Female Teens Step It Up with the Fitbit Zip: A Randomized Controlled Pilot Study

By

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Abstract

Donna Teresa Linck
Female Teens Step It Up with the Fitbit Zip: A Randomized Controlled Pilot Study
(Under the direction of Dr. Julie Zadinsky)

Physical inactivity is a global pandemic. Six percent of all deaths globally (approximately 3.2 million people) are the result of insufficient physical activity, and 80% of adolescents worldwide do not get the recommended levels of daily physical activity. Depression is a major cause of disability worldwide and is a significant disease of burden for most age groups. Female adolescents are more than twice as likely to experience depressive symptoms as their male counterparts. The primary purpose of this randomized controlled pilot study was to determine if the use of electronic activity monitors, specifically Fitbit Zips, and daily step goals would increase physical activity participation in female adolescents. The secondary purpose was to determine if participation in a 12-week intervention using Fitbit Zips together with step goals would reduce depressive symptoms in female adolescents. The tertiary purpose was to determine the feasibility of recruiting and retaining female adolescents (80% or more) in the study and having them adhere to the research protocol. There were no available research studies examining physical activity and depressive symptoms in female adolescents using Fitbit Zips as an intervention to increase physical activity and decrease depressive symptoms. A convenience sample of 44 female adolescents from two church youth groups in the southeastern United States participated in the study. The mean age of the participants was 16.6 years. Psychosocial variables such as self-efficacy, social support, and commitment to a plan of action were assessed. Using mixed
model analysis, no significant differences ($p = .678$) were found between the experimental (Fitbit-E) and control groups (Fitbit-C) on average median steps per day. The Fitbit-C group had 6,088.3 ($SE = 668.6$) average median steps per day at baseline, but only had 2,783.7 ($SE = 698$) average median steps per day at posttest. The Fitbit-E group had a lesser decline with 6,279.1 ($SE = 661$) average median steps per day at baseline and 4,339.4 ($SE = 728$) average median steps per day at posttest. Both groups’ depression scores, as measured by the CES-D, decreased from pretest to posttest, indicating an improvement in depressive symptoms. However, the difference between the two groups on depression scores was not statistically significant ($p = .425$). Post hoc pairwise comparisons yielded statistically significant decreases in depression scores for the Fitbit-C group ($p = .002$) and for the Fitbit-E group ($p < .001$) from pretest to posttest. Additionally, 42 out of 44 participants (95%) completed final CES-D surveys, and 35 out of 44 (79.5%) had some final step count data at post-test. Therefore, it was feasible to recruit and retain 80% of the participants in this RCT pilot study, and they did adhere to the protocol. This study helps bring to light the importance of promoting physical activity and assessing for depressive symptoms in the female adolescent population. Although there were no significant differences between the experimental and control groups on depressive symptoms for the 12-week intervention period, within each group there were significant decreases in depressive symptoms. The results from this study provide the groundwork to further investigate the impact of EAMs on physical activity and depressive symptoms in female adolescents.

Keywords: physical activity, depression, adolescents, electronic activity monitors
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Chapter 1: Introduction

This chapter begins with discussion of the background, statement of the problem, and significance of the study. This is followed by a brief description of the specific aims and hypotheses used to guide the research. Finally, the conceptual framework and definitions of key concepts and terms relevant to the study are presented.

Background

Physical inactivity is of global public health significance for all ages and is linked to the pervasiveness of major non-communicable diseases and chronic conditions (WHO, 2017a). In a global report from 2000, approximately 60% of people worldwide over 15 years of age were lacking moderate-intensity physical activity, based on WHO and U.S. Department of Health and Human Services (USDHHS) recommendations (Dumith, Hallal, Reis, & Kohl, 2011; USDHHS, 2008; WHO, 2017a). Physical inactivity is a global pandemic. It is the fourth leading cause of mortality (Dumith et al., 2011; Kohl et al., 2012) and is a major risk factor for hypertension, obesity, stress, cancer (breast and colon), depression, and anxiety (WHO, 2017a). Globally, approximately 3.2 million deaths are a result of physical inactivity every year, with nearly 18% of the world’s population not participating in any type of physical activity (Dumith et al., 2011; WHO, 2017c).

Lee et al. (2012) calculated population attributable fractions (PAFs) for the world’s most prevalent non-communicable diseases (NCDs) to determine the effect of physical inactivity on life expectancy. These NCDs included coronary heart disease, type 2 diabetes, and breast and colon cancers (Lee et al., 2012). PAFs are estimates of the proportion of new cases of a disease that would not happen if a certain risk factor,
such as physical inactivity, were removed (Rowe, Powell, & Flanders, 2004). Results indicated that if the world’s population became more active, as much as 10% of the principal NCDs would be eradicated, thereby substantially increasing life expectancy (Lee et al., 2012).

Physical inactivity in the adolescent population is an important area for health-related research. In 2010, over 80% of adolescents in the world were not meeting WHO physical activity recommendations (WHO, 2017a, 2017b). Furthermore, females were found to be less active than males in all countries surveyed, with 84% vs. 78% not achieving the WHO physical activity recommendations for youth 11 to 17 years of age (WHO, 2017a, 2017b).

Much of the decline in physical activity begins in childhood and adolescence, especially for females (Kimm et al., 2002). In a longitudinal study of 1,213 African American and 1,166 Caucasian females who were enrolled in the National Heart, Lung, and Blood Institute Growth and Health Study, activity levels of participants significantly decreased over time (Kimm et al., 2002). For example, the median activity levels dropped by 83% (over a 10 year period) for the 2,400 female youths surveyed at 9 or 10 years of age and then again at 18 or 19 years of age (Kimm et al., 2002). These percentages equated to a 64% and 100% decline in physical activity for Caucasian and African American female participants, respectively (Kimm et al., 2002).

Factors associated with this decline in physical activity were higher body mass index (BMI) and lower parental education level for the older aged girls (16 to 17 years of age) for both races (Kimm et al., 2002). Smoking was associated with decreased physical activity for Caucasian girls and pregnancy for African American girls (Kimm et
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al., 2002). The study participants were recruited from a health maintenance organization located in the Washington, D.C. area and from schools in the San Francisco and Cincinnati areas (Kimm, et al., 2002).

Accelerometer data taken from the 2003-2004 National Health and Nutritional Examination Survey (NHANES) were used to describe physical activity patterns and to determine physical activity prevalence in children and adults from the United States (Troiano et al., 2008). Physical activity prevalence was based on participants achieving the recommended 60 minutes per day of moderate to vigorous physical activity (MVPA) established by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM). Based on participants who completed the survey, the physical activity prevalence dropped from 35% for the females 6 to 11 years of age, to 3% for those who were 12 to 15 years of age (Troiano et al., 2008).

Substantially less research on the effectiveness of physical activity participation on depression is available for adolescents than for adults. Some studies have found associations between physical activity and improved mental health in adolescents (McDowell, MacDonncha, & Herring, 2017; McMahon et al., 2017); however, many of these studies reported significant design weaknesses or small to moderate effect size limitations (Biddle & Asare, 2011; Brown, Pearson, Braithwaite, Brown, & Biddle, 2013). Therefore, studying physical activity participation as a health promotion behavior for female adolescents is a meaningful topic for nursing research (Mohamadian & Arani, 2014; Pender, Bar-Or, Wilk, & Mitchell, 2002; Robbins, Gretebeck, Kazanis, & Pender, 2006; Robbins, Pender, & Kazanis, 2003; Taymoori & Lubans, 2008). Furthermore, it is important for nurse researchers to investigate possible reasons for the substantial
decline in physical activity for female adolescents (Butt, Weinberg, Breokon, & Claytor, 2011).

The World Health Organization (WHO) reports depression as the leading cause of disability worldwide, contributing substantially to the global burden of disease and affecting over 300 million people (Marcus, Yasamy, van Ommeren, Chisholm, & Saxena, 2012; WHO, 2017d). A significant consequence of depression is that it can lead to suicide. Each year more than 800,000 deaths (worldwide) are the result of suicides (WHO, 2017d). Moreover, suicide is the second leading cause of death for 15 to 29-year-olds (WHO, 2017d). In 2015, an estimated three million 12 to 17-year-old American adolescents (approximately 12.5%) will have experienced a major depressive episode (National Institute of Mental Health [NIMH], 2017; Substance Abuse and Mental Health Services Administration [SAMHSA], 2015).

Female adolescents are more likely than their male counterparts (19.5% vs. 5.8%) to experience a major depressive episode (SAMHSA, 2015). Moreover, subsyndromal symptoms of depression occur much more frequently in female adolescents than males (Frost, Hoyt, Chung, & Adam, 2015). Unfortunately, subsyndromal depressive symptoms are associated with considerable psychosocial dysfunction, which can lead to an increased risk of major depressive disorder (MDD) in both males and females (Fergusson, Horwood, Ridder, & Beautrais, 2005; Lewinsohn, Seeley, & Zeiss, 2000). In summary, there is a need to address the pervasiveness of depressive symptoms experienced by female adolescents and to promote enjoyable physical activities for them that are motivating and sustaining into adulthood (Butt et al., 2011).
Statement of the Problem

There are two significant problems facing adolescents worldwide, depression and physical inactivity (WHO, 2017e). According to the U.S. NHANES study, physical activity levels for both males and females decreased significantly from 42% of children (6 to 11 years of age) to 8% of adolescents (12 to 19 years of age) meeting the WHO recommendation of 60 minutes per day of physical activity for each age group (Troiano et al., 2008; WHO, 2017a). Troiano et al. (2008) found substantial decreases in the physical activity levels for individuals as they progressed from childhood into adolescence and then from adolescence into adulthood. The adults who participated in the WHO recommended 30 minutes per day of physical activity (for adults) was less than five percent for this study (Troiano et al., 2008).

Depression in the adolescent population is also of considerable public health concern, as it is one of the leading causes of illness and mortality for this group (Kumar, Robinson, & Till, 2015). Patel (2013) asserts that effectively managing depression in the adolescent population should be a worldwide health priority. Adolescence is a critical time of individual growth when the development of lifelong habits and behaviors occurs (Kumar et al., 2015). Therefore, managing depression and its associated symptoms are of vital importance because of the potentially negative effects on adolescents’ future health, habits, and behaviors (Kumar et al., 2015; Patel, 2013; Thapar, A., Collishaw, Pine, & Thapar, A. K., 2012). To explore the significance of physical activity on depressive symptoms, McMahon et al. (2017) used cross sectional data from the multi-center study, Saving and Empowering Young Lives in Europe, and found that greater
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frequency in physical activity participation was associated with lower levels of
depressive symptoms in the 11,110 adolescents studied.

Female adolescents are less active than their male counterparts, and they have
a much higher prevalence of depressive symptoms (SAMHSA, 2015; Thapar et al.,
2012). Therefore, research is needed to find ways to promote enjoyable, creative,
practical, and cost-effective physical activities for female adolescents (Butt et al., 2011).

Regular participation in physical activity for female adolescents may potentially lessen
their depressive symptoms, thereby providing a future for them as healthier, happier,
and more productive adults.

The primary purpose of this randomized controlled pilot study was to determine if
the use of electronic activity monitors (EAMs), specifically Fitbit Zips, and daily step
goals increased physical activity participation (measured in steps) in female
adolescents. The secondary purpose was to determine if participation in a 12-week
intervention using Fitbit Zips together with step goals reduced depressive symptoms in
female adolescents. The tertiary purpose was to determine the feasibility of recruiting
and retaining female adolescents (80% or more) in the study and having them adhere to
the research protocol.

Significance of the Study

Both physical inactivity and depressive symptoms are significant problems in the
female adolescent population. Investigators have found relationships between increased
physical activity and decreased levels of depression in female adolescents (Al-Eisa,
Burgadda, & Melam, 2014; Dishman et al., 2006; Jerstead, Boutelle, Ness, & Stice,
2010; Neissaar & Raudsepp, 2011; Raudsepp & Neissaar, 2012; Sheperd, Krägeloh,
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Ryan, & Schofield, 2012). However, a causal relationship between increased physical activity and decreased depressive symptoms has not been demonstrated with this population; therefore, higher quality experimental research, such as randomized controlled trials (RCTs), have been recommended (Biddle & Asare, 2011; Brown et al., 2013; Burnsnall, 2014). Additionally, attention to the influence of specific psychosocial variables such as social support and self-efficacy on physical activity participation is warranted (Dishman et al., 2006; Neissaar & Raudsepp, 2011).

Significance of Social Support

Social support is a major predictor of physical activity participation in female adolescents (Ammouri, Kaur, Neuberger, Gajewski, & Choi, 2007; Cheng, Mendonça, Mélo, & de Farias Júnior, 2014; Mohamadian & Arani, 2014; Wu & Pender, 2002). Specifically, for this study, social support is defined as “a network of interpersonal relationships that provide psychological and material resources intended to benefit an individual’s ability to cope” (Pender, Murdaugh, & Parsons, 2015, p. 200). Having persons such as friends, family members, teachers, and healthcare workers readily available to emotionally encourage and physically assist the individual in performing the desired action is considered a network of social support (Pender et al., 2015). Social support has been found to be instrumental in determining an individual’s predisposition to participate in health-promoting behaviors such as physical activity (Dowda, Dishman, Pfeiffer, & Pate, 2007; Pender et al., 2015).

Significance of Self-Efficacy

Self-efficacy and perceived self-efficacy are important concepts pertinent to physical activity participation in female adolescents (Pender et al., 2015). Bandura
(1994) stated “self-efficacy beliefs determine how people feel, think, motivate themselves, and behave” (para. 1). These beliefs influence several aspects of individuals’ lives, to include personal choices, degree of motivation, functioning, resilience, and vulnerability (Bandura, 1994). Similarly, perceived self-efficacy is defined as individuals’ thoughts about how well they can accomplish a desired action (Bandura, 2004; Pender et al., 2015). More specifically, Bandura (1994) stated that, “perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (para. 1).

For this study, perceived self-efficacy and self-efficacy were both considered important and inter-related terms. However, to avoid confusion, self-efficacy (for physical activity) was the main concept used in this study, and it was the concept that was operationalized. Therefore, self-efficacy was used instead of perceived self-efficacy in the PEPME conceptual framework.

Finding appropriate and effective ways to promote physical activity participation in female adolescents is a difficult and challenging task. There are a growing number of studies assessing the efficacy of EAMs for increasing physical activity levels in adult populations (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015b; Lewis, Lyons, Jarvis, & Baillargeon, 2015; Thorndike et al., 2014). However, there has been limited research on the use of EAMs as a prospective means of promoting physical activity participation in adolescents (Ortiz, Tueller, Cook, & Furberg, 2016). For this study, EAMs are defined as consumer wearable activity trackers that can provide objective feedback on individuals’ physical activity progress (steps, heart rate, calories...
expended, and distance traveled) either directly through visual screening or indirectly
with an associated application (Lewis et al., 2015).

This research was one of the first known studies to investigate the use of
commercially available EAMs, specifically Fitbit Zips, with female adolescents for
promoting physical activity participation and decreasing depressive symptoms. The Fitbit
Zip devices worn by the participants provided immediate feedback for the experimental
group on the number of steps taken, calories burned, and total distance traveled.
However, steps per day was the main outcome variable assessed from the available
Fitbit Zip data. The control group study participants were given covered Fitbit Zips.
Covered Fitbit Zips had black pieces of tape over the monitor faces such that the
screens could not be seen by the participants, not allowing for any direct visual
feedback. To explore the purposes of this study, there were three specific aims and
hypotheses.

Specific Aims, Research Questions, and Hypotheses

Specific Aim, Research Question, and Hypothesis One

Specific aim one. The first specific aim was to measure whether female
adolescents would show a significant increase in their average median steps per day
after 12 weeks of using Fitbit Zips together with daily step goals, as compared with the
control group of female adolescents who used covered Fitbit Zips without daily step
goals.

Research question one. Will use of Fitbit Zip activity trackers together with daily
step goals increase female adolescents’ physical activity levels (average median steps
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per day) as compared with a control group of female adolescents using covered Fitbit Zip activity trackers without daily step goals?

**Hypothesis one.** There will be a statistically significant increase in the average median number of steps per day taken by the female adolescent participants after 12 weeks of using Fitbit Zip activity trackers together with daily step goals, as compared with a control group of female adolescents using covered Fitbit Zip activity trackers without daily step goals.

**Specific Aim, Research Question, and Hypothesis Two**

**Specific aim two.** The second specific aim was to measure whether female adolescents would show a significant decrease in their depressive symptoms after 12 weeks of using Fitbit Zips together with daily step goals as compared with the control group of female adolescents who used covered Fitbit Zips without daily step goals.

**Research question two.** Will use of Fitbit Zip activity trackers together with daily step goals lead to a reduction in depression scores for female adolescent participants as measured by the 20 items in the CES-D, compared with a control group of female adolescent participants using covered Fitbit Zip activity trackers without daily step goals?

**Hypothesis two.** There will be a statistically significant decrease in depression scores, as measured by the 20 items in the CES-D, for the female adolescent participants after 12 weeks of using Fitbit Zip activity trackers together with daily step goals as compared with a control group of female adolescents using covered Fitbit Zip activity trackers without daily step goals.
Specific Aim, Research Question, and Hypothesis Three

**Specific aim three.** The third specific aim was to determine if it would be feasible to recruit and retain (retention of 80%) female adolescents who would adhere to the study protocol for a randomized controlled pilot study using Fitbit Zips.

**Research question three.** Will it be feasible to recruit and retain (retention of 80%) female adolescents who will adhere to the protocol for a randomized controlled pilot study using Fitbit Zips?

**Hypothesis three.** It will be feasible to recruit and retain (retention of 80%) female adolescents who will adhere to the study protocol for a randomized controlled pilot study using Fitbit Zips.

**Conceptual Framework**

**Nola Pender's Health Promotion Model (Revised)**

Nola Pender’s revised Health Promotion Model [HPM (revised)] is an explanatory model for health behavior and was the foundation for the conceptual framework of this study (Pender et al., 2015). The original HPM was proposed in 1982 and subsequently revised in 1996. Figure 1.1 illustrates Pender’s HPM (revised) with a detailed representation of all concepts (Pender et al., 2015). Nola Pender approaches health from a holistic perspective, which is not limited to the absence of disease, but is aimed at strengthening individuals’ assets, potentials, and competencies for achieving optimal health throughout their lifespan (Peterson & Bredow, 2013).

The theoretical roots of the HPM (revised) arise from Feather’s expectancy-value theory and Bandura’s social cognitive theory (Pender et al., 2015; Pender, 2011). The expectancy-value theory postulates that individuals participate in activities they deem
worthwhile and establish goals they feel are attainable (Feather, 1992; Pender et al., 2015). The social cognitive theory proposes that individuals’ behaviors, thoughts, and environments are all interconnected (Bandura, 2004). Therefore, to make a health behavioral change, individuals must appraise their personal thought processes about their self-efficacy, interpersonal relationships (social support) and self-evaluation (Bandura, 2004; Pender et al., 2015).

