolescents. Shannon has been practicing as a registered nurse for over seven years, working exclusively in the emergency department setting. She is currently enrolled in the Family Nurse Practitioner program at California State University San Marcos where she has researched and developed the proposed study. Shannon will elicit the help of her research chair advisor, Dr. Pamela Kohlbry, her content expert, Dr. Wendy Hansbrough, her three research assistants (TBD), and a statistician (TBD), to ensure her study is executed in the most professional and accurate manner as possible. As PI, Shannon will play a predominant role in recruitment of participants, data collection, data analysis, and act as general coordinator of the study processes including meetings with the study participants and assistant personnel. Shannon will allocate 40% of her time or 500 hours (approximately 15 hours per week for 32 weeks) at $65 per hour to the proposed study, thus requesting $32,500 over the entire study period.

Dr. Pamela Kohlbry, Ph.D., RN, CNL will serve as the advisor for this proposal. Dr. Kohlbry is an Associate Professor at California State University San Marcos, School of Nursing and a nurse researcher. Her research interests focus on health promotion, health informatics, quality of life, chronic illness and cultural competency. Dr. Kohlbry is a doctorally-prepared nurse and has worked over 35 years in the field of nursing. As an advisor she will provide essential mentoring for the PI ensuring successful role out and completion of study. Dr. Kohlbry will allocate 10% of her time or 100 hours of assistance at $100 per hour for a total of $10,000 for the entire grant proposal.

Dr. Wendy Hansbrough, Ph.D., RN, will serve as the content expert for this proposal. Dr. Hansbrough is an Assistant Professor at California State University San Marcos, School of Nursing and a nurse researcher. Her research interests focus on nursing presence and leadership. Dr. Hansbrough is a doctorally-prepared nurse and has worked over 25 years in the field of burn unit nursing. She will serve as a content expert to ensure that the research is theoretically based and methodologically sound. Dr. Hansbrough will allocate 10% of her time or 100 hours of assistance at $100 per hour for a total of $10,000 for the entire grant proposal.

To Be Determined, Research Assistant one (1), will serve as the primary in-field support person for the PI. The best candidate for this grant proposal would be a nursing student working toward their bachelor of science in nursing degree. The research assistant will be bilingual in Spanish and English, and preferably with professional or volunteer experience as a research assistant in the health care setting. The research assistant will be asked to completed the CITI training on the protection of human participants in research. The candidate should live within a 50-mile radius of the selected research site and have access to a vehicle for travel to the site. The assistant will support the PI in recruitment of adolescent participants by helping to print and hang flyers in the selected school. The research assistant would help to educate school faculty regarding the proposed study so they may employ non-coercive verbal advertisement in the presence of prospect participants. The assistant will aid in collection of consent and assent forms during Fall Open House night and provide translation for Spanish-speaking parents and translation of forms. The assistants will aid with data collection and input including BMI, WC, and PA, as well as ensure
completeness of SOBPAS questionnaires. The research assistant will devote 25% of their time to this project requiring reimbursement for time, translation, and travel to and from study site. The research assistant will provide 150 hours of service at $10 per hour for a total of $1,500 for the entire grant proposal ($10 x 150 hours = $1,500).

To Be Determined, Research Assistant two (2), will serve as the primary in-field support person for the PI. The best candidate for this grant proposal would be a nursing student working toward their bachelor of science in nursing degree. The research assistant will be bilingual in Spanish and English, and preferably with professional or volunteer experience as a research assistant in the health care setting. The research assistant will be asked to completed the CITI training on the protection of human participants in research. The candidate should live within a 50-mile radius of the selected research site and have access to a vehicle for travel to the site. The assistant will support the PI in recruitment of adolescent participants by helping to print and hang flyers in the selected school. The research assistant would help to educate school faculty regarding the proposed study so they may employ non-coercive verbal advertisement in the presence of prospect participants. The assistant will aid in collection of consent and assent forms during Fall Open House night and provide translation for Spanish-speaking parents and translation of forms. The assistants will aid with data collection and input including BMI, WC, and PA, as well as ensure completeness of SOBPAS questionnaires. The research assistant will devote 25% of their time to this project requiring reimbursement for time, translation, and travel to and from study site. The research assistant will provide 150 hours of service at $10 per hour for a total of $1,500 for the entire grant proposal ($10 x 150 hours = $1,500).