Promoting Exercise for Physical and Mental Health (PEPME)

Based on Nola Pender’s HPM (revised), the promoting exercise for physical and mental health (PEPME) conceptual framework, illustrated in Figure 1.2, was developed and used in this study. The PEPME conceptual framework focuses on the following concepts: personal factors, self-efficacy, and social support (included in the construct, behavior-specific cognitions and affect); commitment to a plan of action; physical activity participation; and depressive symptoms. Depressive symptoms in the context of this study were based on key components of depressive symptomology, such as feelings of sadness, guilt, insignificance, uselessness, and powerlessness, as well as experiencing mental and physical retardation, appetite changes, and problems sleeping (Radloff, 1977). The Center for Epidemiologic Studies - Depression Scale (CES-D) was used to evaluate depressive symptoms in this study because it is a valid and reliable tool for assessing depressive symptoms in the adolescent population (Sawyer, Pfeiffer, & Spence, 2009). The CES-D is not a diagnostic tool, but diagnosing depression was not an objective of this study and is beyond the scope of practice of the PI (Radloff, 1977).

*Figure 1.2. Promoting Exercise for Physical and Mental Health (PEPME). The construct, Behavior-Specific Cognitions and Affect (BCA), includes the concepts of social support and self-efficacy for physical activity.*
Personal factors. Personal factors are defined as individual characteristics that help predict the success of the targeted behavior; they include biological, psychological, and sociocultural influences that may affect health behaviors (Pender et al., 2015). The specific personal factors for this study that are included in the PEPME conceptual framework are demographic data (race, age, grade level in school), baseline depression scores, and height and weight for body mass index (BMI) determination. Other studies have shown that factors such as age, race, grade level in school, and depressive symptoms can have a significant impact on physical activity behaviors (Ammouri, et al., 2007; Robbins, Pender, Ronis, Kazanis, & Pis, 2004; Standiford, 2009). In the PEPME conceptual framework, the personal factors of race, age, BMI, and depression scores have direct effects on both physical activity participation and the BCA concepts of social support and self-efficacy for physical activity.

Behavior-specific cognitions and affect (BCA). The construct of BCA is defined as the perceptions, thoughts, and feelings that individuals experience which may influence their attitudes and actions toward a health-promoting behavior (Pender, 2011). In Pender’s HPM (revised), cognitive processes related to physical activity participation include the following: what are the benefits and barriers, what is one’s self-efficacy, who are the interpersonal influences (such as social support, role models, and norms), what are the competing demands, and what situational factors exist in the form of external environmental influences (Pender, 2011). All of these concepts help define and describe the construct of BCA (Pender, 2011).

For the PEPME conceptual framework, the two behavior-specific cognitions and affect concepts explored are self-efficacy and social support for physical activity. These
two concepts are influenced by the individual’s perceptions and level of motivation (Pender et al., 2015). In a cross-sectional study, Mohamadian and Arani (2014) found social support and self-efficacy (based on Pender’s revised HPM) to be significant predictors of physical activity behavior in Iranian female adolescents. Similarly, Taymoori, Rhodes, and Berry (2010) found that social support had significant effects on physical activity through self-efficacy. Because of their relevance in previous studies as well as Pender’s HPM (revised), social support and self-efficacy are important to the PEPME conceptual framework. Also, both social support and self-efficacy can be impacted through nursing interventions (Pender et al., 2015). According to Pender (1996), self-efficacy and social support mediate the relationship between personal factors and physical activity participation. Moreover, self-efficacy and social support both directly and indirectly impact physical activity participation through commitment to a plan of action (Pender, 1996). For this study and specifically for the PEPME conceptual framework, self-efficacy and social support for physical activity are the two BCAs concepts explored.

**Self-efficacy for physical activity.** The definition of self-efficacy used in the PEPME conceptual framework study is the individual’s perception of their ability to successfully engage in a health-promoting behavior such as physical activity (Pender, 2011; Peterson & Bredow, 2013). Self-efficacy for physical activity has been significantly correlated with engagement in physical activity for female adolescents (Spence et al., 2010; Taymoori, Niknami, Berry, Ghofranipour, & Kazemnejad, 2008). Pender’s theoretical propositions related to individuals who have a higher level of self-efficacy are: (a) there will be fewer barriers to participating in health-promoting behavior and (b) there
will be an increased level of commitment toward performing health-promoting behavior (Pender, 2011).

For example, if individuals’ self-efficacy for physical activity is high, they might find fewer barriers to participating in the physical activities and be more committed to scheduling time for them. Using the HPM (revised) as their conceptual framework, Taymoori and Lubans (2008) found self-efficacy to be a mediator of physical activity in Iranian female adolescents. Additionally, Wu and Pender (2002) used structural equation modeling (SEM) to examine the relationships among several concepts from Pender’s HPM (revised) on data collected from 832 Taiwanese adolescents. SEM results indicated that the strongest predictor of physical activity behavior was self-efficacy (Wu & Pender, 2002). In the PEPME conceptual framework, self-efficacy for physical activity had direct effects as well as indirect effects on physical activity participation through commitment to a plan of action.

**Social support for physical activity.** Social support is defined as “a network of interpersonal relationships that provide psychological and material resources intended to benefit an individual’s ability to cope” (Pender et al., 2015, p. 200). Social support by parents, teachers, healthcare providers and peers has been shown to be instrumental in promoting physical activity in female adolescents (Ammouri et al., 2007; Robbins, Stommel, & Hamel, 2008; Wu & Pender, 2002). According to Pender (2011), the theoretical proposition for social support for physical activity participation is that the individual is “more likely to commit to and engage in health-promoting behaviors when significant others model the behavior, expect the behavior to occur, and provide assistance and support to enable the behavior” (Pender, 2011, p. 5). Along with self-
efficacy, social support is an important concept in the PEPME conceptual framework. Social support for physical activity had both direct effects and indirect effects on physical activity participation through commitment to a plan of action in the PEPME conceptual framework.

**Commitment to a plan of action.** Pender et al. (2015) define the concept of commitment to a plan of action as the impetus or intention for initiating a behavioral change, such as participating in physical activity. This concept is directly influenced by social support and self-efficacy (Pender, 2011). Goal setting and implementation strategies are important facets of this concept and are directly impacted by the individual’s self-efficacy and social support. Both social support and self-efficacy are instrumental in determining the individual’s predisposition to participate in health-promoting behaviors such as physical activity (Dowda, Dishman, Pfeiffer, & Pate, 2007; Pender et al., 2015).

The theoretical proposition for commitment to a plan of action is “the greater the commitment to a specific plan of action, the more likely health-promoting behaviors are to be maintained over time” (Pender, 2011, p.5). Additionally, the social support provided to the individual can either promote or discourage the commitment to participate in a health-promoting behavior like physical activity (Pender, 2011). Maglione and Hayman (2009) explored the relationships of social support, self-efficacy, and commitment to a plan of action for physical activity on the physical activity behaviors of low-income college students. These three constructs were examined as part of the theoretical framework for their study and were borrowed from Pender’s HPM (revised). Through hierarchical multiple linear regression, Maglione and Hayman (2009) found
commitment to a plan of action mediated the relationships between self-efficacy and physical activity as well as social support and physical activity. In the PEPME conceptual framework, commitment to a plan of action was influenced by self-efficacy and social support for physical activity and had proposed direct effects on physical activity participation.

**Physical activity participation.** The main outcome variable in this study was the concept of physical activity participation, which was objectively measured by the Fitbit Zip in steps per day. All of the concepts in the PEPME framework affect physical activity participation based on the relationships previously discussed. Personal factors, BCA, and commitment to a plan of action directly or indirectly affect physical activity participation (Pender, 2011; Pender et al., 2015). The theoretical proposition for achieving a health-promoting behavior is that individuals can alter their thoughts, feelings, personal influences (such as social support), and environments to help increase their likelihood to participate (Pender, 2011).

The constructs of personal factors, BCA, and commitment to a plan of action are important elements of the PEPME conceptual framework needed to achieve the health-promoting behavior of physical activity participation. Lastly, depressive symptoms can have positive or negative influences on physical activity participation. For example, in a 6-year longitudinal study of 496 female adolescents, Jerstad, Boutelle, Ness, and Stice (2010) found a significant bi-directional relationship between depressive symptoms and physical activity. In the PEPME conceptual framework, physical activity participation was influenced by personal factors and commitment to a plan of action and had a proposed bidirectional relationship with depressive symptoms.
Depressive symptoms. The second outcome variable of interest is the concept of depressive symptoms, which has a proposed bidirectional relationship with physical activity (Jerstad et al., 2010). For example, depressive symptoms may affect physical activity participation, and physical activity participation may affect depressive symptoms. Gunnell et al. (2016) found that adolescents who had higher levels of depressive symptomology at the age of 13.5 years experienced a larger decline in their physical activity participation ($p < .05$). The study by Gunnell et al. (2016) was conducted over an 11-year period and included 1,160 adolescents who were 10 to 21 years of age.

Direct relationships of physical activity on depression in adolescents and children have also been studied. For example, in two separate systematic reviews, both Brown et al. (2013) and Larun, Nordheim, Ekeland, Hagen, and Heian (2006) found small but significant effects of physical activity interventions on decreasing depressive symptoms in children and adolescents. However, in this study and based on the PEPME conceptual framework, a bidirectional relationship between physical activity participation and depressive symptoms is proposed.

Definitions of Key Concepts and Terms

In this section, definitions of key concepts and terms used in the study are presented. In some cases, a concept or term is defined as used in the literature. In other cases, the PI developed the definition specifically for this study.

PEPME Concepts

Promoting exercise for physical and mental health (PEPME). PEPME is a conceptual framework based on Nola Pender’s Health Promotion Model (revised) that
was developed for the purpose of studying physical activity participation and depressive symptoms in the female adolescent population (Pender et al., 2015).

**Behavior-specific cognitions and affect (BCA).** The definition of the construct, BCA, is the perceptions, thoughts, and feelings that individuals experience and that may influence their attitudes and actions toward a health-promoting behavior (Pender, 2011). This construct includes several concepts that explore the individual’s personal thoughts and feelings about performing the desired health-promoting behavior or action (Pender, 2011). The two BCA concepts investigated in this study are self-efficacy and social support for physical activity. These two concepts contain key motivational elements that influence the individual to participate in health promotion behaviors such as physical activity (Pender et al., 2015). The potential influence of self-efficacy and social support for physical activity on physical activity participation and depressive symptoms are important to understanding the PEPME conceptual framework.

**Self-efficacy for physical activity.** Bandura (1994) stated, “self-efficacy beliefs determine how people feel, think, motivate themselves, and behave” (para. 1). These beliefs influence several aspects of individuals’ lives, to include personal choices, degree of motivation, functioning, resilience, and vulnerability (Bandura, 1994). Similarly, perceived self-efficacy is defined as individuals’ thoughts about how well they can accomplish a desired action (Bandura, 2004; Pender et al., 2015). More specifically, Bandura (1994) explained that “perceived self-efficacy is defined as people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (para. 1). Perceived self-efficacy and self-efficacy were both considered important and inter-related terms. For this study, self-
efficacy for physical activity was the concept operationalized. It was defined as how confident and motivated an individual is for participating in physical activity.

**Social support for physical activity.** Social support is defined as “a network of interpersonal relationships that provide psychological and material resources intended to benefit the individual’s ability to cope” (Pender et al., 2015, p. 200). Social support for physical activity can be instrumental such as transportation or funding, psychological such as emotional encouragement, or instructional such as counseling (Mendonça et al., 2014; Pender, 2015).

**Health-promoting behavior.** Health-promoting behavior is defined as “the desired behavioral end point or outcome of health decision-making and preparation for action” (Pender, 2011, p. 4). A major reason for participating in health promoting behaviors is that these behaviors can positively impact the individual’s overall health. Participation in health-promoting behaviors is the ultimate goal for the PEPME conceptual framework. According to Pender et al. (2015), involvement in health-promoting behaviors, such as physical activity, will help individuals experience improved life satisfaction with fewer chronic health conditions and better functional capacity.

**Commitment to a plan of action.** Commitment to a plan of action is defined as the impetus or intention for initiating a behavioral change, such as physical activity participation (Pender et al., 2015). According to Pender et al. (2015), the following underlying cognitive processes are necessary for committing to a plan of action:

1. Commitment to carry out a specific action at a given time and place and with a specified person or alone, irrespective of competing preferences
Depressive symptoms. The definition of depressive symptoms in this study is having feelings of sadness, guilt, fear, insignificance, loneliness, uselessness, and powerlessness, as well as experiencing deficits in both mental and physical health, to include problems with concentration, appetite, and sleep (Radloff, 1977). This definition is based on the major components of depressive symptomology taken from the clinical literature that was used to validate the CES-D scale. To understand depression as a chronic disease, the World Federation of Mental Health (2010) provides the following definition:

Depression is a serious illness that affects the mind, brain, and body. It can affect anyone regardless of age, ethnic background, socio-economic status, or gender. The causes of depression are thought to be a combination of genetics, biology, and emotional factors. (p. 7)

Other Concepts and Terms

Electronic activity monitors. In this study, an electronic activity monitor (EAM) is defined as “a wearable device that objectively measures lifestyle PA [physical activity] and can provide feedback, beyond the display of basic activity count information, through the monitor display or a partnering application to elicit continual self-monitoring of activity behavior” (Lewis et al., 2015, p. 2).

Physical activity. Physical activity is defined “as any bodily movement produced by skeletal muscles that requires energy expenditure” (WHO, 2017a, para. 1). WHO and the USDHHS agree that the guidelines for adolescents’ physical activity are to
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participate in a minimum of 60 minutes per day of moderate to vigorous physical activity. The physical activity should consist of mainly aerobic-type exercises, while also including strength building resistance type activities no less than three days per week (USDHHS, 2008; WHO, 2010).

Physical inactivity. Physical inactivity for adolescents is defined as getting less than 60 minutes per day of moderate to vigorous exercise (WHO, 2017c). Dumith et al. (2011) defines physical inactivity in the general population as achieving less than 30 minutes of moderate activity five out of seven days per week, or less than 20 minutes of vigorous activity at least three out of five days per week, or achieving less than 600 metabolic equivalent (MET) minutes per week overall. One MET is the amount of energy that an individual expends while resting in a seated position (Bushman, 2012).

Summary

Physical inactivity and depression are significant problems that are affecting the mental and physical health of female adolescents worldwide. This study utilized EAMs, specifically Fitbit Zips, along with daily step goals to impact physical activity participation (increased steps) and depressive symptoms (decrease CES-D scores). No previous research studies investigating the effects of EAMs with daily step goals on increasing physical activity participation and decreasing depressive symptoms in the female adolescent population were found.

The PEPME conceptual framework, which is based on Nola Pender's HPM (revised), was developed for this study. The emphasis of the PEPME conceptual framework is on health promotion, focusing on how personal factors, self-efficacy, social support, and commitment to a plan of action influence physical activity participation and
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depressive symptoms. Specific to this study, the concepts of self-efficacy, social support, and commitment to a plan of action used in the PEPME conceptual framework focus on the health promotion outcome of physical activity participation. The next chapter provides a review of the literature for the major concepts included in the PEPME conceptual framework and their corresponding relationships. Also presented is a qualitative literature review on female adolescents’ beliefs and behaviors about physical activity.
Chapter 2: Review of the Literature

In this chapter, key concepts from the Promoting Exercise for Physical and Mental Health conceptual framework (PEPME) are reviewed, and important relationships among these concepts are examined. Also reviewed are the physical activity guidelines for children and adolescents from the American Academy of Pediatrics (AAP), American College of Sports Medicine (ACSM), Institute of Medicine (IOM), U.S. Department of Health and Human Services (USDHHS), and the World Health Organization (WHO). Additionally, electronic activity monitors (EAMs) are examined as a means for acquiring objectively measured physical activity information (steps per day).

Several focused literature reviews are presented exploring the major concepts of this study and how they relate to the female adolescent population. In addition, female adolescents’ beliefs and behaviors about physical activity as well as various strategies to promote physical activity in this population are also reviewed. Moreover, a key review of the literature is presented where the relationships among depression, physical activity, and EAMs are systematically examined. Search strategies used to conduct the literature reviews are described in the various sections of the chapter.

Depression

Significance of Depression

According to WHO (2017d), over 300 million people of all ages and from all countries suffer from depression. Depression is now considered a significant contributor to the world’s burden of disease and is the number one cause of illness and debility (Whiteford, Ferrari, Degenhardt, Feigin, & Vos, 2015; WHO, 2017e). The ultimate cost of
depression is suicide, which accounts for nearly one million deaths per year (worldwide) and is the second leading cause of mortality for young people 15 to 29 years of age (WHO, 2017d). Examining U.S. data from 2011, nearly 16% of 15,425 students from 158 schools participating in the CDC’s Youth Risk Behavior Surveillance System (grades 9 to 12) had seriously contemplated committing suicide (CDC, 2011). In addition, almost 30% of the same students reported feeling sad and hopeless on most days for greater than two consecutive weeks (CDC, 2011). The percentage of females was greater than males for both contemplating suicide (19.3% versus 12.5%, respectively) and feeling sad and hopeless (35.9% versus 21.5%, respectively; CDC, 2011). Finally, the overall estimated direct cost for mental illnesses in 2009 for the United States was $175.7 billion (Kockaya & Wertheimer, 2010), with major depressive disorder (MDD) affecting more than 2.8 million U.S. adolescents (NIMH, 2014).

Major depressive disorder (MDD) is one of nine different depressive disorders recognized in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). The other eight depressive disorders include disruptive mood dysregulation disorder, substance/medication-induced depressive disorder, premenstrual dysphoric disorder, other specified depressive disorder, depressive disorder due to a medical condition, unspecified depressive disorder, specifiers for depressive disorders, and persistent depressive disorder (American Psychiatric Association, 2013). Each of these disorders has the following shared conditions: “the presence of sad, empty, or irritable mood, accompanied by somatic and cognitive changes that significantly affect the individual’s capacity to function” (DSM-5, Depressive disorders chapter, 2013, para 1).
The definition of depressive symptoms in this study is having feelings of sadness, guilt, fear, insignificance, loneliness, uselessness, and powerlessness, as well as experiencing deficits in both mental and physical health to include problems with concentration, appetite, and sleep (Radloff, 1977). This definition is based on the major components of depressive symptomology taken from the clinical literature that was used to validate the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is an epidemiological tool for measuring individuals' symptoms of depression, with a central focus on the “depressed mood” component (Radloff, 1977). The CES-D is verified as suitable for both the clinical and general population as a valid and reliable tool for measuring depressive symptomology (Radloff, 1977). In this study, depressive symptoms were assessed using the CES-D.

**Depression in Adolescents**

The National Institute of Mental Health (2014) estimates that over 11% of American adolescents will experience a depressive disorder by the time they are 18 years of age. Symptoms of depression interfere with social and occupational tasks and may lead to poor school performance, social problems, drug use, lack of employment, and suicidal ideation (SAMHSA, 2014). Some typical manifestations of depression observed in adolescents are (a) negative moods leading to frustration and agitation, (b) emotional volatility, (c) increases in body weight and hunger, (d) physical body complaints, (e) excessive time spent sleeping, and (f) a heightened sensitivity to ridicule, causing strained personal relationships (Rey, Bella-Awusah, & Jing, 2012).