To Be Determined, Research Assistant three (3), will serve as the primary in-field support person for the PI. The best candidate for this grant proposal would be a nursing student working toward their bachelor of science in nursing degree. The research assistant will be bilingual in Spanish and English, and preferably with professional or volunteer experience as a research assistant in the health care setting. The research assistant will be asked to completed the CITI training on the protection of human participants in research. The candidate should live within a 50-mile radius of the selected research site and have access to a vehicle for travel to the site. The assistant will support the PI in recruitment of adolescent participants by helping to print and hang flyers in the selected school. The research assistant would help to educate school faculty regarding the proposed study so they may employ non-coercive verbal advertisement in the presence of prospect participants. The assistant will aid in collection of consent and assent forms during Fall Open House night and provide translation for Spanish-speaking parents and translation of forms. The assistants will aid with data collection and input including BMI, WC, and PA, as well as ensure completeness of SOBPAS questionnaires. The research assistant will devote 25% of their time to this project requiring reimbursement for time, translation, and travel to and from study site. The research assistant will provide 150 hours of service at $10 per hour for a total of $1,500 for the entire grant proposal ($10 x 150 hours = $1,500).

Consultant: A statistician will serve as an essential consultant member to the research team, leading the initial coding of the demographic data, inputting data throughout the study into the SPSS 21.0 analysis software, and assisting in final data analysis and interpretation. The ideal applicant, to be determined, will be at least a masters-prepared statistician with experience in statistical analysis of data in research studies. The statistician will allocate 10% of their time to
this grant proposal or provide 50 hours of service at $40 per hour for a total of $2,000 for the entire grant proposal.

**Equipment:** Fitbit Charge device, dual USB wall-charger, and charging cable: The proposed study requires a minimum of 21 Fitbit Charge devices ($130/device) to equip all participants. Each Fitbit Charge package includes a charging cable, but no wall charger. To account for defective, broken or lost devices, nine additional Fitbits will be ordered for a total of 30 Fitbit Charges. This is necessary since Fitbit does not produce replacement wrist straps or batteries for the Charge device. Thirty dual-USB wall chargers ($7/charger) will be ordered so participants can charge their Fitbit device in an electrical wall outlet, and have the option to charge their iPhone simultaneously. Thirty additional charging cables ($7/cable) will be ordered to replace lost charging cables. The estimated total cost for this equipment, including 7.5% California tax, is $4,494 ($130/Fitbit x 30 devices + $7/dual-USB wall charger x 30 + $7/cable x 30 + tax).

Measuring devices: The proposed study requires at least two digital scale ($30/scale), two retractable measuring tape rulers ($10/ruler), and two height rod stadiometer ($100/stadiometer). These measuring tools are essential for calculating BMI and WC. The estimated total cost for this equipment, including 7.5% California tax, is $301 ($30/scale x 2 + $10/ruler x 2 + $100/stadiometer x 2 + tax = $301).

Computer and printer: A laptop computer is essential as a platform to input, store and analyze data. A wireless printer is needed to print flyers, consent and assent forms, instruction brochures, and questionnaires. The estimated total cost for this equipment, including 7.5% California tax, is $2,795 ($2,000/laptop computer + $300/wireless printer + $300/back-up external hard drive + tax = $2,795).

**Supplies:** The SPSS IBM 21.0 software is necessary to run data analysis and can be purchased for $1,330 a year. A one-year subscription will suffice for the duration of the proposed study. General office supplies: General office supplies including copy paper ($30/case x 10 cases), pencils ($10/pack x 1) and pens ($20/box x 1) are essential for generating flyers, filling out consent and assent forms, brochures, and questionnaires. The estimated expense for these items including 7.5% California tax is $355.

**Travel:** The PI and research assistant will be driving their personal vehicles to and from the selected research site. The approximate cost of gasoline is based on 15 round trips to-and-from the research site including the recruitment phase and data collection phase. The cost of gasoline is based on $4/gallon, for a total estimated expense of approximately $150.

The research findings from this proposed study would be disseminated at three conferences: one local conference, one national conference, and one international conference. The local conference, called the 9th Biennial Childhood Obesity Conference, is a 4-day event held in the summer of 2017 (exact dates to be announced) in San Diego, California (Childhood Obesity Conference, 2015). The student registration fee for the conference is $260; poster presentation is complimentary. The conference provides lunch for $11 per day for a total of $44. There will be no lodging or flight costs since the PI resides within the conference city. The total estimated costs to attend this local conference are $304.
The national conference, called the 38\textsuperscript{th} National Conference on Pediatric Healthcare, is a 4-day event held March 16\textsuperscript{th} -19\textsuperscript{th}, 2017 in Denver, Colorado (National Association of Pediatric Nurse Practitioners, n.d.). The student registration fee for this conference is $300 and the poster presentation fee is $100. The average cost of airfare from San Diego to Denver, Colorado is $350 round trip. The estimated cost for a hotel room is $450 for three nights. The cost of a rental car for four days and parking expenses is estimated to be $200. The expense for food is approximately $200 for four days. The total estimated cost to attend this national conference is $1,600.

The international conference, called the 10\textsuperscript{th} International Conference on Health Informatics, is a 3-day event held from February 21\textsuperscript{st}-23\textsuperscript{rd}, 2017 in Porto, Portugal (Health Informatics, 2016). The student registration fee is approximately $649 if selected as a conference speaker; this price includes access to all conference sessions and keynote lectures, as well as coffee breaks, lunches, conference bag and badge, and more. The average cost of airfare from San Diego to Porto is $1,500. The cost of a rental care for three days is $200. The estimated cost for a hotel room is $450 for three nights. The expense for food is approximately $150 for three days. The total estimated cost to attend this international conference is $2,949.

Other: Incentives in the form of Target gift cards are needed for encouraging participant attendance at data-collection meetings and for overall retention of participants in the study. Each participant will receive six gifts cards. The gift card amounts will increase as the data-collection meetings progress to further promote attendance and retention. The total expense for gift cards is $2,835 ($10 + $15 + $20 + $25 + $30 + $35 x 21).

Timeline

The timeline of this study extends over an 8-month period. Throughout that time, participants will partake in seven data-collection sessions in 6-week intervals. The first day of school for the selected study site in late August. For approximately four weeks after that, the PI will recruit students via flyers posted in the school, as well as through verbal awareness made by school educators to the students. These flyers will advertise for prospective participants to attend the school’s Fall Open House night to learn more about the study and to sign up. The Fall Open House will take place in late September, when the majority of parents and participants will be consented and assented for the study. For participants unable to attend the Fall Open House, they may contact the PI with the email address provided on the survey.
The study start date will begin on the next Monday in October, allowing both parents and participants several days to consider the study details. All participants will be made aware they can withdraw from the study at any time. Participants will be asked to bring their smartphone to all meetings. During the first meeting, all participants will meet with the PI and the research assistant in a private room at the selected high school during the student’s PE class. The first and last meeting of the study may last 20-30 minutes, however all other meeting should last about 10-15 minutes. A summary of the timeline of events can be seen in Table 1.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 29th, 2016</td>
<td>First day of school. Recruitment phase begins.</td>
</tr>
<tr>
<td>September 27th, 2016</td>
<td>Fall Open House, final recruitment phase, consent/assent signed.</td>
</tr>
<tr>
<td>October 3rd, 2016</td>
<td>Study begins. First meeting with participants: BMI, WC, and SOBPAS measured; Fitbit account activated and device sealed.</td>
</tr>
<tr>
<td>October 10th, 2016</td>
<td>Second meeting with participants: Fitbit unsealed, baseline PA obtained, participants educated on Fitbit use.</td>
</tr>
<tr>
<td>November 21st, 2016</td>
<td>Third meeting with participants: BMI, WC, and PA measured</td>
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<tr>
<td></td>
<td>Winter Break = Dec 21st - Jan 2nd</td>
</tr>
<tr>
<td>January 3rd, 2017</td>
<td>Fourth meeting with participants: BMI, WC, and PA measured</td>
</tr>
<tr>
<td>February 13th, 2017</td>
<td>Fifth meeting with participants: BMI, WC, and PA measured</td>
</tr>
<tr>
<td>March 27th, 2017</td>
<td>Sixth meeting with participants: BMI, WC, and PA measured</td>
</tr>
<tr>
<td>May 8th, 2017</td>
<td>Seventh meeting with participants: BMI, WC, PA and SOBPAS measured. Exit-study questionnaire completed.</td>
</tr>
</tbody>
</table>

*Notes. BMI= body mass index, WC= waist circumference, PA= physical activity, and SOBPAS= Self-efficacy to Overcome Barriers to Physical Activity Scale*
Dissemination Plan

Conferences. The findings obtained through this grant proposal would be presented at a local, national and international conference. The local conference selected by the PI would be the 9th Biennial Childhood Obesity Conference, “the nation’s largest, most influential collaboration of professionals dedicated to combating pediatric obesity/overweight” (Childhood Obesity Conference, 2015). This conference will be held in the summer 2017 and rotates around the county. It focuses on emerging research, best practices and strategies that would promote and sustain physical activity and healthy eating practices to help reverse the childhood obesity epidemic (Childhood Obesity Conference, 2015). This conference would serve as an ideal platform to present results related to the use of wearable technology on obese pediatric patients related to their physical activity.

The national conference chosen by the PI would be the 38th National Conference on Pediatric Healthcare. This is a 4-day event that will be held in spring 2017 in Denver, Colorado. The target group for this conference is pediatric-focused advanced practice nurses who serve on the frontline of childhood and adolescent obesity (National Association of Pediatric Nurse Practitioners, n.d.). Bringing awareness to these healthcare professionals regarding strategies that enhance physical activity such as wearable accelerometers, would contribute important clinic knowledge to the fight against pediatric obesity (National Association of Pediatric Nurse Practitioners, n.d.).