Experts from the National Research Council and IOM estimated that the 2009 cost burden for mental illness of children and young adults in the United States (up to
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age 24) along with the difficulties related to behavior and substance abuse was 247 billion dollars (Denkmire, Perritano, Kane, & Kittleson, 2011). In 2009, only one third of children diagnosed with depression in the United States received medical treatment (Young, 2012), and approximately one in five young people processed through the juvenile justice system were found to have significant mental health issues (Denkmire et al., 2011). As much as 50% of the time, mental health problems start in adolescence and carry over into adulthood (Belfer, 2008). Fergusson, Boden, and Horwood (2007) followed 982 New Zealand youth from 16 to 21 years of age. After adjusting for potential confounders, an association was found ($p < .05$) between the frequency of depressive episodes in adolescence and poor mental health and economic outcomes in early adulthood (Fergusson et al., 2007).

Several risk factors for depression have been identified in adolescents, with the most common being genetics, having a parent or parents with depression, or being of the female gender (Garber, 2006). Patel (2013) contends that effectively managing depression in adolescence is extremely important and should be considered a worldwide health priority, especially since depression is the leading cause of disease and mortality for this population. As adolescent depression passes into adulthood, significant consequences to the global burden of disease may occur (Patel, 2013).

Belfer (2008) reported on the significance of mental illnesses for children and adolescents based on worldwide epidemiological data. According to Belfer (2008), half of all adult mental disorders start in adolescence, and as many as 20% of children and adolescents suffer from debilitating mental health problems. In the United States, up to 15% of children and adolescents will experience symptoms of depression at some point.
in their lives, and by the age of 14 years, the prevalence in females is twice that in males (Bhatia & Bhatia, 2007).

Baldursdottir, Valdimarsdottir, Krettek, Gylfason, and Sigfusdottir (2017) conducted a cross-sectional semi-longitudinal study with data gathered from more than 10,000 Icelandic adolescents. The cross-sectional data came from a national research study, termed Youth in Iceland, and were compiled from three population-based surveys, administered to three different cohorts of students (males and females 10 to 19 years of age), during three distinct points in time (Baldursdottir et al., 2017). During the course of the research project (from 2011 to 2013), surveys were collected from 32,456 Icelandic youth (Baldursdottir et al., 2017). According to the survey results, adolescent participants experienced increased depressive symptomology by the end of the third year (2013), with female adolescents reporting significantly ($p < .001$) higher levels of depressive symptoms than males (Baldursdottir et al., 2017).

**Depression in Female Adolescents**

According to NIMH (2014), female adolescents have significantly more major depressive episodes (MDEs) than males (13% vs. 8%), and they are more likely to have ones with severe impairment (10% vs. 3%). Major depressive episodes are defined as having feelings of depressed mood or loss of interest in regular day-to-day activities lasting two weeks or more, along with four out of seven additional symptoms associated with MDD (SAMHSA, 2013). Several studies have also reported that female adolescents were twice as likely as their male counterparts to have symptoms of MDD (Cohen et al., 1993; Essau, Lewinsohn, Seeley, & Sasagawa, 2010). This gender difference typically has its onset in puberty, with the largest increases occurring between the ages of 15 and
18 years (Cohen et al., 1993; Essau et al., 2010; Hankin, 2006). One-year prevalence of MDD was found to peak around the age of 16 years, meaning that 16 years of age represented the period of time when adolescents were at the greatest risk for meeting the criteria for MDD (Rohde, Beevers, Stice, & O’Neil, 2009). Additionally, Bennik, Nederhof, Ormel, and Oldehinkel (2014) determined that female adolescents displayed increasingly more symptoms of depressed mood than male adolescents and that this difference was most evident in mid-adolescence.

Similarly, Garber (2006) found that depression rates in adolescents were as much as two to three times higher in females than males with possible explanations given as: “hormonal changes, increased stress, differences in interpersonal orientation, tendencies toward rumination and other maladaptive responses to stress, and different socialization experiences” (p.105). The tendency toward rumination in female adolescents has been linked to decreased emotional clarity over time (Rubenstein et al., 2015). Emotional clarity is the ability to understand, define, and be mindful of one’s emotions (Rubenstein et al., 2015). The repetitive and destructive thought processes of rumination have been associated with a greater inability to distinguish, understand, and work through one’s emotions, thus resulting in a potentially vicious cycle of future depressive symptoms (Rubenstein et al., 2015).

Looking at the significance of depression in female adolescents, survey data from the National Longitudinal Study of Adolescent Health were examined from students in grades 7 to 12 (Fletcher, 2008; Rushton, Forcier, & Schectman, 2002). The students were initially surveyed while in school and then again one and six years later, yielding responses from more than 13,000 young people (Fletcher, 2008). Three significant
associations between depressive symptoms and educational achievement emerged only in the female adolescents later interviewed as young adults (Fletcher, 2008). To summarize these findings, females with depressive symptoms during adolescence were less likely to finish high school, enroll in any advanced educational programs, or attend a four-year college, despite graduating from high school (Fletcher, 2008).

In summary, depression is a predominant cause of disability worldwide and is a significant disease of burden for most age groups (Marcus et al., 2012; Whiteford, et al., 2015; WHO, 2017d). Female adolescents are more than twice as likely to experience depressive symptoms as their male counterparts and are more likely to seriously contemplate suicide (CDC, 2011). Therefore, finding interventions for decreasing depressive symptoms in the female adolescent population is an important and relevant area of investigation for nursing research.

**Adolescent Physical Activity Guidelines**

The definition of physical activity used with adolescents is any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2010). Numerous countries and organizations around the world have proposed recommendations for physical activity geared toward maintaining both physical and mental health. WHO (2010) and the U.S. Department of Health and Human Services (USDHHS, 2008; USDHHS, 2012) endorse the following physical activity guidelines for children and adolescents 5 to 17 years of age: (a) accumulate at least 60 minutes/day of moderate to vigorous physical activity (MVPA), (b) have most of the 60 minutes/day of activity be aerobic in nature, and (c) perform muscle and bone strengthening exercises at least three days/week. The CDC (2015) also endorses the WHO and USDHHS physical
activity recommendations and offers various resources to foster physical activity participation.

The American College of Sports Medicine (ACSM), AAP, and the IOM, also concur with the USDHHS and WHO recommendations for physical activity for children and adolescents. The accumulation of 60 minutes of MVPA should include aerobic type exercises such as walking, running, biking, swimming, skating, hiking, martial arts, jumping rope, and dancing (AAP, 2015; ACSM, 2015; IOM, 2015). Various team sports such as basketball, soccer, lacrosse, ice or field hockey, and volleyball, are also considered MVPA (AAP, 2015; ACSM, 2015).

Furthermore, the recommendation of at least three days per week of muscle and bone strengthening exercises includes the need for qualified adult supervision to establish proper exercise techniques and assess participants’ maturity level (ACSM, 2015). Muscle strengthening exercises should involve major muscle groups such as the chest, back, shoulders, arms, abdominals, and hips (AAP, 2015). Some examples of muscle strengthening activities include resistance training (with dumbbells, body weight, or elastic bands), push-ups, sit-ups, and various rock, tree, and wall climbing activities (AAP, 2015; ACSM, 2015). Bone strengthening activities include most weight bearing, aerobic and muscle strengthening exercises previously discussed (AAP, 2015; ACSM, 2015).

The Robert Wood Johnson Foundation enlisted the expertise of the IOM to examine the present state of physical activity and physical education in U.S. schools and make appropriate recommendations for assisting children and adolescents in attaining the USDHHS physical activity guidelines (IOM, 2013). The main
recommendation from the IOM for increasing child and adolescent physical activity participation centered on making sure that all public school system’s stakeholders were committed and involved in the process (IOM, 2013). Termed the “whole of school” approach, the IOM recommended that all entities involved with the schools (students, parents, teachers, administrators, and superintendents) support access to at least 60 minutes per day of MVPA (IOM, 2013). Physical activity access should revolve around a normal school day, with additional opportunities made available before and after school (IOM, 2013). Furthermore, the IOM committee recommended that physical education be a part of the core curriculum such that students could achieve at least half of their 60 minutes of MVPA during the school day (IOM, 2013).

**Significance of Physical Inactivity in Adolescents**

Physical inactivity is a significant problem worldwide, with an estimated annual death toll of 3.2 million people (WHO, 2017c). In addition, physical inactivity is linked to the pervasiveness of major non-communicable diseases (NCDs) such as cardiovascular and respiratory diseases, cancers, and diabetes, with these four diseases accounting for greater than 80% of the 40 million annual deaths linked to NCDs (WHO, 2017a). Alarmingly, more than 80% of adolescents worldwide do not get the recommended level of daily physical activity (WHO, 2017a).

Nader, Bradley, Houts, McRitchie, and O'Brien (2008) used longitudinal data from the National Institute of Child Health and Human Development study, which included 1,032 American youth, to evaluate changes in MVPA of the participants from 9 to 15 years of age. Participation in at least 60 minutes of MVPA, as measured by an accelerometer, decreased substantially from the ages of 9 to 15 years for the youth
studied (Nader et al., 2008). At 15 years of age, only 31% of the youth participated in 60 minutes of MVPA on weekdays and only 17% on weekends, as compared to more than 90% participation for the same youth at 9 years of age for all days of the week (Nader et al., 2008).

Terzian and Moore (2009) used data from the 2003 National Survey of Children’s Health to investigate two types of physical inactivity in adolescents: sedentary behavior, defined as less than 20 minutes of physical activity in the past week, and lack of sports participation, defined as not participating in team or individual sports in the past year. Data analysis results suggested that adolescents who did not participate in physical activity during a given week were more likely (when compared with their more physically active counterparts) to (a) use technology for entertainment three or more hours per day, (b) be above normal weight, (c) have non-exercising parents, (d) be older (15 to 17 years of age), (d) be of the female gender, and (e) spend less time eating with their families, only averaging fewer than three times per week (Terzian & Moore, 2009). From these findings, not having parents who exercise or spend time with their teens may contribute to sedentariness as well as an unhealthy weight for adolescents, especially females, thereby highlighting the importance of parental support (Terzian & Moore, 2009).

Finally, Baldursdottir et al. (2017) had similar findings from their cross-sectional study of more than 10,000 Icelandic adolescents. Both genders experienced decreased levels of physical activity as they aged, with more than 60% of the older adolescents (16 to 19 years of age) not meeting the WHO recommended levels of physical activity (Baldursdottir et al., 2017). Overall the female adolescents were less active than their
male counterparts, and significantly greater numbers of female adolescents ($p < .001$) reported rarely participating in any type of organized sports as compared with male adolescents (Baldursdottir et al., 2017). Similarly, Pate, Dowda, O’Neill, and Ward (2007) surveyed 398 female adolescents in middle school (baseline) and then again in high school and found that their MVPA declined from 45.4% in the eighth grade to 34.1% in the twelfth grade.

**Female Adolescents’ Beliefs about Physical Activity**

Female adolescents are not getting the recommended levels of physical activity, and they are becoming physically inactive adults (Pearson, Braithwaite, & Biddle, 2015). This deleterious passage into adulthood potentially leads to adverse physical and mental health outcomes (Pearson et al., 2015; WHO, 2010). To understand the substantial decline in physical activity that occurs during adolescence, a focused review of qualitative studies was conducted to explore various themes related to female adolescents’ beliefs about physical activity. The databases searched were PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and PsycINFO for a timeframe of approximately 10 years, from January 2006 to June 2017. The keywords used to identify the relevant studies were (1) qualitative, (2) physical activity, (3) exercise, (4) adolescents, (5) females, and (6) beliefs. Inclusion criteria for the review were those studies having a qualitative design component that explored the direct beliefs of healthy female adolescents toward physical activity (as opposed to the investigator’s descriptions or perceptions). Additional inclusion criteria were that the study report be written in the English language and be either a primary peer-reviewed article or a dissertation.
From the search of the three databases, 795 abstracts were screened, and 28 studies met the inclusion criteria. Nine of the 28 articles had the perceptions of both male and female adolescents, while 19 articles focused exclusively on female adolescents’ perspectives. Furthermore, three qualitative reviews of the literature were also appraised for any additional themes related to female adolescents’ beliefs about physical activity. The principal reason for conducting a focused review of qualitative studies was to obtain a deeper understanding of female adolescents’ personal experiences and individual beliefs about physical activity. While the majority of female adolescents’ views concerning physical activity were negative, there were a few positive beliefs about physical activity.

**Positive Beliefs about Physical Activity**

From the focused review of the qualitative literature, the three most common themes for female adolescents' positive beliefs concerning physical activity were improved physical appearance, enhanced mental and physical health, and weight management (Allender, Cowburn, & Foster, 2006; Clark, Spence, & Holt, 2011; Craike, Symons, & Zimmermann, 2009; Loman, 2008; Standiford, 2013; Vu, Murrie, Gonzalez, & Jobe, 2006; Yungblut, Schinke, & McGannon, 2012). Many female adolescents expressed feelings of pleasure while participating in physical activities they enjoyed, yet they felt that enjoyable physical activity opportunities were rarely experienced in the school setting (Clark et al., 2011). In addition, some female adolescents reported having more energy, feeling more relaxed and less stressed, and having a sense of well-being after participating in physical activities they enjoyed (Azzarito, Solomon, & Harrison,
2006; Bélanger et al., 2011; Duberg, Moller, & Sunvisson, 2016; Ketteridge & Boshoff, 2008; Van Kessel, Kavanagh, & Maher, 2016; Whitehead & Biddle, 2008).

The social aspect of exercising as a group, getting encouragement from family members, peers and teachers, and having a place to express oneself were other positive beliefs about physical activity (Allender et al., 2006; Bélanger et al., 2011; Duberg et al., 2016; Knowles, Niven, & Fawkner, 2011). Coleman, Cox, and Roker (2008) looked at differences between 75 female adolescents (15 to 19 years of age) in relation to those who “always” participated in physical activity and those who “never” participated in physical activity. From the in-depth interviews, the single most prevailing factor influencing physical activity participation was peer (friendship group) association (Coleman et al., 2008).

**Negative Beliefs about Physical Activity**

While there were a few favorable attitudes toward physical activity, many of the opinions expressed by female adolescents were centered on their negative views of physical activity. The following sections include some of the major themes related to the negative beliefs about physical activity described by the female adolescents in the qualitative studies reviewed. These themes pertaining to physical activity included concerns about physical appearance, time constraints, type of activities, competition of activities, competence with activities, cost and accessibility of facilities, safety, and social support for participating in activities.

**Body-centered issues and personal appearances.** The importance placed on appearances was a common and highly emphasized theme throughout the literature reviewed. In a focus group study of 49 female adolescents who were 13 to 15 years of
age, the female adolescents expressed being self-conscious about their bodies, feeling uncomfortable dressing in front of others, and disliking having to wear mandatory uniforms (Allender et al., 2006; Azzarito et al., 2006; Brophy et al., 2011; Robbins, Pender, & Kazanis, 2003; Slater & Tiggemann, 2010). In addition, there was significant social pressure to be thin and toned, but not too muscular (Dwyer et al., 2006; Slater & Tiggemann, 2010). Female adolescents reported feeling pressured into participating in gender specific activities, thereby limiting their opportunity to participate in other types of activities that they might have found more enjoyable (Brophy et al., 2011; Spencer, Rehman, & Kirk, 2015). Whitehead and Biddle (2008) used exploratory focus group sessions with 47 female adolescents (14 to 16 years of age) to investigate how the influences from society and its norms affected physical activity. Female adolescents reported feeling inadequate because of the constant reminders from media images to have a perfect and thin body (Whitehead & Biddle, 2008). Consequently, healthy physical perceptions of the female adolescents were not based on eating nutritious foods or exercising regularly, but were based on body shape, size, and overall physical appearance (Spencer et al., 2015; Whitehead & Biddle, 2008).

**Competing demands.** Another common theme identified for female adolescents’ barriers to physical activity was competing demands. For example, interests in talking to friends on the phone, watching movies or television shows, and playing games on the computer generally took precedence over being active (Dwyer et al., 2006; Knowles et al., 2011; Van Royen et al., 2015; Vu et al., 2006). Van Kessel et al. (2016) conducted focus groups with 19 female adolescents to help determine the feasibility of implementing an online physical activity program. The theme of perceived
costs (barriers) of such a program emerged, indicating that participation in physical
activity had to compete with other activities such as school, homework responsibilities,
and employment (Brophy et al., 2011; Eime et al., 2015; Van Kessel et al., 2016).
Additionally, in a scoping review by Spencer et al. (2015), “looking pretty” and being
viewed as feminine were important to female adolescents. The competing demand of
femininity over physical activity precluded some female adolescents from performing
well or fully participating in certain physical activities because they did not want to “show
up” the boys or get too sweaty (Brophy et al., 2011; Spencer et al., 2015; Williams &
Berry, 2015). Yungblut et al. (2012) found that many female adolescents expressed
positive feelings about being active, but stated they disliked going back to class feeling
uncomfortable and sweaty. Therefore, not “feeling gross and sweaty” outweighed the
positive feelings from participating in the physical activity (Williams & Berry, 2015;
Yungblut et al., 2012).

**Competition and competence.** Another shared theme found in several of the
studies was related to competition, together with the displeasure that came with the
competitive aspects of the physical activities offered in the school physical education
classes (Allender et al., 2006; Bélanger et al., 2011; Casey, Eime, Payne, & Harvey,
2009;知二es et al., 2011; Yungblut et al., 2012). Female adolescents felt that if they
were too competitive or proficient at a sport, they would be labeled a tomboy and be
 teased by both their male and female peers (Slater & Tiggemann, 2011; Standiford,
2013). Eime, Payne, Casey, and Harvey (2010) found that female adolescents who
viewed themselves as lacking competence in sports would make excuses for not
participating. In addition, Morrison, Knight, and Crew-Goosen (2015) conducted focus
groups with African American female adolescents who professed that participation in competitive physical activities with boys was embarrassing and uncomfortable, thereby further creating barriers to physical activity participation.

Yungblut et al. (2012) used an interpretive phenomenological approach to study the lived experiences of female adolescents relative to sports and physical activity participation. The social pressure of performing to the expectations of others was a significant barrier to the 35 female adolescent participants (Allender et al., 2006; Yungblut et al., 2012). Similarly, the idea of letting one's fellow team members down was viewed as problematic and also caused female adolescents to shy away from sports and physical activity participation (Casey et al., 2009; Yungblut et al., 2012). Charlton et al. (2014) discussed another aspect of competence that was related to underprivileged adolescents living in South Wales (United Kingdom). The parents of these adolescents had very little disposable income; therefore, the adolescents lacked such basic skills as knowing how to swim or be able to ride a bike (Charlton et al., 2014). These adolescents found their lack of basic abilities to be embarrassing, especially in a sporting environment (e.g., swimming or biking) with their peers (Charlton et al., 2014).

Inaccessibility of facilities and costs. In nine qualitative or mixed methods studies, both the parents and their adolescent children indicated that the inaccessibility of facilities and the cost of participating in specific types of sports or physical activities were barriers to physical activity participation (Baheiraei, Hamzehgardeshi, Mohammadi, Mohammadi, & Nedjat, 2016; Bélanger et al., 2011; Brophy et al., 2011; Charlton et al., 2014; Christian et al., 2016; Madrigal, Adams, Chacon, & Barnya, 2017; Moore et al.,
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2010; Van Royen et al., 2015). Parents of rural female adolescents had concerns about the cost of gas, the distance to travel, and the direct expenses associated with a particular sport or fitness activity in which their daughters wanted to participate (Dwyer et al., 2006). Baheiraei et al. (2016) interviewed 25 Iranian adolescents and found that both genders reported costs and inaccessibility of facilities as major contributors to their lack of physical activity. Females in particular felt their inaccessibility to facilities was much greater than males due to the cultural and societal norms of their country (Baheiraei et al., 2016).

Safety. Some common beliefs concerning safety were related to the actual physical environment of the female adolescents. Safety concerns pertaining to environmental barriers to physical activity participation, especially in urban settings, were presented as follows: unsafe neighborhoods, no pedestrian access along roadways (e.g., no sidewalks), gang hangouts at community facilities, and fear of sexual assault or kidnaping (Dwyer et al., 2006; Moore et al., 2010). Likewise, Van Hecke et al. (2016) conducted focus groups with 30 adolescents 12 to 16 years of age from Belgium about the social and physical environments (termed public open spaces) which influenced their physical activity behaviors. The adolescents from this study expressed similar concerns about the environment related to safety, but also included concerns about the cleanliness and presence of homeless people in these public open spaces (Van Hecke et al., 2016). Azzarito and Hill (2013) used visual ethnography, interviews, and field notes to study the link between female adolescents’ physicality and places in their local communities available for participating in physical activity. One female
adolescent expressed concerns about attending the local gym, stating that she thought she was too young to safely use the training equipment available (Azzarito & Hill, 2013).

**Social support for physical activity.** Bélanger et al. (2011), Eime et al. (2015), and Knowles et al. (2011) reported that the social support for physical activity available to female adolescents affected their beliefs and significantly impacted their willingness to participate in physical activity. Dwyer et al. (2006) found that having parents, siblings, or friends who were unwilling to promote and participate in physical activity was found to be detrimental to female adolescents’ activity levels. In a large multisite study termed the Trial of Activity for Adolescent Girls (TAAG), semi-structured interviews \( n = 80 \) and focus groups \( n = 100 \) were conducted to determine physical activity perceptions of female adolescents in the seventh and eighth grades (Vu et al., 2006). Participants reported experiences with negative peer support, such as taunting and name-calling from boys as a major barrier to physical activity participation (Vu et al., 2006).

Additionally, in a systematic review examining interpersonal factors influencing physical activity in female adolescents, more than 50% of the girls recounted being subjected to excessive teasing and bullying, predominately from male adolescents, while participating in coeducational physical education classes (Standiford, 2013). Negative peer support was a key reason why female adolescents did not want to participate in physical activities (Baheiraei et al., 2016; Casey et al., 2009; Yungblut et al., 2012). Finally, Charlton et al. (2014) found parental support for physical activity (funds, transportation, time, and acceptance) was a significant factor that influenced participation and interest in physical activity for both male and female adolescents.
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**Time.** From a focus group study of 73 female adolescents, many of the female participants discussed having insufficient time to participate in physical activity due to the demands of homework, after school jobs, and household responsibilities (Bélanger et al., 2011; Brophy et al., 2011; Dwyer et al., 2006). Several female adolescents reported having responsibilities for taking care of their younger siblings, such as cleaning the house and cooking meals because their parents frequently worked late (Dwyer et al., 2006). One female adolescent reported having several hours of homework to do each night, and another expressed an interest in just having more free time to do other things (Dwyer et al., 2006; Slater & Tiggemann, 2010). Finally, another time issue presented by female adolescents was related to the scheduling of physical education classes during the school day and not having any time to shower or change before their next class (Williams & Berry, 2015).

In summary, there were numerous negative perceptions and a few positive beliefs expressed by female adolescents concerning physical activity from the qualitative studies reviewed. One important underlying theme from several of the studies was the importance of social support for physical activity. Whether social support was positive or negative, the effect on physical activity participation was evident. In addition, body-centered concerns were prevalent both in promoting and preventing physical activity participation. Concerns were expressed about safety and time constraints related to participating in physical activities, along with the importance of having some variety and fun. Many of the barriers to physical activity were based on the female adolescent’s perception about how she was viewed by others, especially her peers.
Strategies to Promote Physical Activity in Female Adolescents

From the previous focused review of the qualitative literature exploring themes related to female adolescents’ beliefs about physical activity, 19 articles offered strategies for promoting physical activity in this population. One dominant theme for promoting physical activity in female adolescents was related to “fun and enjoyment.” Brooks and Magnusson (2007) conducted three focus group sessions with 36 female adolescents who were 13 to 16 years of age. A key finding was the importance that female adolescents placed on experiencing pleasure and enjoyment from their leisure time activities (Brooks & Magnusson, 2007). They described fun leisure time activities as a way for them to relax, have fun, and socialize with their friends, thus motivating them to participate. Similarly, a focus group of African American female adolescents listed leisure time physical activities such as dancing, running, and basketball as examples of enjoyable activities to inspire them to participate in physical activity (Morrison et al., 2015). The idea of “having fun” was a major predictor of physical activity participation for female adolescents (Martins, Marques, Sarmento, & Carreiro da Costa, 2015).

Due to the significant decline in physical activity levels of adolescents, especially female adolescents, quantitative research studies (specifically RCTs) have been conducted to explore potential interventions to promote physical activity in the adolescent population. The following RCTs reviewed were school-based, with two offering a community component. In addition, various insights into the successful strategies for the promotion of physical activity in female adolescents for the last 10 years are presented. A discussion of the outcomes of these strategies is also offered.
Lastly, specific approaches to create potentially successful physical activity programs within the public school environment are examined.

Many of the investigators utilized formative research or focus groups to support the development of effective strategies for their physical activity interventions (Casey et al., 2013; Casey, Harvey, et al., 2014; Casey, Telford, et al., 2014; Dudley et al., 2010; Felton et al., 2005; Okely et al., 2011; Okely et al., 2017; Robbins, Gretebeck, Kazanis, & Pender, 2006; Robbins et al., 2013; Webber et al., 2008; Young et al., 2006).

Formative research involves the use of various quantitative and qualitative methods to provide background information regarding the suitability of an intervention for a specific population within a designated community (Gittelsohn et al., 2006). From the 19 studies examined, three main strategies for physical activity promotion in female adolescents were identified: personal and behavioral, social support, and environmental and delivery.

**Personal and behavioral strategies for physical activity promotion.** Most of the studies designated behavioral measures as important predictors of physical activity participation. Therefore, they were considered important strategies to implement. Dewar, Plotnikoff, et al. (2013) and Lubans et al. (2010) discussed using several different intervention strategies to increase self-efficacy and promote positive behavioral patterns in female adolescent participants. In the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) study, behavioral and personal strategies used in the intervention were (a) text messaging for encouragement, (b) a student handbook with strategies to overcome obstacles and reduce sedentary behaviors, (c) peer led lunchtime physical activities to recruit younger female participants, and (d) skill enhancing sport activities led by teachers which targeted enjoyable, sustainable types of activities (Dewar et al., 2014;
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Dewar, Morgan, et al., 2013; Lubans et al., 2010). In addition, interactive seminars were available to aid in physical activity confidence building, and pedometers were provided to encourage goal setting and self-monitoring (Dewar et al., 2014; Dewar, Morgan, et al., 2013; Lubans et al., 2010). Robbins et al. (2013) in the Girls on the Move study, offered each female participant two face-to-face counseling sessions with a registered nurse and a tailored internet-based interactive session to motivate and personalize the intervention.

Social support strategies for physical activity promotion. Some of the RCTs that were reviewed used strategies that would influence female adolescents’ social support for physical activity (Casey, Harvey, et al., 2014; Dewar et al., 2014; Dewar, Morgan, et al., 2013; Dudley et al., 2010; Edwardson et al., 2015; Okely et al., 2011; Robbins et al., 2006; Robbins et al., 2013). For example, Lubans et al. (2010) sent newsletters home to provide parents with various methods for encouraging their daughter’s physical activity development and to give them pertinent information related to the progress of the study. Additionally, several investigators used text messaging as a means for providing individualized attention and instituted peer-led activities to establish a sense of ownership and boost participation (Dewar et al., 2014; Lubans et al., 2010). In the Girls Get Going program (Triple G), Casey et al. (2013) initiated the “bring a friend” program for the after school physical activity classes. The investigators instituted these classes to help increase physical activity levels by offering additional opportunities to be active outside of the normal school day. This program encouraged students to find a buddy to attend after school physical activities with them.
Environmental and delivery strategies for physical activity promotion.

Environmental. Modifying physical activity behavior in the school setting is a challenging task, especially with adolescents. There are a number of influential factors to consider, such as individual preferences; school, local, and state policies; and actual physical site limitations (Dobbins, Husson, DeCorby, & LaRocca, 2013). Despite the difficulties encountered, the school environment is typically considered the best venue for promoting physical activity interventions because of the impact it can have on the population of students (Story, Nanney, & Schwartz, 2009). To further clarify, it has been found that school-based physical activity interventions that are integrated into the curriculum have the potential to reach and expose every child to the proposed physical activity (Dobbins et al., 2013; Story et al., 2009).

All the RCTs reviewed were initiated through the schools, and most used the school environment as the central location for their physical activity interventions. Three RCTs incorporated joint school and community settings into their intervention strategies. Casey et al. (2013) used ethnographic fieldwork to develop a tailored physical education program to increase physical activity levels of female adolescents 12 to 15 years of age. The intervention, termed the Triple G program, had a school-based piece and an extracurricular component, which involved community sports and recreation centers (Casey et al., 2013). The two components shared the same conceptual ideals, thus insuring appropriate and consistent delivery of the physical activity interventions within the schools and the communities (Casey et al., 2013). The TAAG study used tailored school-based physical education classes as well as community partners such as local
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YMCAs, fitness facilities, and community centers to help increase physical activity involvement of the participating female adolescents (Webber et al., 2008).

Kahlin, Werner, and Alricsson (2014) provided an after school physical activity opportunity for 60 inactive Swedish female adolescents in the intervention group of their prospective cluster RCT. Four participating sports facilities located in close proximity to the school and homes of the teens were available with free memberships, aerobics classes, and personalized physical activity training (Kahlin et al., 2014). The main goal was to exercise at least 60 minutes per week outside of school. Dudley et al. (2010) addressed environmental factors by using community activity facilities that were currently not being used and modifying the school’s existing facilities to allow for improved access to physical activities.

More recently, Okely et al. (2017) conducted a group RCT named Girls in Sport with 24 secondary schools in New South Wales, Australia. Twelve schools were given the intervention, and twelve schools served as controls. Baseline data were collected from 1,518 female adolescents (mean age of 13.6 years), with the main outcome variable being time spent participating in MVPA as measured with accelerometry (Okely et al., 2017). The investigators used formative research strategies to develop an 18-month action plan for each of the intervention schools that would most significantly impact the physical activity levels of female adolescent participants. The targeted areas of impact included the following: the actual school’s curriculum (types of activities offered), the overall school’s environment (attitudes about physical activity and sports for females), and community links such as fitness clubs and sport centers (Okely et al., 2017).
**Delivery.** Several of the researchers provided informative educational sessions for individuals involved in the studies, such as teachers, instructors, nurses, and participants, mainly to ensure proper delivery of the interventions (Casey et al., 2013; Dewar et al., 2014; Edwardson et al., 2015; Lubans et al., 2010; Okely et al., 2011; Robbins et al., 2006; Robbins et al., 2013). For example, in the NEAT Girls group RCT, teachers involved with the 12-month intervention were encouraged to attend two days of educational workshops at the university that was conducting the research to complete training on delivering the intervention (Lubans et al., 2010).

Likewise, the Girls on the Move study, which was a randomized group trial based on a previous pilot study, required all physical activity instructors to attend a four-hour training session prior to the intervention with another six-hour refresher session near the halfway point of the study (Robbins et al., 2006; Robbins et al., 2013). Additionally, the nursing staff was required to attend two days of training on motivational interviewing for physical activity promotion (Robbins et al., 2013).

The preceding studies examined numerous strategies for promoting physical activity in the female adolescent population. However, many of the overall intervention strategies did not show significant results for physical activity participation with this group. For example, Dewar, Morgan, et al. (2013) found a decrease in sedentary activity time for the female participants in their NEAT intervention, but observed no improvements in physical activity. In addition, Dewar, Morgan, et al. (2013) did not find any significant relationships between the hypothesized mediators and physical activity. Casey, Telford, et al. (2014) reported several barriers to the implementation of their intervention at the school level, resulting in statistically non-significant outcomes.
Consequently, Casey, Telford, et al. (2014) concluded that researchers need to carefully assess the ability and willingness of all individuals involved in the program implementation before initiating any type of intervention. Dudley et al. (2010) reported improvements in physical activity enjoyment and body image as well as smaller declines in physical activity levels for female adolescents participating in their pilot study, but none of the findings had statistical significance.

Furthermore, Kahlin et al. (2014) saw improvements in physical fitness levels and self-rated physical health for inactive female adolescents participating in a RCT. However, the results were not statistically significant. For this RCT, the intervention group had access to at least one day per week of MVPA for a period of six months (Kahlin et al., 2014). Additionally, for the Girls in Sport RCT, Okely et al. (2017) found no improvements in physical activity levels, and only four of the 12 intervention schools implemented the formative research strategies as designed.

Finally, of the last three articles that were reviewed for potential strategies to promote physical activity in female adolescents, two were study protocols for ongoing or upcoming trials (Edwardson et al., 2015; Robbins et al., 2013). In the third article, Webber et al. (2008) reported finding slight improvements in the physical activity levels (~3.5 minutes more of brisk walking per day) for female adolescents from the intervention schools (who participated in the three-year TAAG study) compared with the control schools.

Designing and implementing successful strategies for promoting physical activity with female adolescents is a challenging task for researchers. This is demonstrated in the studies reviewed. However, in the following section, two school based RCTs and
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One mixed methods feasibility study are presented as examples of successfully implemented strategies for promoting physical activity participation in the adolescent population.

**Successful strategies for physical activity promotion.** One successful strategy that was employed to help promote physical activity participation in female adolescents was a program termed Lifestyle Education for Activity Program (LEAP), which was integrated into the high school curriculum (Pate et al., 2005). This program used an instructional as well as an environmental component to increase the physical activity levels of ninth grade females from schools taking part in the intervention. The physical education instructional component consisted of a behavioral education designed to help promote positive long-term lifestyle changes. In addition, a physical activity portion allowed for gender-specific choices with an emphasis on self-efficacy and enjoyment. The environmental element helped create a school atmosphere that encouraged physical activity for all female adolescents. For example, faculty and staff were role models for physical activity, and there was an increased school-wide communication effort to promote physical activity. In addition, the school nurse purposefully encouraged female students to be active (Pate et al., 2005).

Results from the LEAP program showed a statistically significant increase in MVPA with the intervention group over the one year implementation period (Pate et al., 2005). In addition, there was an increase in the prevalence of physical activity for females who were not enrolled in physical education classes, indicating that the environmental component had a positive effect on physical activity participation (Pate et al., 2005). Felton et al. (2005) examined one of the 12 intervention schools as a case
study and found increases in both MVPA ($p < .01$) and vigorous physical activity ($p = .04$) for the same group of female participants from the eighth to the ninth grades. Overall, the RCT demonstrated that a well-structured and scientifically sound school-based intervention can increase the number of female adolescents who participate in vigorous physical activity and contribute to increasing physical activity levels in the country’s youth (Pate et al., 2005). Saunders et al. (2012) used a seven-step process to assess the sustainability of the LEAP program, three years post-intervention. They found positive long-term effects for vigorous physical activity for the girls, now in the twelfth grade, who were from the intervention schools that had fully implemented the original intervention (Saunders et al., 2012).

Melnyk et al. (2013) implemented another successful strategy that included both male and female adolescents. These investigators conducted a cluster RCT with 779 ethnically diverse American adolescents who were 14 to 16 years of age and from 11 different high schools in the southwest (Melnyk et al., 2013). The COPE (Creating Opportunities for Personal Empowerment) Healthy Lifestyles TEEN (Thinking, Emotions, Exercise, and Nutrition) intervention group was compared with an attention control group of adolescents (Healthy Teens) on several outcome variables. The COPE Healthy Lifestyles TEEN program met once per week for 15 weeks with a six-month follow-up. The program included cognitive behavioral skills training along with 20 minutes of physical activity as part of the students’ health classes (Melnyk et al., 2013). The Healthy Teens control group had weekly classes that included discussions of relevant health topics. The COPE teens’ physical activity level, as measured in steps per day, significantly increased ($p = .03$) over the attention control group at the six-month follow-
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up. Similar results were sustained over an additional six months (Melnyk et al., 2015). In addition, there was a significant reduction in the percentage of overweight and obese COPE teens from baseline to 12 months ($p = .02$) versus the Healthy Teens control group, resulting in significantly lower BMIs ($p = .001$) for the intervention group (Melnyk et al., 2015).

Christian et al. (2016) developed a voucher system to help promote physical activity participation of 115 adolescent girls and boys (average age 13 years) of lower socioeconomic status (SES) from Wales (UK). The vouchers were given in increments of £5 for six months with a £25 per student maximum. The vouchers could be used to pay for coaches and/or physical activity classes at school or out in the community or for buying new sports equipment for either personal or school use (Christian et al., 2016). With the vouchers and the cooperation of various retailers and facilities, the low SES adolescents were able to have access to physical activity opportunities that they otherwise would not have had (Christian et al., 2016). The investigators found significant decreases in self-reported sedentary behavior, improvements in views towards physical activity, and increases in social interactions with peers (Christian et al., 2016).

In summary, developing effective strategies for promoting physical activity in all adolescents, but specifically female adolescents, is problematic and has many complex issues to address. Important to most female adolescents is the need to have a fun component to their physical activities. Having suitable environments and adequate social support from parents, teachers, and peers are also important factors for promoting physical activity in female adolescents. Finally, the presence of appropriate role models and effective delivery methods for interventions are important for success.
Physical Activity and Depression in Female Adolescents

A literature search was conducted to find studies exploring the relationship between physical activity and depression in female adolescents. Searched databases included PubMed, CINAHL, the Cochrane Library, and PsycINFO. A timeframe of approximately 10 years was used, starting January 1, 2006 and ending June 30, 2017. Search terms included physical activity, exercise, sports, motor activity, depression, and depressive disorders. Inclusion criteria were those studies that reported on a relationship between physical activity and depression in the female adolescent population, aged 13 to 18 years. Additional inclusion criteria were that the study report be written in the English language and be either a primary peer-reviewed article or a dissertation. Searches of the four databases yielded 3,683 reports. After transferring the selected reports into EndNote reference management software, removing duplicates, and reviewing titles and abstracts, 17 articles met all inclusion criteria except for the age range of 13 to 18 years. Only eight studies met the initial age inclusion criteria; therefore, the age group was expanded to include 10 to 25-year-olds females, thus allowing for all 17 studies to be used. In addition, four literature reviews were examined, however, no additional studies were found in these published reviews.