The international conference chosen by the PI would be the 10th International Conference on Health Informatics. This is a 3-day event that will be held in spring 2017 in Porto, Portugal (Health Informatics, 2016). The purpose of this conference is to bring together researchers and practitioners interested in the application of information and communication technologies (ICT)
to healthcare and medicine (Health Informatics, 2016). This conference is also a meeting place for those interested in understanding the human and social implications of technology in the healthcare systems (Health Informatics, 2016). Finding from the proposed study using wearing accelerometers in obese teens would potential contribute to one of the major conference topics “wearable health informatics (Health Informatics, 2016).

**Journals.** The findings obtained through this grant proposal will be submitted to three chosen journals including Preventative Medicine, the International Journal of Behavioral Nutrition and Physical Activity, and the Journal of Pediatrics. Preventive Medicine is a peer-reviewed, international scholarly journal that publishes original articles on the science and practice of disease prevention, health promotion, and public health policymaking (Elsevier, 2015). The readership of this journal includes but is not limited to primary and secondary prevention entities including clinical, behavioral and public health professionals, nurse practitioners, physician assistants, researchers and policy makers, as well as students, residents, and fellows (Elsevier, 2015). Preventive Medicine would serve as an appropriate platform for findings from this study since the journal’s goal is to publish research that will have an impact on the work of practitioners in disease prevention and health promotion.

The International Journal of Behavioral Nutrition and Physical Activity (IJBNPA) is an open access, peer-reviewed online journal devoted to furthering the understanding of the behavioral aspects of diet and physical activity (IJBNPA, 2016). This journal is unique in its focus on the behavioral aspects of diet and physical activity; it includes multiple levels of analysis, populations, groups and individuals, and addresses epidemiology, behavioral, and theoretical research areas (IJBNPA, 2016). The readership of this journal includes but is not limited to healthcare professionals from academia & clinic, nurse practitioners, physician
assistants, fitness professionals, researchers and policy makers, as well as students, residents, and fellows (IJBNPA, 2016). The IJBNPA, would serve as an appropriate platform to submit findings from this study since they may contribute to the practical and theoretical innovations with respect to physical activity behaviors.

The Journal of Pediatrics is an international peer-reviewed journal that advances pediatric research and serves as a practical guide for pediatricians who manage health and diagnose and treat disorders in infants, children, and adolescents (Journal of Pediatrics, 2015). The readership of this journal includes but is not limited to pediatric healthcare professionals, general and subspecialty physicians and clinicians, researchers, educators, practicing and general pediatricians, nurse practitioners/physician assistants, hospitalists, residents, fellows, and others (Journal of Pediatrics, 2015). This journal would serve as an appropriate platform to submit findings from this study since they may contribute to the journal’s goal of publishing high quality, original articles that are immediately applicable to practice; this includes insightful and novel clinical strategies that are related to every aspect of child health.


Appendix A

Fitbit Application and Dashboard

In addition to visual feedback from the device itself, all Fitbit accelerometers wirelessly sync data to any laptop/computer (Mac, PC) or smartphone device (iPhone, Android phones) (Fitbit, 2014a). This is done automatically after the user completes a one-time account set up on the Fitbit.com website, and follows the instructions to activate the device. When activation is complete, the Fitbit user has access to their “dashboard”, an electronic display of their PA progress in colorful, easy to read charts and graphs (Fitbit, 2014a). The Fitbit website also awards user’s PA progress with achievement “badges” when they meet certain PA milestones (i.e. first time walking 10,000 steps in one day). Users can choose to share their daily or weekly PA progress through Fitbit’s “sharing” setting which posts data to the user’s Facebook and Twitter accounts (Fitbit, 2014g). This allows family and friends to also monitor the user’s progress and send icons that encourage or challenge them, called “cheer or taunts” (Fitbit, 2014a). This element of Fitbit technology significantly adds to the source of self-efficacy.
Appendix B

Permission to Use Figure

Shannon Hutton

to david.lubans

Hello Professor Lubans,

My name is Shannon Hutton. I am a graduate student at California State University in San Marcos, California, U.S.A. I am working toward a degree in Masters of Science in Nursing, with a track in Family Nurse Practitioning.

I am writing to you on behalf of your publication:

I am currently writing a grant proposal that aims to implement strategies to prevent and/or reduce obesity in adolescents. You and your colleagues, Charlie Foster and Stuart J.H. Biddle, discuss the notion of self-efficacy to mediate change in physical activity. I would like to request permission to use Figure 1 on page 464, titled "Overview of mediation analysis".

Thank you for your consideration!