Casey, Harvey, et al. (2014) conducted a cluster RCT with 614 female adolescents currently enrolled in seventh through ninth grades of school. The intervention, termed the Triple G program, had both a school-based and an extracurricular component (Casey, Harvey, et al., 2014). The extracurricular portion involved the utilization of community sports and recreation centers as additional venues for creating more opportunities for female adolescents to participate in physical activity
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(Casey, Harvey, et al., 2014). Health related quality of life was determined by the PedsQL 4.0 Generic Core Scales for Teens and included three measures of health: general health, physical health, and psychosocial health (Casey, Harvey, et al., 2014). All health-related quality of life scores for the intervention group were significantly higher than those in the control group for the one year program (Casey, Harvey, et al., 2014).

In another RCT, 40 Korean female adolescents who were 16 years of age were randomly assigned (20 in each group) to either a dance movement therapy group (DMT) or a control group (Jeong, Hong, Lee, & Park, 2005). Psychological and neurobiological measures were analyzed. The dance movement therapy group’s scores for psychological distress decreased significantly after the 12-week intervention. Also, concentrations for plasma serotonin increased, while the dopamine concentrations decreased with the DMT (Jeong et al., 2005). Similarly, 49 females (18 to 20 years of age) participated in a 16-week, two-way crossover trial (Nabkasorn et al., 2006). The intervention included 50 minutes of mild intensity jogging, five times per week for eight weeks, while the control portion did their normal daily activity regimen (Nabkasorn et al., 2006). Depression scores, as measured by the CES-D, decreased after each group completed the eight-week intervention period (Nabkasorn et al., 2006). Improvements were seen post intervention for increased lung capacity, peak VO2, and workload (Nabkasorn et al., 2006). In addition, decreases were found in heart rate, cortisol, and epinephrine levels (Nabkasorn et al., 2006).

A six-year longitudinal study of 496 female adolescents (average age 13 years) was conducted to explore a potential bi-directional relationship between physical activity and depressive symptoms (Jerstad et al., 2010). Results indicated that physical activity
was significantly associated with the reduction of risk for increases in future depressive symptoms as well as for future onset of major-minor depression (Jerstad et al., 2010). Additionally, decreases in future physical activity participation were significantly associated with current depressive symptoms and major-minor depression (Jerstad et al., 2010).

Hemat-Far, Shahsavari, and Mousavi (2012) conducted a quasi-experimental study with 20 Iranian women, 18 to 25 years of age, who were diagnosed with MDD. The females were divided into two groups (10 in the experimental group and 10 in the control group) and were asked to participate in the eight-week study (Hemat-Far et al., 2012). The experimental group took part in 40 to 60 minutes of moderate intensity exercise, three times per week, while the control group continued their normal activities (Hemat-Far et al., 2012). Depressive symptoms were measured pre- and post-test using the Beck Depressive Inventory (BDI). The experimental group had a significant decrease in depressive symptoms \( p < .02 \) as measured by the BDI (Hemat-Far et al., 2012). Moreover, Stella et al. (2005) studied 40 obese female adolescents (average age 16 years) who were divided into the following four groups: aerobic, anaerobic, leisure activity, and control. Body mass and depressive symptoms were measured at baseline and again after the 12 weeks (Stella et al., 2005). All groups except for the control group had significant decreases in body mass; however, only the aerobic exercise group had significant decreases in depression scores as measured by the BDI (Stella et al., 2005).

In contrast, Johnson et al. (2008) analyzed a random sample of baseline data taken from the TAAG study, to investigate the relationship between physical activity and depression in 1,397 sixth-grade female adolescents (average age 12 years). No
significant relationship was found between physical activity levels and depressive symptoms (Johnson et al., 2008). Similarly, Dowda et al., (2007) used a cross-sectional design to study 1,381 working and non-working females in high school (seniors). No significant association was found between physical activity levels and depressive symptoms (CES-D) for the subset of 325 participants who wore accelerometers to measure actual physical activity levels (Dowda et al., 2007). Curiously, Boyer (2007) found that symptoms of depression (measured by the CES-D) actually increased for those female adolescents who participated in five or more days/week of physical activity.

In this study, ninth and tenth grade female adolescents (total of 363) completed several surveys, and structural equation modeling was used to analyze the results (Boyer, 2007).

In a two-year longitudinal study of 181 female adolescents (average age 11.2 years), latent growth modeling was used to explore the relationship between the natural progression of leisure time physical activity, self-efficacy, and depressive symptoms (Neissaar & Raudsepp, 2011). From the results, it was determined that as physical activity decreased, depressive symptoms increased and self-efficacy decreased (Neissaar & Raudsepp, 2011). Self-efficacy and physical activity diminished when female adolescents perceived an increase in depressive symptoms (Neissaar & Raudsepp, 2011). Similarly, Raudsepp and Neissaar (2012) studied 277 female adolescents (average age 12.4 years) over a three-year period to assess changes in physical activity and depressive symptoms. CES-D scores and physical activity were inversely associated, demonstrating a relationship between increased physical activity...
and decreased depressive symptoms over the timeframe of the study (Raudsepp & Neissaar, 2012).

Davidson, Werder, Trost, Baker, and Birch (2007) used structural equation modeling to evaluate various pathways between maturity at age 11 years, based on the Pubertal Development Scale (PDS), and MVPA at age 13. Of the 168 female adolescent participants, those who exhibited greater maturity levels at 11 years of age had an associated reduction in psychological well-being at 13 years of age, which in turn resulted in a general dissatisfaction for physical activity and ultimately led to decreased MVPA for the 13-year-olds (Davidson et al., 2007). Looking at leisure time physical activity during adolescence, Hoegh Poulsen, Biering, and Andersen (2016) conducted a prospective cohort study with 887 Danish female adolescents whose data were collected at 14 or 15 years of age and then again at 20 or 21 years of age. The study results revealed that an association existed between low levels of leisure time physical activity in adolescence and future mental health problems as young adults for females (Hoegh Poulsen et al., 2016). That is, female adolescents who initially reported decreased levels of leisure time physical activity (at 14 or 15 years of age) had a 60% higher chance of having diminished mental health (at 20 or 21 years of age), compared with the female adolescents who initially reported increased levels of leisure time physical activity (Hoegh Poulsen et al., 2016).

Finally, Raudsepp (2016), also employing latent growth modeling analyses, examined sedentary behavior and depressive symptoms over time for 341 female adolescents residing in Tartu, Estonia. Participants’ data were collected three times over a four-year period, starting when they were approximately 11 years of age and ending
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when they were approximately 15 years of age (Raudsepp, 2016). Statistically significant associations ($p < .05$) were found between baseline depressive symptoms (measured using the CES-D) and sedentary behavior over the four years of data collection. Female adolescents who had higher baseline depression scores demonstrated larger increases in sedentary behavior as compared with female adolescents who had lower baseline depression scores (Raudsepp, 2016).

Cross-sectional studies have shown mixed results. For example, Dishman et al. (2006) found a significant association between physical activity and decreased depressive symptoms in their study of 1,250 female adolescents (twelfth graders), through positive influences on physical self-concept. Shepherd, Krägeloh, Ryan, and Schofield (2012) found a small but significant association between physical activity and decreased depressive symptoms for 148 female adolescents 16 to 18 years of age. Similarly, in a sample of 76 Saudi Arabian female students, Al-Eisa et al. (2014) found a negative correlation between depressive symptoms and physical activity as measured by steps per day after three weeks of walking.

Four literature reviews were found, and each was screened for additional primary articles that were not included in the original search. A general synopsis of each review is presented to provide an overall depiction of the relationships between physical activity and depression among male and female adolescents. There were no additional primary articles found meeting the inclusion criteria for the literature reviews examined.

Bursnall (2014) conducted a systematic review of the literature to examine the relationship between physical activity and depressive symptoms in adolescents. There were ten articles that met the inclusion criteria of articles published in English about
physical activity for depressed adolescents. The results indicated a strong inverse correlation between physical activity and depressive symptoms, with recommendations being that additional research is needed to determine causality. Though cause and effect could not be determined from the review, nurses and other healthcare providers need to communicate with adolescents and their families about the importance of meeting the physical activity guidelines of at least 60 minutes of MVPA per day, as set forth by WHO and the USDHHS (Bursnall, 2014).

Brown, Pearson, Braithwaite, Brown, and Biddle (2013) conducted a systematic review and meta-analysis to look at physical activity interventions and depression in children and adolescents. Nine studies met the inclusion criteria of having (a) physical activity interventions; (b) participants who were 5 to 19 years of age; (c) a quantitative measure for depression; (d) a comparison group with no activity; and (e) published in English in peer-reviewed journals. The study found a small significant overall effect for physical activity on depression. Recommendations indicated the need for additional experimental studies with a focus on outcomes to validate their findings and provide information on viable physical activity programs that reduce depressive symptoms in the adolescent population (Brown et al., 2013).

Johnson and Taliaferro (2011) conducted a review of the research literature to investigate relationships between physical activity and depressive symptoms among middle and older adolescents. Nineteen studies met their inclusion criteria of studies published between 1997 and 2010 with participants having an average age between 14 and 19 years or enrolled in grades 9 to 12 (Johnson & Taliaferro, 2011). Also included were longitudinal studies that followed the participants from junior high into high school
or early adulthood (Johnson & Taliaferro, 2011). Physical activity (which included participation in sports) and symptoms of depression were found to have an inverse relationship. Recommendations included incorporating physical activity into nursing care plans for adolescents experiencing depressive symptoms (Johnson & Taliaferro, 2011).

Larun et al. (2006) conducted a Cochrane review of the literature on exercise as a treatment and prevention of anxiety and depression in children and young people. Sixteen studies were included with participants’ ages ranging between 11 and 19 years. Results showed a small, favorable effect of exercise for decreasing depressive symptoms in adolescents. However, due to the inadequate number of studies, the heterogeneity of the population, and design limitations, definitive conclusions were difficult to make (Larun et al., 2006). Recommendations included the need for rigorously designed RCTs with adequate follow-up data to provide meaningful clinical significance (Larun et al., 2006).

The review of literature on the effects of exercise on depression in adolescents indicated that additional experimental studies with rigorous design methodology are needed. Specific to depression reduction, physical activity versus no intervention was potentially useful, but the research evidence was inadequate. Studies using interventional designs were relatively low in quality, and several of the reviews reported cross-sectional results that could not eliminate reverse causality or could potentially misrepresent relationships (Biddle & Asare, 2011).

**Female Adolescents’ Social Support for Physical Activity**

Social support for physical activity is an important concept for the PEPME conceptual framework used in this study. According to Pender et al. (2015), social
support is defined as “a network of interpersonal relationships that provide psychological and material resources intended to benefit an individual’s ability to cope” (p. 200). Social support for physical activity within the female adolescent population centers on individuals who are readily available to facilitate and encourage the adolescent’s participation in physical activities. The various types of social support can be informational, emotional, co-participation, modeling, or instrumental (Laird, Fawkner, Kelly, McNamee, & Niven, 2016). For example, adolescents may need transportation to and from physical activity venues (instrumental) and/or need verbal encouragement (emotional) or advice (informational) regarding their physical activity involvement (Dowda et al., 2007; Laird et al., 2016). Examples of social supporters for adolescents are peers, parents, teachers, and any other persons who may provide verbal or physical support for them (Bandura, 2004; Pender et al., 2011). Social support is instrumental in determining the individual’s predisposition to participate in health promoting behaviors like physical activity (Dowda et al., 2007; Pender et al., 2015).

Searching the literature from January 2006 to June 2017 with PubMed, CINAHL, Cochrane Library, and PsycINFO databases, 25 primary articles plus one recent systematic review that included a meta-analysis were found. The search terms used were social support, physical activity, adolescents, and females. Inclusion criteria were those studies that reported on a relationship between physical activity and social support in the female adolescent population, aged 13 to 18 years. Additional inclusion criteria were that the study report be written in the English language and be either a primary peer-reviewed article or a dissertation.
According to Knowles et al. (2011), the social support for physical activity available to female adolescents affects their beliefs and significantly impacts their willingness to participate in physical activity. Peer support was found to be strongly associated with physical activity participation in female adolescents in several studies (Beets, Pitetti, & Forlaw, 2007; Grant, Young, & Wu, 2015; Kuo et al., 2009; Lytle & Murray, 2009; Raudsepp & Viira, 2008; Young et al., 2014). However, in one case, Dunton, Schneider, and Cooper (2007a) found that lower levels of initial friend support led to increased levels of physical activity in a nine-month longitudinal study. For this study, a school-based physical activity and health program met five days per week and took the place of the regular PE class time. The objective of the program was to help sedentary female adolescents improve their activity and fitness levels (Dunton et al., 2007a). These findings suggest that a group physical activity program occurring during school hours may benefit female adolescents lacking peer support (Dunton et al., 2007a).

Social support for physical activity from family members and teachers as well as friends was positively associated with physical activity in several studies (Ardestani, Niknami, Hidarnia, & Hajizadeh, 2015; Dowda et al., 2007; Eime et al., 2015; Foran, Cermak, & Spruijt-Metz, 2013; Graham, Baier, Friend, Barr-Anderson, & Nuemark-Sztainer, 2014; Lytle et al., 2009; Mohamadian & Arani, 2014; Taymoori et al., 2010; Thompson, Berry, & Hu, 2013; Verloigne, Cardon, Craemer, D’Haese, & Bourdeaudhuij, 2016). Ardestani et al. (2015) found that peer support was significantly associated with increased physical activity in Iranian female adolescents. Burns, Murphy and MacDonncha (2014) had the same finding for Irish female adolescents. Dishman, Dunn,
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Sallis, Vandenbarg, and Pratt (2010) used latent growth modeling to examine a random sample ($n = 971$) of cross-sectional data taken from a large RCT of sixth and eighth grade female adolescents. The objective was to study the relationships between accelerometer measured physical activity and social-cognitive variables, (e.g., social support for physical activity). Interestingly, perceived social support was directly related to physical activity for sixth graders, but there was no direct relationship between the two concepts for eighth graders in the sample (Dishman et al., 2010).

Similarly, Dishman, Saunders, Motl, Dowda, and Pate (2009) used latent growth modeling on data collected from 195 African American and Caucasian female adolescents in the eighth, ninth, and twelfth grades. Study results suggested that having perceptions of strong social support for physical activity lessened the decline in physical activity only for female adolescents who initially had high self-efficacy for physical activity (Dishman et al., 2009). Yet even if initial self-efficacy was high, there was a larger decline in physical activity if female adolescents thought their social support had diminished (Dishman et al., 2009). In a study of 1,422 sixth graders (54% females), Peterson, Lawman, Fairchild, Wilson, and Van Horn (2013) used structural equation modeling to examine the relationship of parental social support on adolescent physical activity. For the female adolescents in the study, instrumental support from parents was directly related to physical activity; however, emotional support was inversely related (Peterson et al., 2013). A possible explanation for the negative impact of parental emotional support on female adolescents’ physical activity participation was that encouragement from parents could have been viewed as obligatory or officious, thus causing an opposite reaction (Peterson et al., 2013). Additionally, Young et al. (2014)
found an association between physical activity and peer support for female adolescents in the sixth and eighth grades; however, a similar association was not found with family support.

Motl, Dishman, Saunders, Dowda, and Pate (2007) also used structural equation modeling to explore the correlational relationships between perceived equipment availability, perceived self-efficacy, perceived social support, and self-reported physical activity participation for female adolescents in the twelfth grade. A statistically significant ($p < .01$) relationship between perceived social support and self-reported physical activity was found for the 1,655 female adolescents studied (Motl et al., 2007). Using specific data from the Aarhus School Survey of health behaviors for 2,100 Danish adolescents, Henriksen, Ingholt, Rasmussen, and Holstein (2016) investigated four aspects of parental support for physical activity. These included the following types of parental physical activity support: praise or encouragement, joint participation, personal observation, and discussion. All four types of parental support from both mothers and fathers of the 1,069 female adolescents who completed surveys were significantly associated with physical activity (Henriksen et al., 2016).

Dewar, Plotnikoff, et al. (2013) conducted a 12-month follow-up study on low-income female adolescents ($n = 235$) to examine the relationship between social-cognitive variables and physical activity. Structural equation modeling results produced no association between physical activity and parental social support at 12 months (Dewar, Plotnikoff, et al., 2013). Likewise, Dunton, Schneider, and Cooper (2007b), in a nine-month study, found that social support did not mediate the effects of a school-based intervention on physical activity and fitness levels of female adolescents.
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Additionally, Eime et al. (2015) found that family and peer social support for physical activity significantly decreased over the two-year period from grade 7 to grade 9 for the female adolescents surveyed. Previously, Eime, Harvey, Craike, Symons, and Payne (2013) found family support and access to sports clubs to be strong mediators for physical activity participation through sports facilities. In other words, the greater the SES of the families and their surrounding neighborhoods, coupled with access to sports facilities, the more likely female adolescents would participate in sports club activities, which was further enhanced by family support (Eime et al., 2013). This study was conducted with 732 female adolescent students (grades 7 and 11) from various geographic regions of Australia whose age ranged from 11 to 20 years (Eime et al., 2013).

Finally, in a systematic review and meta-analysis of the literature, Laird et al. (2016) explored the role of social support on physical activity for female adolescents. Significant associations, although small, were found between all providers of social support and physical activity. Instrumental, encouragement, and modelling support were found to also have small but significant associations with physical activity. Laird et al. (2016) concluded from their meta-analysis results that social support was not a strong predictor for female adolescents’ physical activity. However, social support providers could potentially enhance physical activity participation (Laird et al., 2016).

Social support for physical activity in female adolescents is an important concept to consider for this Fitbit Zip RCT pilot study. Few studies have shown limited or no associations between social support and physical activity in female adolescents. However, many studies have shown that family, teacher, and peer social support have
significant associations with physical activity participation in this population. Therefore, encouraging female adolescents to participate in physical activities is critical. Educating parents and teachers on ways to be more supportive of physical activity participation for the female adolescents with whom they are associated is also essential. Finally, offering opportunities for female adolescents to enjoy physical activities with their peers was found as a preferred option for many of the participants interviewed.

**Female Adolescents’ Self-Efficacy for Physical Activity**

Self-efficacy for physical activity is another important theoretical concept in the PEPME conceptual framework and is related to individuals’ thoughts about how well they can accomplish a proposed action (Pender et al., 2015). Self-efficacy is a construct from Albert Bandura’s social cognitive theory and is anchored in the beliefs of individuals – i.e., if individuals think a specific action can be easily performed or accomplished, then their self-efficacy will be high (Bandura, 2004). If individuals believe they have the proficiency and skills (whether they do or not) to do an activity or task, they will be more likely to participate in the activity or accomplish the task (Pender et al., 2015). If there is a feeling of inadequacy or ineptness about the proposed action, self-efficacy will be low (Bandura, 2004).