Sincerely,
Shannon Hutton

David Lubans

to me

Hi Shannon
That's fine. Good luck with your grant
Appendix C

Recruitment Flyer

We need students for a research study that looks at the effects of fitness tracking devices on teens’ activity level and other health outcomes. You will be given a Fitbit Charge, and we will be measuring your height, weight, waist circumference, and confidence levels. Participants will get to keep their Fitbit device and will enjoy other perks along the way!

Who Can Participate?
- 14-year-olds entering freshman year in high school
- You are currently inactive
- You are currently overweight/obese*
- You own or have access to a smart phone

Learn More & Sign up?
Go with your parent to the FALL OPEN HOUSE on Sept 27th, 2016!!

Questions?
Shannon Hutton
Principle Researcher
shan.hutton@gmail.com
Appendix D

Target Sample Calculation

To establish the target population for this study, demographic data was analyzed on 14-year-old adolescents residing in San Diego (SD) County. The total population in SD County was 3,211,252 people in 2013 (United States Census Bureau, 2014). While the number of 14-year-olds in SD County was not available, City-Data (2009) reports the population of 10 to 14-year-olds in the City of SD was 79,520 in 2000. Since this number represents only those residing in the City of SD versus the County, the total population of the City of SD was found: 1,227,000 in 2000 (Google, 2014). The percentage of 10 to 14-year-olds for the City of SD was then established by dividing 79,520 / 1,227,000, which = .0648 or 6.5%. This percentage was applied to the total population of SD County: 3,211,252 x 6.5%, resulting in approximately 208,731 ten to 14-year-olds in SD County. This number was divided by five to represent each year in the age range of 10 to 14 years old: 208,731 / 5 = 41,746 fourteen-year-olds in SD County. To approximate for the percentage of that population that is overweight or obese, the Centers for Disease Control (2014a) figure of 20.5% was applied: 41,746 x 20.5%. This calculation yielded approximately 8,558 overweight and obese 14-year-olds in San Diego County.
Appendix E

FITNESSGRAM Aerobic Capacity Atlas, Grade 9, San Diego County
Appendix F

G-power Calculation for Repeated Measures ANOVA

![G*Power 3.1 screenshot](image_url)
Appendix G

Self-efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS) & Permission to Use Research Tool

How confident are you that you can overcome each thing and still do moderate or vigorous physical activity? (please circle one number for each thing) We have listed a number of things that may make it difficult for people to do moderate or vigorous physical activity.

- Vigorous physical activity: Examples include jogging, fast bicycling, basketball, soccer, swimming laps, or fast dancing.
- Moderate physical activity: Examples include fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors.

<table>
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<th>Not at all confident (1)</th>
<th>Not very confident (2)</th>
<th>Somewhat confident (3)</th>
<th>Confident (4)</th>
<th>Very confident (5)</th>
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<td>3</td>
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<td>5</td>
</tr>
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<td>Not having fun</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>Having friends who are not supportive</td>
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<td>4</td>
<td>5</td>
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<td>The cost of doing physical activity</td>
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<td>Having other interests (for example, using the internet, watching television or videos, or playing computer games)</td>
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<td>Community programs and facilities not being available</td>
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<td>5</td>
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<td>Feeling tired or low in energy</td>
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<td>5</td>
</tr>
<tr>
<td>22</td>
<td>Feeling embarrassed about others watching</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23</td>
<td>Having family responsibilities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24</td>
<td>Not feeling motivated</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

(Dwyer et al., 2012)
Appendix H

Permission to Use Research Tool

Shannon Hutton

to dwyer

Hi Dr. Dwyer,

My name is Shannon Hutton. I am a graduate student at the California State University in San Marcos, California, United States of America. My degree focus is a masters in science of nursing, family nurse practitioner.


Currently, I am proposing a research study the examines the effects of wireless accelerometer fitness trackers (e.g. Fitbit Charge) on overweight and obese adolescents. One of my dependent variables includes the participants’ level of self-efficacy before and after the study. I would like to request permission to use your scale: Self-efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS).

Thank you for your consideration.

Sincerely,

Shannon Hutton

John Dwyer

to me

Hi Shannon,

Sounds like an interesting study. Yes of course you can the SOBPAS. I have attached the SOBPAS for your convenience.

All the best in your research.

Cheers,

John

John Dwyer, PhD (Psychology)
Associate Professor, Applied Human Nutrition
Dept of Family Relations and Applied Nutrition
University of Guelph
Macdonald Institute, room 227B
Guelph, Ontario, Canada N1G 2W1
Phone: 519-824-4120_ext_52210
Fax: 519-766-0691
Email: dwyer@uoguelph.ca
Personal profile: http://www.uoguelph.ca/family/people/applied-human-nutrition-faculty/staff/dr-john-dwyer
Expertise: Psychology of physical activity and sport; obesity prevention
Appendix I

Demographic Survey Form

All of the information on this form will be transferred onto a password locked computer and then shredded to protect your privacy. This information will only be used to remind you when meeting days are coming up and to provide an accurate description of the sample population included in the study. Your name and information will always be kept confidential and locked in a secured area.