Searching the literature from January 2006 to June 2017 with PubMed, CINAHL, Cochrane Library, and PsycINFO databases, and using the search terms of self-efficacy, perceived self-efficacy, physical activity, adolescents, and females resulted in some overlap with the social support literature review. Inclusion criteria were those studies that reported on a relationship between physical activity and self-efficacy in the female adolescent population, aged 13 to 18 years. Additional inclusion criteria were
that the study report be written in the English language and be either a primary peer-reviewed article or a dissertation. Using this search strategy, 24 studies were found that were specific to female adolescents and self-efficacy or perceived self-efficacy for physical activity. Presented are results of the studies on perceived self-efficacy and self-efficacy for physical activity participation.

Dewar, Plotnikoff, et al. (2013) conducted a 12-month follow-up study of low-income female adolescents (n = 235) to examine the relationships between social-cognitive variables and physical activity. Structural equation modeling explained a small proportion of the variance (28%) in physical activity (Dewar, Plotnikoff, et al., 2013). However, self-efficacy was found as the only social-cognitive variable associated with physical activity at the 12-month follow-up (Dewar, Plotnikoff, et al., 2013). Direct relationships between self-efficacy and physical activity were seen in several studies (Barr-Anderson et al., 2007; Dishman et al., 2010; Huberty, Dinkel, & Beets, 2014; Lubans et al., 2012; Mirghafourvand, Mohammad-Alizadeh-Charandabi, Tavanezhad, & Karkhaneh, 2014; Mohamadian & Arani, 2014; Neissaar & Raudsepp, 2011; Taverno Ross, Dowda, Beets, & Pate, 2013; Taymoori et al., 2010). Additionally, positive changes were seen pretest to posttest in self-efficacy scores for a convenience sample of 41 African American female adolescents participating in a 12-week church-based physical activity program (Thompson et al., 2013).

In a quasi-experimental study, Teerarungsikul et al. (2009) found perceived self-efficacy to be significantly higher in the intervention group (p < .001) as compared with the control group after eight weeks of the physical activity intervention. Furthermore, using data from a large sample of female adolescents (n = 2,791) involved in the TAAG
study, Barr-Anderson et al. (2007) found significant associations between self-efficacy for physical activity and structured school-based and non-school-based physical activity programs. Female adolescents with greater self-efficacy and physical activity enjoyment were more willing to take part in organized physical activity programs either during school or after school (Barr-Anderson et al., 2007). In contrast, Dunton et al. (2007b) determined that self-efficacy and all other social-cognitive variables did not mediate the effects of school-based interventions on physical activity or fitness levels.

Several additional studies reported on the mediation effects of various types of self-efficacy on physical activity associated with female adolescents’ physical activity behaviors (Beets et al., 2007; Casey, Harvey, et al., 2014; Dishman et al., 2009; Dowda et al., 2009; Motl et al., 2007; Robbins, Pender, Ronis, Kazanis, & Pis, 2004; Verloigne et al., 2016). For example, Dishman et al. (2009) performed mediation and moderation analysis on survey data collected from participants ($n = 195$) who were in the control arm of the LEAP study for a timeframe of three years. Statistical analysis using latent growth modeling found that the relationship between changes in physical activity and perceived social support was moderated by self-efficacy to overcome barriers to physical activity (Dishman et al., 2009). In other words, female adolescents who felt socially supported and had higher self-efficacy for physical activity had less of a decline in their physical activity levels (Dishman et al., 2009). However, female adolescents who did not feel socially supported had a greater decline in physical activity, despite initially having higher self-efficacy (Dishman et al., 2009). Similarly, Beets et al. (2007) and Dowda et al. (2009) found that self-efficacy for overcoming barriers to physical activity mediated the relationship between physical activity and peer support for female
adolescents who participated in their studies. Additionally, Lytle et al. (2009) found that if female adolescents (from the TAAG study data in 2006) experienced an increase in self-efficacy and social support for physical activity, their activity levels also increased, whereas Young et al. (2014) found that an increase in self-efficacy was associated with higher levels of physical activity for female adolescents in the eleventh grade.

Ardestani et al. (2015) conducted a cross-sectional study with 400 Iranian female adolescents to determine which social cognitive concepts predicted physical activity behaviors for this population. Both self-efficacy for overcoming barriers to physical activity and self-efficacy for physical activity were found to be strong predictors of physical activity participation (Ardestani et al., 2015). Similarly, Graham et al. (2014) determined that self-efficacy for overcoming barriers to physical activity was one of the strongest correlates ($p < .001$) for physical activity. However, in the longitudinal analysis (at 6-month follow-up), self-efficacy for overcoming barriers to physical activity was no longer significant (Graham et al., 2014). Participants in the study were 365 female adolescent volunteers participating in the New Moves study, which was a school-based group-randomized research study involving 12 high schools in the Minneapolis/St. Paul, Minnesota area (Graham et al., 2014).

Casey, Telford, et al. (2014) conducted a cluster RCT with lower SES Australian female adolescents (grades seven to nine) in 12 different communities. There were eight schools in the intervention group and eight schools in the control group. The intervention schools were provided with designated physical education classes each week and a corresponding sporting activity outside of school at a recreation facility. Using linear mixed model analysis, no significant differences were found between the two groups for
physical activity or for potential mediators such as self-efficacy (Casey, Telford, et al., 2014). However, Eime et al. (2015) reported that self-efficacy for physical activity remained stable for the female adolescents over the course of their three-year longitudinal study.

In summary, self-efficacy for physical activity is an important predictor of physical activity participation in female adolescents. Several of the studies reviewed found significant associations among self-efficacy for physical activity or self-efficacy for overcoming barriers to physical activity and physical activity participation. Finding ways to positively influence self-efficacy for physical activity in female adolescents may help thwart the decline in physical activity that typically occurs throughout adolescence and into adulthood.

**Female Adolescents’ Commitment to a Plan of Action for Physical Activity**

Commitment to a plan of action is another important concept in the PEPME conceptual framework for this study. Commitment to a plan of action is based on an intention to carry out a health behavior, which is physical activity participation in this study (Pender et al., 2011). According to Pender et al. (2011), commitment to a plan of action is the “commitment to carry out a specific action at a given time and place and with a specified person or alone, irrespective of competing preferences (implementation intention) and identification of definitive strategies for eliciting, carrying out, and reinforcing the behavior” (p. 49). The plan to participate in physical activity includes identifying specific strategies to succeed in completing the action (e.g., taking workout clothes to school to wear at the gym).
Commitment to a plan of action is a concept that was developed specifically for Pender’s HPM (revised), but has not been used extensively in the literature. Maglione and Hayman (2009) found that “commitment to a plan of physical activity” fully mediated relationships between social support and physical activity behavior in a group of low-income college students. In the same study, commitment to a plan of physical activity also fully mediated the relationships between self-efficacy and physical activity behavior (Maglione & Hayman, 2009). According to Pender et al. (2015), if there is not a strategy for accomplishing the desired action and there is only “intention” without a level of commitment, the action may not occur. Therefore, the concept of commitment to a plan of action warrants further exploration with female adolescents because of its impact on physical activity participation.

**Electronic Activity Monitors**

Electronic Activity Monitors (EAMs), sometimes called consumer wearable physical activity monitors, are extremely popular with U.S. consumers and have been of scientific research interest as possible valid and reliable tools for attaining objective measures of physical activity (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015a; Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015b; Lewis et al., 2015). According to the International Data Corporation (IDC), the various fitness tracker manufactures sold 78.1 million devices in 2015, resulting in a growth of 171.6% over the previous year (2016). Many of these devices use accelerometer technology and have the capability to store several days of data that can be downloaded to a computer or synced with a smart phone (Barton, 2015; Lee, Kim, & Welk, 2014). In addition, they are
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typically customer friendly by being small, non-invasive, and affordable (Lee et al., 2014).

There are many types of EAMs (also termed consumer-based physical activity trackers) that have various levels of capabilities. The technology for these devices is constantly evolving. Ferguson, Rowlands, Olds, and Maher (2015) examined seven different EAMs and compared each of them to research grade activity monitors. The seven devices studied by Ferguson et al. (2015, p.2) were Fitbit One (Fitbit, Inc.), Fitbit Zip (Fitbit, Inc.), Jawbone UP (Jawbone, San Francisco), Misfit Shine (Misfit, San Francisco, CA), Nike Fuelband (Nike, Inc., Oregon, WA), Striiv Smart Pedometer (Striiv, Inc. Redwood City, CA), and Withings Pulse (Withings, Issy les Moulineaux, France). The comparison instruments used were two research grade tri-axial accelerometers/multi-sensor devices: BodyMedia SenseWear Model MF (BodyMedia Inc., Pittsburg, PA) and ActiGraph GT3X+ (Actigraph, Pensicola, FL). Both research grade devices have been established as reliable and valid measurement tools for physical activity (step counts) and sleep duration under free-living conditions (Ferguson, 2015). All seven of the devices studied were highly correlated \((r = .94-.99)\) for step counts with the two research grade instruments. The Fitbit Zip and Fitbit One were found to be two of the better performing EAMs (Ferguson, 2015).

In a systematic review of the literature of EAMs as interventional modalities, EAMs were found to help motivate adults to increase their physical activity and others to achieve weight loss (Lewis et al., 2015). An EAM is defined as “a wearable device that objectively measures lifestyle physical activity and can provide feedback, beyond the display of basic activity count information, via the monitor display or through a partnering
application to elicit continual self-monitoring of activity behavior” (Lewis et al., 2015, p.2). Effect sizes from the review provided initial evidence of potentially significant clinical implications (for increased weight loss and physical activity); however, effectiveness relative to other interventions has not yet been established (Lewis et al., 2015). Lee, Kim, and Welk (2014) reported that these innovative consumer-friendly activity monitors may prove to be scientifically advantageous in the realm of health promotional lifestyle choices such as increased physical activity.

Fitbit activity trackers are valid and reliable devices for measuring steps (Diaz et al., 2015; Evenson, Goto, & Furberg, 2015; Kooiman et al., 2015; Tully, McBride, Heron, & Hunter, 2014; Wen, Zhang, Liu, & Lei, 2017). The number of studies related to testing the reliability and validity of the various types of Fitbit activity monitors is growing rapidly. There are a handful of studies that have been conducted using Fitbit activity monitors for physical activity promotion with adult populations and a very few with adolescents, but none specifically with female adolescents. One study by Gaudet, Gallant, and Bélanger (2017) and one systematic review by Ridgers, McNarry, and Mackintosh (2016) were examined because both used younger people (19 years old or younger) as their study population.

Gaudet et al. (2017) used a seven-week quasi-experimental crossover design to study whether wearing a Fitbit Charge HR would increase physical activity for 46 adolescents (13 to 14 years of age) randomly selected for the study. Having access to the Fitbit Charge HR was significantly \( (p = .01) \) associated with increased MVPA (increases averaged greater than 15 minutes/day) for those participants who were in the maintenance or action stage of behavior change (Gaudet et al., 2017). However,
according to Gaudet et al. (2017), there were no changes in MVPA for those participants who were in the other three stages of behavior change (pre-contemplation, contemplation, or preparation).

Ridgers et al. (2016) conducted a systematic review of the literature for studies related to the feasibility and effectiveness of using wearable activity trackers to help increase the amount of physical activity participation in younger people (5 to 19 years of age). They only found five relevant studies (through August 2016). However, they concluded that there was potential for using EAMs to help increase physical activity participation in this population and that more research is warranted (Ridgers et al., 2016). Because of the paucity of research in this area, conducting studies using EAMs, like the Fitbit Zip, for physical activity promotion for all adolescents is a new, exciting, and growing domain for nursing investigation.

**Depression, Physical Activity and Electronic Activity Monitors**

The key literature search for this study was conducted to review relationships among depression, physical activity, and EAMs in female adolescents. These relationships were the major focus of this study and were systematically reviewed in the literature. The databases searched included PubMed, CINAHL, PsycINFO, and the Cochrane Library. Search terms were selected based on relevant major headings appropriate to the specific databases and were as follows: physical activity, exercise, sports, physical inactivity, depression, depressive disorders, pedometers, electronic activity monitors, consumer wearable activity trackers, and Fitbit. Inclusion criteria for the review were any studies that evaluated the use of electronic activity monitors (i.e., pedometers) for measuring physical activity (steps) with some measure of depressive
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symptoms in the female adolescent population. Additional inclusion criteria were that the study report be written in the English language and be either a primary peer-reviewed article or a dissertation. Exclusion criteria were studies that dealt with any type of physical or mental illnesses other than depression, non-peer-reviewed articles, editorials, and letters to editors. The four databases utilized for the literature review were searched from January 2000 through June 2017.

The primary population of interest was female adolescents. The initial search of the four databases, which included the major concepts of physical activity, depression, and EAMs, yielded no studies meeting the inclusion criteria. Therefore, the review was extended to other populations. Table 2.1 shows the results from the four databases searched with the expanded inclusion criteria. There were 216 reports after expanding the search to all age groups and genders. After transferring the 216 reports into EndNote reference management software, removing duplicates and reviewing titles and abstracts, 22 reports were found that met the expanded inclusion requirements.

The results from this review of the relationships between physical activity (in terms of steps/walking), depression (depressive symptoms) and electronic activity monitors (predominately pedometers) were varied. Many of the studies found were conducted with older adults due to concerns about the natural decline in physical activity that occurs with aging. For example, in the New Zealand Healthy Steps RCT with adults 65 years of age or older, Kolt et al. (2012) found that the pedometer-based Green Prescription group increased their walking time by 49.6 minutes/week as compared with 28.1 minutes/week ($p < .03$) for the standard Green Prescription group at the 12-month follow-up. Both groups showed improvements in the following areas (as measured by
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the Short Form Health Survey): physical functioning, mental health, vitality, and general health (Kolt et al., 2009; Kolt et al., 2012).

Table 2.1

Database Searches for Physical Activity, Depression, and Electronic Activity Monitors

<table>
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<tr>
<th>Search Term Group</th>
<th>Search Terms</th>
<th>PubMed</th>
<th>CINHAL</th>
<th>PsycINFO</th>
<th>COCHRANE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Physical Activity or Exercise or Physical Inactivity or Sports</td>
<td>290,461</td>
<td>170,085</td>
<td>98,004</td>
<td>753</td>
</tr>
<tr>
<td>B</td>
<td>Depression or Depressive disorder</td>
<td>165,109</td>
<td>107,302</td>
<td>203,031</td>
<td>2,612</td>
</tr>
<tr>
<td>C</td>
<td>Pedometers or Electronic Activity Monitors or Consumer Wearable Technology or Fitbit</td>
<td>2515</td>
<td>1,715</td>
<td>750</td>
<td>171</td>
</tr>
<tr>
<td>A and B</td>
<td>Physical Activity and Depression concepts</td>
<td>11,060</td>
<td>6,292</td>
<td>8,070</td>
<td>349</td>
</tr>
<tr>
<td>A and C</td>
<td>Physical Activity and EAMs concepts</td>
<td>1,880</td>
<td>1,384</td>
<td>689</td>
<td>62</td>
</tr>
<tr>
<td>B and C</td>
<td>Depression and EAMs concepts</td>
<td>75</td>
<td>67</td>
<td>51</td>
<td>109</td>
</tr>
<tr>
<td>A and B and C</td>
<td>Physical Activity Depression and EAMs concepts</td>
<td>65</td>
<td>56</td>
<td>45</td>
<td>50</td>
</tr>
</tbody>
</table>

Note. Search terms included additional filters of English and humans.

Using a subset of data from the Healthy Steps study (first 225 participants to complete the study), Patel, Keogh, Kolt, and Schofield (2013) found that both Green Prescription groups demonstrated statistically significant improvements in depressive symptomology ($p < .005$), general mental health functioning ($p < .001$), and total walking physical activity ($p < .001$) post-intervention and at the 12-month follow-up. However, Snyder, Colvin, and Gammack (2011), using the same Geriatric Depression Scale as
Patel et al. (2013) and with the same age group of adults (65 years of age or older),
found no statistically significant changes in depression levels with the use of pedometers
to increase physical activity levels. Initially Snyder et al. (2011) saw a significant
increase in steps per day during the first four weeks of pedometer use \((p < .035)\), but
two weeks after the pedometers were removed and then returned with the screens
covered, the improvements in steps per day were not sustained (Snyder et al., 2011).

Sugden et al. (2008) initially conducted a feasibility pilot study with 45 sedentary
older women 70 years of age or older to determine if a theory-based behavior change
intervention (BCI) with and without pedometers would increase physical activity
(accelerometry counts) and potentially improve depressive symptoms. McMurdo et al.
(2010), based on the positive results from the feasibility study by Sugden et al. (2008),
conducted a RCT with 204 sedentary older women, and after three months, the BCI
group had significantly greater accelerometer counts than the control \((p = .002)\) and the
BCI + pedometers \((p = .04)\) groups. However, no significant changes in depressive
symptoms or physical activity levels (accelerometry) between the three groups (no
intervention, BCI, and BCI + pedometers) remained after six months. In a small sample
of sedentary older women (11 participants 70 years of age or older), Overdorf, Kollia,
Makarec, and Szeles (2016) found lower BDI scores after six weeks of a line dancing
intervention as compared with baseline scores. Pedometers were used to assess step
counts in the fourth week of the intervention to compare steps taken on the three line
dancing days per week verses steps taken on the four non-line dancing days. Paired
sample t-tests indicated significantly more steps \((p < .041)\) were taken on the line
dancing days than on the non-line dancing days (Overdorf et al., 2016).
Similarly, Rosenberg et al. (2012) found no statistically significant differences between groups of older adults (mean age 84 years) studied on any of the following outcome measures: steps, mental health, physical function, cognitive function, and environmental variables. In addition, Montgomery (2010) did not find statistically significant correlations between increased physical activity and improvements in mood and depressive symptoms when studying a group of 32 postpartum African American women. The study participants were given Yamax Digiwalker SW-200 pedometers to measure their daily physical activity (steps per day) over a 12-week period (Montgomery, 2010). Finally, Hernandez, Prohaska, Wang, and Sarkisan (2013) found no significant differences in physical activity (steps per day) between depressed and non-depressed participants enrolled in an exercise intervention at the end of the first, twelfth and twenty-fourth months. The participants were 572 Latinos from 27 senior centers in the Los Angeles area who were aged 60 years or older; depression symptoms were measured using the Geriatric Depression scale (Hernandez, 2013).

In contrast, Fukukawa et al. (2004) found that baseline steps of older Japanese participants (65 to 79 years of age) were negatively associated with depressive symptoms as measured by the CES-D scale. Interestingly, this association was not found with the middle-aged (40 to 64 years of age) Japanese participants (Fukukawa et al., 2004). However, Vallance, Eurich, Lavallee, and Johnson (2013) reported significantly lower depressive symptoms (measured by the CES-D) for the male study participants (aged 55 years or older) who were in the higher steps per day group as compared with the men in the lower steps per day group. In addition, there were
significant associations \((p < .05)\) between higher average steps per day and all indices of the health-related quality of life (HRQoL) scale (Vallance et al., 2013).

Al-Eisa, Buragadda, and Melam (2014) found that increased physical activity (steps per day) was associated with decreased depressive symptoms \((p \leq .05)\) as measured by the BDI. The participating Saudi Arabian female college students were provided with pedometers and were asked to walk a minimum of 6,000 steps per day for a period of three weeks (Al-Eisa et al., 2014). Similarly, Abedi, Nikkah, and Najar (2015) conducted a RCT with 106 postmenopausal Iranian women to determine if pedometer usage and step goals (increase steps by 500 per day) would improve symptoms of depression, anxiety, and insomnia. Both the step counts and depression scores were significantly improved for the intervention group \((p < .001)\) as compared with the control group (no pedometers or step goals) after 12 weeks (Abedi et al., 2015). Likewise, McKercher et al. (2009) found that for the women evaluated, a greater number of leisure time steps per day was significantly associated with a lower prevalence of depression. The corresponding research data were extracted from the Childhood Determinants of Adult Health study, which was a 20-year follow-up to the original study of 1,995 adults (26 to 36 years of age) who completed physical activity (International Physical Activity Questionnaire) and depression instruments (Composite International Diagnostic Interview) as children or adolescents (McKercher et al., 2009; McKercher et al., 2013; McKercher et al., 2014).

In another study using college aged students, specifically freshman, Melnyk, Kelly, Jacobson, Arcoeleo, and Shaibi (2014) assessed the effects of a new course called Freshman 5 to Thrive: COPE (Creating Opportunities for Personal Empowerment)/
Healthy Lifestyles. A pre/posttest quasi-experimental design was used to determine if the 33 freshmen enrolled in the new course would have better outcomes than the comparison group of 16 on several outcomes. However, the outcomes variables measured of interest to this review were depressive levels and physical activity, which were limited to only the COPE group and not the comparison group. Melnyk et al. (2014) found significant decreases ($p < .05$) in depressive symptoms for the COPE students with elevated baseline depression scores (measured using the Beck Youth Inventory). In addition, Melnyk et al. (2014) found significant increases ($p < .003$) in physical activity over the course of the semester for COPE participants (measured by the SW-200 Digi Walker Pedometer in steps per day).

Parfitt and Eston (2005) found that children who averaged more than 12,000 steps per day had better mental health outcomes, such as lower depression and anxiety and higher self-esteem, than children who averaged less than 9,200 steps per day. Correlational analysis suggested that physical activity (steps per day) was negatively correlated with depressive symptoms ($p < .01$) for the 70 children (mean age 10.4 years old) studied (Parfitt & Eston, 2005). Furthermore, in a prospective cohort study of 676 children (originally 8 years of age), Olive, Telford, Byrne, Abhayaratna, and Telford (2016) used cross-sectional analyses to determine trends in depressive symptomology and physical activity patterns of participants over the course of eight years. The participants were selected from the larger Australian study called Lifestyle of our Kids (LOOK), which started in 2005. The results indicated that children with more depressive symptoms (measured using the Children’s Depression Inventory) were more likely to be
less physically active than children with lesser depressive symptomology (Olive et al., 2016).

In a group of 30 overweight Thai adults, aged 35 to 59 years, Yuenyongchaiwat (2016) found that increased physical activity levels improved both mental and physical health of the participants. In this quasi-experimental study, participants were asked to complete the Profile of Mood States (POMS) scale and document their daily steps in a journal (Yuenyongchaiwat, 2016). The physical activity goal for the 12-week intervention was to accumulate at least 10,000 steps per day as measured by Yamax SW-200 pedometers (Yuenyongchaiwat, 2016). The pre/post intervention changes in the POMS resulted in a significant change in mood ($p < .001$) when achieving at least 10,000 steps per day (Yuenyongchaiwat, 2016).

Kerr et al. (2008) studied adults who had been recently diagnosed with mild-to-moderate depression or who had recurrent mild-to-moderate depression. These participants were prescribed escitalopram (Lexapro) and were also given the following interventions: printed workbooks (“Mood Mastery Guide”), pedometers, weekly emails, and personalized counseling by a registered nurse practitioner (Kerr et al., 2008). After 12 weeks, depression scores were significantly lowered ($p < .001$), as measured by the Patient Health Questionnaire Depression Scale, and physical activity levels had significantly increased ($p < .03$), as measured by steps per day (Kerr et al., 2008).

In contrast, Chao (2011) found no statistically significant effects on physical activity promotion or any other physical or mental health outcomes for the 60 adults with severe and persistent mental illnesses who were participating in the RCT. In a non-randomized pretest posttest design, Vanroy, Seghers, Bogaerts, Wijtzes, and Boen
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(2017) also found no statistically significant effects on physical activity or mental health (anxiety and depression) outcomes for the 135 adult participants. The participants were members of the Flemish Federation for Sports and Recreation in Mental Health Care, which catered to individuals who had been diagnosed with some type of a mental disorder (Vanroy et al., 2017). Self-reported physical activity participation increased in the short term (10 weeks) for both groups. Both studies utilized various walking interventions with pedometers as an objective measurement tool for physical activity.

In summary, the use of electronic activity monitors, such as pedometers, to promote physical activity in the general population, while also improving symptoms of depression, has shown some positive results. Most of the studies were conducted with older adults. There were limited studies with younger people, and there were no studies specifically targeting female adolescents. One study with female college students revealed increases in physical activity levels and decreases in depressive symptoms after a three-week walking intervention.

Summary

In this chapter, a review of the literature on concepts essential to the PEPME conceptual framework and on relationships among the framework’s concepts was presented. The significance of depression in the form of depressive symptoms and physical inactivity in the female adolescent population was discussed. In addition, recommended guidelines for physical activity instituted by several government and private organizations were presented, to include the AAP, ACSM, IOM, USDHHS, and WHO. A focused review of the qualitative literature related to female adolescents’ beliefs
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about physical activity and strategies for promoting physical activity in this population also was presented.

In addition, focused reviews of the literature for the concepts of depression and physical activity were presented whereby significant declines in physical activity were found as females moved from childhood into adolescence. These females were also more likely to experience depressive symptoms as compared with males. Therefore, finding novel ways to promote physical activity participation in this population is of great importance. The potential mental and physical health benefits of physical activity for female adolescents provide the impetus for continuing to conduct research on this topic.

Finally, reviewing the literature for relationships among depression, physical activity, and EAMs in female adolescents yielded no applicable studies. Therefore, the search was expanded to include populations of different ages and both sexes. Studies utilizing pedometers such as EAMs to increase levels of physical activity (steps per day) and decrease depressive symptoms have yielded mixed results. Consequently, future research is needed to better understand how EAMs (like Fitbit Zips) can promote increased physical activity participation and decreased depressive symptoms in the female adolescent population. In the next chapter, the methods for conducting the research study on this topic will be described.
Chapter 3: Methods

Described in this chapter are the research methods and study setting for this randomized controlled pilot study. A two group, pre-test/post-test research design was conducted using female adolescents as participants. Information is presented on study participant recruitment, inclusion and exclusion criteria, selection process, and sample size calculation. Additionally, the survey instruments used to operationalize the concepts of the PEPME conceptual framework are discussed. Finally, human subject protections; data collection, management, and analysis; and methodological rigor are discussed.

The primary purpose of the study was to determine whether the use of electronic activity monitors (EAMs), specifically Fitbit Zips, and daily step count goals would increase physical activity participation (measured in steps) in female adolescents. The secondary purpose was to determine if participation in a 12-week intervention using Fitbit Zips together with step goals would reduce depressive symptoms in female adolescents. The third purpose was to determine the feasibility of recruiting and retaining female adolescents (80% or more) who adhere to the research protocol.

Research Design

This study used a randomized controlled trial (RCT), two group pre-test/post-test design, to investigate the potential effects of Fitbit Zip usage on physical activity and depressive symptoms in a convenience sample of 44 female adolescents (Shadish, Cook, & Campbell, 2002). The female adolescents participating in the study attended one of two large church youth groups in the southeastern United States. Study participants’ personal factors (age, race, grade in school, and BMI), self-efficacy, social
support, commitment to a plan of action, physical activity, and depressive symptoms were assessed.

**Setting**

**Site 1**

The first site chosen for this study was a Roman Catholic parish located outside a large metropolitan area in the southeastern United States. The church served over 3,700 families in 2015 with a membership of approximately 10,000 people. In 2015, the geographic area upon which the church derived its membership had a racial distribution of 61% Caucasian, 28% Hispanic, 8% African American, 2% Asian, and 1% other, with a median income level of $51,026 (U.S. Census Bureau, 2016a). Over 80 different ministries were offered for member involvement, and over 20 church services (masses) were held weekly. Additionally, three weekly worship services were conducted in Spanish for the church’s large Hispanic membership.

The church typically had an active youth ministry program, which included approximately 1,600 young people from elementary school to high school. The focus of the teen youth group was on the Eucharist, with attention to the spiritual and psychosocial needs of teens. The youth groups met on Sunday evenings after their regular evening church services. However, the meeting times were sporadic over the course of the study as changes were being made to the youth program leadership. Unfortunately, the inconsistent scheduling of the youth group meetings adversely affected recruitment of potential study participants. The female adolescent attendance per meeting only averaged 20 to 30 girls from 13 to 18 years of age throughout the duration of the study. This setting was originally chosen based on the diverse female
adolescent population and the willingness of the church leadership to participate in the study. However, prior to the commencement of the study, the leadership of the youth group changed, creating some additional challenges for recruitment.

Site 2

The second site chosen for this study was a large congregation of the Wesleyan church located outside a large metropolitan area in the southeastern United States. In 2015, the church’s membership included over 15,000 people on eight different campuses. Also in 2015, the racial distribution for the geographic location of the church was approximately 39% Caucasian, 21% Hispanic, 28% African American, and 12% Asian with a median income level of $60,289 (U.S. Census Bureau, 2016b). Sunday church services were held at eight different locations, providing over 25 worship services per week. During the time of the study, the church had numerous outreach ministries where they provided support through volunteers. In addition, financial resources were allocated for other local non-profit ministries as well as many disadvantaged groups worldwide.

The church had an active youth ministry program, which included approximately 3,000 young people from elementary school to high school. While conducting the study, the high school (H12) youth group met on Tuesday evenings. The H12 meetings were attended year-round. The teen youth group sessions provided opportunities for spiritual and practical lessons, while encouraging creativity and dialog through adult-led small groups. In addition, the teen youth provided volunteer services as missionaries as well as directly to the church through beautification projects on many of the campuses. Many of the study participants from the H12 group volunteered on Wednesday evenings as
leaders for the middle school youth program. The female adolescent attendance averaged at least 100 girls from 13 to 18 years of age each week on the main campus, except for the months of June and July when participation decreased for the summer break. This setting was chosen based on the diverse female adolescent population and the willingness of the church leadership to participate in the study.

Sample

Inclusion and Exclusion Criteria

Inclusion criteria included female adolescents who were (a) 13 to 18 years of age, (b) English speaking, (c) able to walk without physical limitations, (d) able to have access to a cell phone with text messaging capabilities, and (e) physically available for the duration of the study. Excluded from the study were female adolescents who had any medical condition that prevented them from walking or who were currently pregnant. Eligibility requirements were documented on the informed consents and were acknowledged by the participants who were 18 years old and by the parent or guardian for participants who were 13 to 17 years of age.

Sampling Procedure and Requirements

After obtaining University Institutional Review Board (IRB) approval, study participants were recruited from the two church youth groups based on the inclusion and exclusion criteria. Signed parental or guardian permission and participant consent or assent were obtained as appropriate. The Principal Investigator (PI) presented the purpose and expectations of the research project to the participants and their parents. Baseline data collected from eligible participants included the following information: age, race, height and weight (for BMI), and current grade level in school. Additionally,
individual phone numbers were collected for text messaging and communication purposes.

The female adolescents who met inclusion criteria from both churches were randomized to either the Fitbit-E group or the Fitbit-C group. Randomization was performed using PROC PLAN in SAS® version 9.4 (Cary, NC) to generate the numbered sequence used to assign each participant to either the experimental or control group. Specifically, block randomization was used to provide balance and reduce bias for the assignment of the participants to each group; this is considered appropriate for studies with smaller sample sizes (Efrid, 2011). A randomized list for 90 subjects was created, based on a priori power calculations explained below, and blocks of size two were used to ensure equal allocation to treatment and control at any time during study enrollment. However, only the first 44 numbers were used for the study (Appendix A).

**Participant Sampling Technique**

Convenience sampling was implemented to obtain the 44 female adolescent participants. Convenience sampling is a non-probability sampling method that is used to select individuals who possess the desired characteristics that are needed to appropriately answer the research questions (Etikan, Musa, & Alkassim, 2016). Participants who are recruited using convenience sampling are available at the appointed time and place and are willing to participate in the study (Etikan et al., 2016).

For recruitment purposes, each church was given informational flyers about the study prior to the PI attending the first youth group meeting. The flyers were provided to the youth group leadership for distribution. In addition, information about the study was emailed to potential participants as an upcoming event for the church. The flyer and
email included the following information: (a) purpose of the study; (b) location, time, and date for the first meeting with the PI; and (c) contact information for the PI.

Sample Size Determination

The sample size per group was determined using SAS® version 9.4 STAT/PROC GLMPOWER® under a repeated measures ANOVA design with two groups and two measurement times. An alpha level of .05, power of .80 and .90, and compound symmetric correlation between measurement times with a correlation of .6 were assumed. Powers of .80 and .90 are typically used for sample size calculations because beyond a power of .90 the large increases needed in sample size are associated with very small increases in power (Bernstein, 2008). The sample size was determined a priori based on the statistical analysis required to answer the research questions and was estimated based on information gleaned from similar studies by Lubans, Morgan, Callister, and Collins (2009) and Lubans et al. (2010).

The means and standard deviations in each group at each measurement time (shown in Table 3.1) were used to determine the sample size (Lubans et al., 2009; Lubans et al., 2010). A sample size of 36 per group (72 subjects) was needed to show the difference in change in average median steps per day between the intervention and control groups with 80% power. Due to a potential loss-to-follow-up rate of 20%, the target enrollment number was 45 subjects in each group (90 subjects total). Interventions need to have retention rates of 70% or greater to be considered effective; therefore, a retention rate of 80% was chosen as the target for this study (Amico, 2009).

However, at the end of the recruitment period, only 44 participants were enrolled in the study. The recruitment period was limited because it needed to be closely tied to
the academic calendar of the participants. It was reasoned that during summer break, many participants would be unavailable for data collection due to personal obligations or travel out of state. Therefore, the last participants needed to be enrolled no later than 12 weeks prior to the end of the academic school year. Historically, both church youth groups were less attended during the summer break from school, typically due to family vacations, work obligations, or mission trips (according to the church youth directors). After consultation with the PI's PhD advisory committee concerning the limited recruitment timeframe and the smaller sample size (44 versus 90), the dissertation project was approved to move forward as a pilot study.

Table 3.1
Sample Size Estimation

<table>
<thead>
<tr>
<th>Group</th>
<th>Standard Deviation</th>
<th>Baseline</th>
<th>12 weeks</th>
<th>Number per Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>2500</td>
<td>10,000</td>
<td>11,500</td>
<td>36</td>
</tr>
<tr>
<td>Control</td>
<td>2000</td>
<td>10,000</td>
<td>10,000</td>
<td>48</td>
</tr>
</tbody>
</table>

Note. Sample size per group was calculated using SAS® 9.4 STAT/PROC GLMPOWER® under a repeated measures ANOVA design with two groups and two measurement times.

Participant Recruitment and Enrollment

The PI gave the hosting churches pertinent information about the study to procure approval to conduct the research project with their youth groups' female adolescents. After obtaining the appropriate IRB and site approvals, the PI actively recruited eligible participants for the study. Both churches had previously established contacts who were willing to help the PI with logistics and recruitment for the study. Recruitment sessions for each church were held to solicit study participants. The PI attended one youth group meeting before the study's initiation to present the research
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proposal. Time was provided near the end of the youth group church services to explain the research study to the female adolescents. Male adolescents were excused from the presentation.

The PI obtained a list of names and phone numbers of female adolescents who were interested in participating in the study and contacted them by phone to discuss potential study participation. The recruitment period lasted for approximately three weeks. After that time, enrollment was terminated to insure completion of the study within two weeks after the end of the school year. The PI compiled a list of names of the females who had agreed to follow-up with the PI at subsequent youth group meetings where parental permission and participant consent or assent could be obtained.

Additionally, take home informational packets were provided for any interested participants whose parents could not meet with the PI individually or who needed more time to consider whether they wanted to participate in the study. Participants whose parents were unable to meet face to face with the PI due to scheduling conflicts returned the take home packets with the appropriate signed permission forms, consents, and/or assents.

Youth group meetings for both churches consisted of the youth minister’s hour-long sermon, which served as his weekly message to the youth. After the sermon, the youth were divided into small groups. Site 1 adolescents were segregated by gender for small group sessions. Site 2 adolescents were assembled by grade and gender. Groups were led by an adult volunteer. For both sites, the parents provided their permission, female adolescents who were 18 years of age or older provided their consent, and adolescents 13 to 17 years old provided their assent before any study related materials.
were offered to the participants. Female adolescents were given verbal information about the purpose of the study. Additionally, the PI answered questions from the parents and the female adolescent participants either in person or by telephone.

After attending the initial youth group meeting (pre-intervention) and subsequently obtaining the appropriate permission, consent, and assent, the PI collected baseline information from the 44 eligible study participants. In addition, participants completed the following baseline survey instruments: PEPME Demographics Questionnaire (Appendix B), Center for Epidemiologic Studies-Depression scale (Appendix C), the Physical Activity Questionnaire for Adolescents (Appendix D), Self-Efficacy scale (Appendix E), Physical Activity Exercise Social Support scale (Appendix F), and Commitment for Physical Activity scale for Adolescents (Appendix G).

Instrumentation

The Fitbit Zip and several survey instruments were used in this study. A detailed description of the Fitbit Zip is provided in the following section. In addition, explanations of the psychometric properties for the various scales utilized in the study are presented. Table 3.2 provides summaries of the various instruments' alpha coefficients (measurement of the scale's reliability) taken from previous studies that evaluated the use of these instruments with female adolescents.
Table 3.2
*Alpha Coefficient Ranges for Instruments from Previously Published Studies Conducted with Adolescents*

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Studies Reviewed</th>
<th>Total Items</th>
<th>Subscales</th>
<th>Scoring Ranges</th>
<th>Alpha Coefficients Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS for PA&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>8</td>
<td>None</td>
<td>0 - 3</td>
<td>.83</td>
</tr>
<tr>
<td>SE for PA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4</td>
<td>8</td>
<td>None</td>
<td>1 - 5</td>
<td>.81 -.83</td>
</tr>
<tr>
<td>CPASA&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1</td>
<td>11</td>
<td>None</td>
<td>0 - 3</td>
<td>.81</td>
</tr>
<tr>
<td>CES-D&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>20</td>
<td>Somatic, Positive Affect, Depressed Affect, Interpersonal</td>
<td>0 - 21</td>
<td>.648</td>
</tr>
<tr>
<td>PAQ-A&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3</td>
<td>8</td>
<td>None</td>
<td>1 - 5</td>
<td>.75 - .88</td>
</tr>
</tbody>
</table>

*Note. SE = Self-Efficacy; SS = Social Support; PA = Physical Activity; CPASA = Commitment for Physical Activity Scale for Adolescents; CES-D = Center of Epidemiologic Studies – Depression scale; PAQ-A = Physical Activity Questionnaire for Adolescents.