First Name: _____________________________________________

Last Name Initial: _____

Age: ________

Assigned Sex at Birth:

☐ Female

☐ Male

☐ Would rather not say

Ethnicity:

☐ White

☐ Hispanic or Latino

☐ Black or African American

☐ Native American or American Indian

☐ Asian / Pacific Islander

☐ Other ________________________________

☐ Would rather not say

Home Phone Number: _________________________________

Cell Phone Number: _________________________________

Email: ____________________________________________
Appendix J

Exit-Study Questionnaire

First Name: __________________________________________
Last Name Initial: ______

1. Did you look at your Fitbit app or dashboard?
   ☐ I don’t know
   ☐ No
   ☐ Yes
   If yes, please circle how often:
   5-----------------4-----------------3-----------------2-----------------1-----------------0
   (5=Very often) (0=Not at all)

2. Did you connect with any friends on your Fitbit app or send or receive any “cheers” or “taunt” messages?
   ☐ I don’t know
   ☐ No
   ☐ Yes

3. Did you share any of your Fitbit activities with other Fitbit users, or on a social media site such as Facebook, Twitter, Pinterest or others?
   ☐ I don’t know
   ☐ No
   ☐ Yes
   If yes, please circle how often:
   5-----------------4-----------------3-----------------2-----------------1-----------------0
   (5=Very often) (0=Not at all)

4. Did any of your family members try to motivate you to do better?
   ☐ I don’t know
   ☐ No
   ☐ Yes

5. Did you log your food on the Fitbit app, or think your eating habits changed by being in the study?
   ☐ I don’t know
   ☐ No
   ☐ Yes

5. Did you willingly remove your Fitbit or were you asked to remove your Fitbit to partake in sports or other activities during the day?
   ☐ I don’t know
   ☐ No
   ☐ Yes
   If yes, please circle how often:
   5-----------------4-----------------3-----------------2-----------------1-----------------0
   (5=Very often) (0=Not at all)
Appendix K

Informed Consent

Invitation to Participate
My name is Shannon Hutton. I am a family nurse practitioner student at California State University San Marcos. I am doing a study that aims to understand if having teens wear a fitness tracker, called the Fitbit Charge, will affect their activity level, body mass index (BMI), waist circumference (WC), and self-confidence levels. You, called the “participant” in this letter, is invited to join this study because they meet specific criteria designed by me, the “researcher”.

Requirements of Participation
This study is designed to last 8 months, the duration of the school year. Throughout that time the participant will be asked to meet 7 times with the researcher and the researcher’s assistant. Meeting will be held in a private room at Mission Bay High School during PE class. Each meeting lasts about 10-15 minutes. The participant must bring their smartphone to each meeting.

Meeting 1:
• Participant will have BMI and WC measured.
• Participant will fill out a questionnaire about their confidence level during exercise.
• Participant will receive their Fitbit Charge, worn on their non-dominant wrist.
• Participant’s Fitbit Charge and account will be activated via Fitbit “app” on their smartphone
• The Fitbit screen will be covered with tape for 1 week; tape is not to be removed and the participant should not look at their Fitbit app or change their normal activities.

Meeting 2 (after one week has past):
• The tape will be removed from the Fitbit Charge.
• Participant will receive a 10-minute class on how to use their Fitbit Charge and instructions that summarize this class. It is very important the participant always charge their Fitbit Charge battery at night and wear their Fitbit during the day.

Meeting 3 (after six weeks has past):
• Participant will have their BMI and WC measured.
• Participant will show their activity level results through their Fitbit app on their smartphone.

Meetings 4, 5, and 6 (each six weeks apart): same as “Meeting 3”.

Meeting 7 (after six weeks has past)
• Participant will have their BMI and WC measured.
• Participant will show the researcher their activity level through smartphone Fitbit app
• Participant will re-take questionnaire about their confidence level during exercise.

Benefits
The greatest benefit to the participant is potential weight lose through increasing physical activity. Burning calories through physical activity helps to counteract the amount of calories consumed through food being eaten. The Centers for Disease Control states that the only way to maintain weight loss is to engage in regular physical activity. When a person is overweight or
obese, physical activity also helps to reduce the risk for having diseases in the future such as diabetes and heart disease. Regular exercise makes bones and muscle stronger, improves sleep, relieves stress, and can lower blood pressure and cholesterol levels. Also, the participant’s involvement in the study will add valuable knowledge to the area of research.

Confidentiality & Risks
The participant will not need to provide their social security number or address. The participant will give their first name, last name initial, age, height, weight, email address and phone number. A code number will be assigned to the participant’s name so the data collected cannot be directly linked to the participant. All information will be kept in a locked laptop. It is possible others may learn of the participant’s enrollment in the study, however the researcher and assistant will make every effort to be as discrete and brief as possible during meetings with the participant. If the participant experiences any negative feelings during the study, supportive resources will be provided; also the participant may leave the study at any time without consequences.

Incentives
If the participant attends all meetings throughout the length of the study, they will get to keep their Fitbit Charge. The participant will also receive Target® gift cards beginning at the second meeting which will increase in amount along the way. A summary of the incentives:

- Meeting 1 = participant receives Fitbit Charge
- Meeting 2 = participant receives $10 Target® gift card
- Meeting 3 = participant receives $15 Target® gift card
- Meeting 4 = participant receives $20 Target® gift card
- Meeting 5 = participant receives $25 Target® gift card
- Meeting 6 = participant receives $30 Target® gift card
- Meeting 7 = participant receives $35 Target® gift card

Voluntary Participation
Participation is voluntary. The participant does not have to join the study and may withdraw at any time. The participant will not experience any consequences for deciding not to participate or for leaving the study.

Questions
The California State University San Marcos Institutional Review Board (IRB) has approved this study. For any questions I will be happy to answer them now or you may contact me at any time: Shannon Hutton, 970-618-7312, shan.hutton@gmail.com. For questions about the rights of the participant, please contact the California State University San Marcos IRB at 760-750-4029. Keep a copy of this form for your records. Thank you.

☐ I agree to allow my child to participate in this research study.

Parent/Guardian’s Name ____________________ Parent/Guardian’s Signature ____________ Date ____________

__________________________  ___________________________  _______

__________________________  ___________________________  _______

Researcher’s Signature
Assent to Participate in Research

Invitation to Participate
My name is Shannon Hutton. I am a family nurse practitioner student at California State University San Marcos. I am doing a study that wants to understand if having teens wear a fitness tracker, called the Fitbit Charge, will affect their activity level, body mass index (BMI), waist circumference (WC), and self-confidence levels. You are invited to join this study because you meet the specific reasons required me, the “researcher”.

Requirements of Participation
The study is designed to last the duration of the school year or 8 months. Throughout that time you will be asked to meet with the researcher and the researcher’s assistant 7 times. Meeting will be held in a private room at Mission Bay High School during your PE class. Each meeting lasts about 10-15 minutes. You must bring your smartphone to each meeting.

Meeting 1:
• You will have your BMI and WC measured.
• You will fill out a questionnaire about your confidence level during exercise.
• You will receive your Fitbit Charge, which you will wear on your non-dominant wrist.
• Your Fitbit Charge and account will be activated through the Fit “app” on your smartphone.
• The Fitbit screen will be covered with tape for one week; tape is not to be removed and you cannot look at your Fitbit app or change their normal activities and routines.

Meeting 2 (after one week has past):
• The tape will be removed from the Fitbit Charge.
• You will receive a 10-minute class on how to use your Fitbit Charge and instructions that summarize this class. It is very important you always charge the Fitbit battery at night and wear the Fitbit during the day.

Meeting 3 (after six weeks has past):
• You will have your BMI and WC measured.
• You will show your activity level results through the Fitbit app on your smartphone.

Meetings 4, 5, and 6 (each six weeks apart): same as “Meeting 3”.

Meeting 7 (after six weeks has past)
• You will have your BMI and WC measured.
• You will show your activity level results through the Fitbit app on your smartphone.
• You will re-take a questionnaire about your confidence level during exercise.

Benefits
The greatest benefit to you is potential weight lose through increasing physical activity. Burning calories through physical activity helps to counteract the amount of calories consumed through food being eaten. The Centers for Disease Control states that the only way to maintain weight loss is to engage in regular physical activity. When a person is overweight or obese, physical activity also helps to reduce the risk for having diseases in the future such diabetes and heart
disease. Regular exercise makes bones and muscle stronger, improves sleep, relieves stress, and can lower blood pressure and cholesterol levels. Also, your involvement in the study will add valuable knowledge to the area of research.

Confidentiality & Risks
You will not need to provide your social security number or address. You will give their first name, last name initial, age, height, weight, email address and phone number. A code number will be assigned to your name so the data collected cannot be directly linked to you. All information will be kept in a locked laptop. It is possible others may learn of your enrollment in the study, however the researcher and assistant will make every effort to be as discrete and brief as possible during meetings with you. If you experience any negative feelings during the study, supportive resources will be provided; also you may leave the study at any time without consequences.

Incentives
If you attend all 7 meetings throughout the length of the study you will get to keep your Fitbit Charge. You will also receive Target® gift cards beginning at the second meeting; the gift card amounts increase along the way:

• Meeting 1= you receive your Fitbit Charge
• Meeting 2= you receive a $10 Target® gift card
• Meeting 3= you receive a $15 Target® gift card
• Meeting 4= you receive a $20 Target® gift card
• Meeting 5= you receive a $25 Target® gift card
• Meeting 6= you receive a $30 Target® gift card
• Meeting 7= you receive a $35 Target® gift card

Voluntary Participation
Participation is voluntary. You do not have to join the study and may withdraw at any time. You will not experience any consequences for deciding not to participate or for leaving the study.

Questions
The California State University San Marcos Institutional Review Board (IRB) has approved this study. For any questions about this study I will be happy to answer them now or you may contact me: Shannon Hutton, 970-618-7312, shan.hutton@gmail.com. For questions about your rights as a participant, please contact the California State University San Marcos IRB at 760-750-4029. Keep a copy of this form for your records. Thank you.

☐ I agree to participate in this research study.

Participant’s Name ___________________________ Participant’s Signature ___________________________ Date ___________________________

Researcher’s Signature ___________________________
Appendix L

Instructions for Fitbit Account Set Up and Device Activation

To activate the device the user must first install Fitbit Connect, free software that connects (“pairs”) the device to the Fitbit.com website (Fitbit, 2014c). The Fitbit.com website is free to user, and at a minimum requires the new device user to set up an online account that asks for personal information including age, gender, height and weight (Fitbit, 2014c). Walking stride length and running stride length is automatically estimated on the user’s height and gender, or can be entered manually (Fitbit, 2014b). Fitbit provides instructions on how to measures stride length on their website (Fitbit, 2014b). A “wireless sync dongle” is then inserted into the designated laptop or computer USB port allowing the device to begin “pairing” to the new software and Fitbit.com website dashboard (Fitbit, 2014c). A four digit number will appear on the Fitbit device, that number is then entered on the Fitbit website screen when prompted (Fitbit, 2014c). After clicking “next,” the device is ready for stepping (Fitbit, 2014c).

An alternative to pairing a Fitbit device to a computer is through automatic Bluetooth Low Energy synchronization between the Fitbit device and a smartphone with the Fitbit app (Fitbit, 2014d). The Fitbit app is free and downloadable through any smartphone app store. Once the Fitbit app is downloaded, the app is opened via tapping it, the correct product type is selected, and then personal details are entered including age, gender, height, weight, name, email address and password (Fitbit, 2014d). From here, the device is now ready for use.
How do I log or record an activity if I forgot to wear my Fitbit Charge?

If you forgot to wear your Fitbit or you wanted to log an activity that does not require steps (i.e. cycling):

1. Log into your fitbit.com dashboard
2. At the top of the page click Log > Activities.
3. Click a common activity or search for one. If the activity is not in our system, create your own by clicking the Create custom activity text that appears below the search field.
4. Enter the duration, distance (if applicable), and start time of your activity. You can enter the number of calories burned if you’d like to.
5. Click Log Activity. Your activity will now be visible and editable in the Logged Activities area.

For more information on these topics or if you have additional questions about your Fitbit Charge, you can go to this website:

https://help.fitbit.com/?p=charge

OR

Contact the researcher:
Shannon Hutton
970-618-7312
shan.hutton@gmail.com

Thank you for your participation!

About Your Fitbit Charge!
For iOS/Apple device users
How do I charge my Fitbit Charge?

Your Charge comes equipped with a rechargeable lithium-polymer battery. With normal use, your Charge should last about 7 to 10 days before needing a charge. You can check the level of your battery by opening up the Fitbit app and looking at the battery icon on the top-right.

To charge your Fitbit Charge:

- Plug charging cable into a USB port and plug the other end into the port on the back of the Charge
- A battery icon on the display will show the charging progress.
- Charging completely takes between an hour and two hours.

What if my tracker is not syncing with the Fitbit app?

- Verify iOS/phone’s software is updated to the latest version by going to: Settings > General > Software Update to check for updates
- Verify Bluetooth is enabled/"on" by going to: Settings > Bluetooth > on

If your tracker is still not syncing, restart your tracker (you will not lose your data):

1. Plug your charging cable into the back of your Charge.
2. Once your Charge is charging, press and hold the button for 10 to 12 seconds until you see the Fitbit icon and a version number (e.g. "V30"). Let go of the button.
3. Unplug your tracker from the charging cable. After your tracker has restarted, reboot your iOS phone.
4. Open the Fitbit app to initiate a sync.

If your tracker still won’t sync and your iOS device is managing multiple Bluetooth connections, disconnect from the other Bluetooth devices (headset, stereo, etc.)