<sup>a</sup>Ling, Robbins, Resnicow, & Bakhoya, 2014.  
<sup>b</sup>Dishman et al., 2002; Dishman et al., 2010; Motl et al., 2000; Saunders et al., 1997.  
<sup>c</sup>Robbins et al., 2017.  
<sup>d</sup>Allison, Roeger, Martin, and Keeves, 2001; Cuijpers, Boluijt, & Van Straten, 2008; Garrison, Addy, Jackson, McKeown, & Waller, 1991; Johnson et al., 2008; Verloigne, et al., 2016.  

**Fitbit Zip Activity Tracker**

The Fitbit Zip device is a wireless, compact EAM that tracks number of steps, distance travelled, and calories expended (Fitbit Inc., 2016). According to the Fitbit Zip Product Manual, the device is most accurate when it is worn close to the body and is clipped onto the user's pants, belt, waistband, shirt pocket, or bra (Fitbit Inc., 2016). For this study, steps per day were the information collected from the Fitbit Zip stored data, by accessing the Fitbit website. Fitbit Zips employ 3-axis accelerometers to more
accurately measure body movements (steps) as compared with other devices, such as pedometers, that only use single axis accelerometers (Fitbit, 2016). The Fitbit Zip is not waterproof, but it is sweat and splash proof as well as rainproof. The device is small and non-intrusive and has the following size and weight dimensions: height, 1.5”; width, 1.1”; depth, 0.38”; weight, 0.282 ounces. (Fitbit, Inc., 2016, p.7).

The Fitbit Zip has a memory capacity that enables it to store daily totals for several months and minute-by-minute data for seven days. Data can be downloaded in 30-day increments or less from the Fitbit website in one of the two following formats: an Excel spreadsheet or a comma-separated values (CSV) file. For this study, the Excel spreadsheet format was used.

The Fitbit Zip runs on a 3V coin battery (CR 2025) that lasts approximately four to six months and can synchronize with computers and smart phones with the proper operating system parameters (Fitbit, Inc., 2016). The device objectively measured step counts for both groups of participants. Email addresses and passwords were assigned to each user for personalized Fitbit Zip data tracking purposes. The PI was the only person with the password for each user’s account for the Fitbit website where the information was available for downloading. To download data, each participant’s Fitbit Zip had to be physically located within 15-20 feet of the PI’s computer. Therefore, the PI had to meet with each participant face to face. Each participant’s Fitbit Zip was synced with the PI’s computer so the PI could log onto all participants’ accounts to access the data.

An, Jones, Kang, Welk, and Lee (2017) tested 10 different commercially available activity trackers for accuracy over three conditions: treadmill walking or
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jogging, indoor-track walking, and 24-hour free-living activity. The participants were 35 healthy adults (ages 19 to 65) who simultaneously wore all the trackers for the treadmill and indoor track testing (An et al., 2017). However, for the 24-hour free-living condition, three devices were randomly assigned and taken home for the participants to wear along with a reference pedometer for comparison (An et al., 2017). The Fitbit Zip and the Withings Pulse were found to be the most accurate devices for step counts over the three different conditions (An et al., 2017).

Schneider and Chau (2016) tested the validity of the Fitbit Zip for measuring steps and MVPA in three cohorts of adolescents, totaling 87 young people (average age 12 years). All three groups of Fitbit Zip users revealed strong correlations with the Actigraph (gold standard) in both steps per day ($r = .72-.96$) and MVPA ($r = .67-.94$) (Schneider & Chau, 2016). Schneider and Chau (2016) concluded that the Fitbit Zip was a reliable and valid tool for assessing physical activity in free-living adolescents if it was worn (adherence) for at least four days per week and for at least eight hours per day (Schneider & Chau, 2016). Furthermore, Schneider and Chau (2016) noted that the Fitbit Zip was a much more affordable alternative for measuring physical activity at a price of $60 versus the Actigraph, which was priced at $225.

Self-Efficacy Scale for Physical Activity

The concept of self-efficacy was operationalized using the Self-Efficacy scale (Appendix E), originally developed for use with fifth, eighth, and ninth grade females (Dishman et al., 2002; Motl et al., 2000; Saunders et al., 1997). The scale showed good test–retest reliability (.84) for the 605 female adolescents surveyed from the Trial of Activity for Adolescent Girls (TAAG) pilot study (Dishman et al., 2005). Furthermore,
factorial validity was supported through confirmatory factor analysis, which provided a good fit with data obtained from a random sample of 1,893 females who completed the scale in the sixth and the eighth grades during the original TAAG study (Dishman et al., 2010). The scale had good reliability with Cronbach’s alpha values of .81 and .83 for sixth and eighth graders, respectively (Dishman et al., 2010). The scale includes eight items that are scored on a 5-point scale, ranging from 1 (disagree a lot) to 5 (agree a lot), addressing adolescents’ perception of their self-efficacy for physical activity (Dishman et al., 2010). The following is a sample question from the survey: “I can be physically active during my free time on most days no matter how busy my day is” (Dishman et al., 2010).

**Social Support for Physical Activity Scale (Adolescent Version)**

The concept of social support for physical activity was operationalized using the Social Support for Physical Activity scale (Appendix F) recently developed by Ling et al. (2014). The revised Health Promotion Model proposed by Nola Pender (1996) was the theoretical foundation for its development. The scale includes eight items that address adolescents’ perception of their social support for physical activity participation. Scores range from 0 (never) to 3 (often), for questions such as: “Someone buys clothes or equipment for me so I can be physically active or do sports” (Ling et al., 2014). A higher score on the social support for physical activity scale meant that the adolescent’s perception of having social support for participating in physical activities was greater.

Participants using the Social Support for Physical Activity scale in a study by Ling et al. (2014) were 509 racially diverse American fifth, sixth, and seventh graders. The scale had good reliability with Cronbach’s alpha of .83 and test-retest reliability of .78.
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(Ling et al., 2014). The 509 participants’ mean scores for social support were positively correlated with accelerometer data that were also collected from the participants (Ling et al., 2014). This accelerometer data provided an objective measure of physical activity, suggesting satisfactory criterion-related validity for the scale (Ling et al., 2014).

Commitment for Physical Activity Scale for Adolescents (CPASA)

The CPASA (Appendix G) was used to operationalize the concept of commitment for a plan of action. The PEPME and Pender’s HPM (revised) has “commitment to a plan of action” as an important positive determinant for physical activity participation (Pender et al., 2015). The CPASA is a compilation of three different commitment scales: Planning for Exercise by Pender et al. (2011), Commitment to Physical Activity by Debate, Huberty, and Pettee (2009) and the Trial of Activity for Adolescent Girls (TAAG) Self-management scale (Robbins et al., 2017). The CPASA has 11 items, and the scoring ranges from 0 (never) to 3 (often), for questions such as “I make time for physical activity” (Robbins et al., 2017). The CPASA scale was principally based on Nola Pender’s proposition that the concept of ‘commitment to a plan of action’ has major influences on physical activity as a health promoting behavior (Robbins et al., 2017).

Robbins et al. (2017) conducted two test-retest studies and one prospective study to validate the psychometric properties of the CPASA with three groups of underserved, urban female youth from the fifth to eighth grades residing in the midwestern United States. The average age of the girls was 12.64 years, and the age range was 11-15 years. The first test-retest study occurred in the summer of 2013, with 51 girls completing the testing using the original 26-item combined scale (Robbins et al.,
2017). The second test-retest study also occurred in the summer of 2013, when 91 girls completed the testing using the 11-item CPASA (Robbins et al., 2017). Finally, for the prospective study (initiated in the fall of 2013) the 11-item CPASA was completed by 503 female adolescents who also wore accelerometers for seven consecutive days (Robbins et al., 2017).

Through confirmatory and exploratory factor analysis, the factor structure of the CPASA scale was cross-validated by Robbins et al. (2017) using two independent samples taken from the previously discussed prospective study of 503 female adolescents. Good internal consistency reliability was determined from the prospective study’s results, yielding a Cronbach’s alpha of .81, with item-total coefficients ranging from .35 to .64 (Robbins et al., 2017). The test–retest reliability was calculated using the intraclass correlation coefficient (ICC) and was found to be excellent at .88 (Robbins et al., 2017). The construct validity was supported by correlation analysis with the constructs from Pender’s HPM (revised) and the content validity index was good at .77 (Robbins et al., 2017). In addition, the CPASA correlated significantly with physical activity levels as measured by accelerometry (ActiGraph GT3X-plus). Through analysis of the psychometric properties of the CPASA (using the three different sample populations of female adolescents), Robbins et al. (2017) determined that the CPASA had acceptable psychometric properties for the female adolescent population.

Center of Epidemiologic Studies - Depression Scale (CES-D)

The CES-D (Appendix C) was used to evaluate changes in depressive symptomology. The CES-D has been evaluated in psychiatric settings, where it was found to have very high internal consistency (.90), and moderate test-retest correlations.
ranging from .45 to .70 (Radloff, 1997). The self-report scale requires participants to respond according to their personal experiences from the past week and includes 20 items with scores ranging from zero to 60. For example, for the question, “I was bothered by things that do not usually bother me,” the range of possible responses are from 0 (less than one day) to 3 (5 to 7 days) for this scale (Radloff, 1977). Four of the questions are reverse scored. For example, one reverse-scored question is: “Felt I was just as good as other people” (Radloff, 1977).

In a sample population of 1,392 Dutch adolescents, Cuijpers, Boluijt, and van Straten (2008) established the CES-D as a valid and reliable screening tool for depressive symptoms with good sensitivity and specificity. This conclusion was made based on the assessment of a subsample of 243 adolescents (199 recruited from schools and 44 from the internet). These adolescents were assessed using the depression section of the Mini-International Neuropsychiatric Interview (M.I.N.I.), which is considered a gold standard for evaluating the presence of depressive disorders (Cuijpers et al., 2008). For the school subsample, the sensitivity was 100, and the specificity was 87. Using a receiver operating characteristic (ROC) analysis, the best cut-off score on the CES-D was 22 (Cuijpers et al., 2008). Cronbach’s alpha was calculated as .89, representing good reliability (Cuijpers et al., 2008). Furthermore, looking at the clinical significance of the CES-D in intervention studies, Schultz et al. (2002) found that a change of 6 points was considered a clinically significant change in depressive symptomology.

Allison, Roeger, Martin, and Keeves (2001) conducted a study on the risk relationship between suicidal ideation and depressive symptoms in both male and
female adolescents during their first year of high school. For this study, Allison et al. (2001) found excellent internal reliability for the CES-D, yielding a Cronbach’s alpha coefficient of .92 for a sample of 919 Australian female adolescents (average age 13.5 years). In another study, the CES-D was used as a screening tool for depressive symptoms in a sample of 2,465 adolescents who were 11 to 17 years of age (Garrison, Addy, Jackson, McKeown, & Waller, 1991). Cronbach’s alpha coefficient was .89 for the 1,029 Caucasian females in the analysis and .82 for the African American females, demonstrating good internal consistency (Garrison et al., 1991).

Factorial invariance across gender and time of the CES-D was studied in a community sample of 2,650 adolescents from Australia (Verhoeven, Sawyer, & Spence, 2012). The average age of the participants was 13 years, and there were 1,273 females included in the analysis. Cronbach’s alpha coefficient (internal consistency) calculated for the CES-D with this specific group of female participants was good and ranged from .78 to .80 (Verhoeven et al., 2012). Finally, Johnson et al. (2008) used the CES-D to measure depressive symptoms in a random sample of 1,397 female adolescents (average age 12 years old) participating in the TAAG study. Cronbach’s alpha coefficient for this study was .85, indicating good internal consistency (Johnson et al., 2008). Based on the studies examined, the CES-D had established psychometric properties in the general adolescent and female adolescent populations, (such as the population in this study), thus making it an appropriate scale for this research.

Physical Activity Questionnaire for Adolescents (PAQ-A)

The PAQ-A (Appendix D) includes eight items that are used to assess the level of physical activity performed in the last seven days. The ninth item pertains to illness or
other circumstances that prohibit physical activity and therefore is not counted in the overall calculation (Kowalski, Crocker, & Donen, 2004). The PAQ-A was modified from the Physical Activity Questionnaire for Older Children (PAQ-C) and was found to have convergent validity for physical activity for high school aged students (Kowlaski et al., 1997). In a Danish study, Bervoets et al. (2014) evaluated the Dutch version of the PAQ-A for reliability and validity with 47 adolescents, 12 to 17 years of age. Based on expert committee evaluations, the content validity of the PAQ-A was found to be excellent with a Cronbach’s alpha coefficient of .82, indicating good reliability (Bervoets et al., 2014). In a study designed to measure the psychometric properties of the PAQ-C and the PAQ-A, 210 teens from the midwestern United States took the PAQ-C as 11-year-olds and then the PAQ-A as 13-year-olds (Janz, Lutuchy, Wenthe, & Levy, 2008). Both demonstrated good internal consistency, with Cronbach’s alpha coefficients ranging from .75 to .88 (Janz et al., 2008). The key reasons for using the PAQ-A were the cost (free), time effectiveness, simplicity of administration, and proven reliability and validity with the adolescent population (Kowalski et al., 2004).

PEPME Demographics Questionnaire

Demographics information was collected by self-report from the study participants using the PEPME demographics questionnaire (Appendix B). The information included date of birth, race, and academic grade level. Additional information was collected at baseline and post-test (height and weight), but was not specifically included in the PEPME demographics questionnaire.
Data Collection Procedures

Data collection took place on several different occasions, depending on the availability of the participants. Prior to initiation of the study, eligible participants were contacted and instructed to attend the data collection meeting. Table 3.3 and Table 3.4 illustrate the data collection timeline for the study. The pre-intervention (PIN) phase was when parental permission and adolescent consent or assent were obtained. Additionally, participants were randomized to either the Fitbit-E or the Fitbit-C group. The PIN phase took place over a period of approximately two weeks. Each person was given a covered Fitbit Zip to wear for seven consecutive days to obtain initial average median daily step counts. Finally, the following baseline information was collected and surveys administered: cell phone number, height, weight, PEPME demographics questionnaire, CES-D, self-efficacy scale, social support scale, PAQ-A, and CPASA. Heights and weights were evaluated using a Detecto 439 Eye Level Beam Physician scale 400lb x 4oz W/ Height Rod. BMIs were calculated (in kilograms per meters squared) based on the height and weight results for each participant (CDC, 2015).

Activity journals (Appendix H) were also distributed to all participants. Participants were instructed to use their journal to record daily activities and specify the location (waist, bra, or pocket) where the Fitbit Zips were worn each day. Instructions were provided on the inside of each activity journal. Green, Rafaeli, Bolger, Shrout, and Reis (2006) reported that both electronic and paper journals were viable methods for collecting research related information. However, written activity journals were chosen for this study to minimize access to additional personal information, such as email addresses, which would have been necessary for utilizing electronic activity journals.
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Both church settings were used to collect baseline data and any subsequent data unless participants were unable to attend the regularly scheduled youth church services. If scheduling conflicts occurred, other arrangements were made to obtain follow-up data. For example, the PI would meet participants at alternate locations and at specified times that were convenient for the participants.
Table 3.3

*Timeline of Study Activities (Pre-Intervention through Intervention Week Four)*

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Study Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Intervention</td>
<td></td>
</tr>
<tr>
<td>Recruitment &amp; Study Enrollment PIN-1</td>
<td>• Recruited participants</td>
</tr>
<tr>
<td></td>
<td>• Contacted interested participants</td>
</tr>
<tr>
<td></td>
<td>• Obtained parental permission and adolescent consent or assent</td>
</tr>
<tr>
<td>Emails/Randomization PIN-2</td>
<td>• Created email addresses for study participants for Fitbit website</td>
</tr>
<tr>
<td></td>
<td>• Assigned random number generated identification numbers</td>
</tr>
<tr>
<td>Baseline Data Collection PIN-2</td>
<td>• Administered all survey instruments</td>
</tr>
<tr>
<td></td>
<td>• Measured height and weight</td>
</tr>
<tr>
<td></td>
<td>• Randomized participants to Fitbit-E and Fitbit-C groups</td>
</tr>
<tr>
<td></td>
<td>• Distributed covered Fitbit Zips to determine baseline step counts for duration of one week</td>
</tr>
<tr>
<td></td>
<td>• Distributed activity journals</td>
</tr>
<tr>
<td></td>
<td>• Text messaged (Appendix I) two times per day (2x/day) to remind them to wear their Fitbit Zips</td>
</tr>
<tr>
<td>Intervention</td>
<td></td>
</tr>
<tr>
<td>Week 1</td>
<td>• Downloaded step counts from covered Fitbit Zips</td>
</tr>
<tr>
<td></td>
<td>• Distributed numbered Fitbit Zips to both groups</td>
</tr>
<tr>
<td></td>
<td>• Text messaged (2x/day) participants to remind them to wear their Fitbit Zips</td>
</tr>
<tr>
<td></td>
<td>• Provided Fitbit-E group with written step goals*</td>
</tr>
<tr>
<td>Weeks 2-4</td>
<td>• Both groups continued to wear designated Fitbit Zips</td>
</tr>
<tr>
<td></td>
<td>• Downloaded step counts from Fitbit Zips from both groups who were available</td>
</tr>
<tr>
<td></td>
<td>• Text messaged (2x/day) participants to remind them to wear their Fitbit Zips</td>
</tr>
</tbody>
</table>

*Note.* PIN-1 = Pre-Intervention Week 1; PIN-2 = Pre-Intervention Week 2; CES-D = Center of Epidemiologic Studies - Depression scale  
*aStep goals were determined from baseline average steps per day counts and an incremental progression toward recommended steps per day for adolescents.*
Table 3.4

**Timeline of Study Activities (Intervention Week Five through Final Meeting)**

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Study Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention (cont. from Table 3.3)</strong></td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>▪ Downloaded step counts from Fitbit Zips from both groups who were available&lt;br&gt;▪ Text messaged (2x/day) participants to remind them to wear their Fitbit Zips&lt;br&gt;▪ Drawings for one Fitbit Charge 2 and three $25 gift cards</td>
</tr>
<tr>
<td>Weeks 6-8</td>
<td>▪ Both groups continued to wear designated Fitbit Zips&lt;br&gt;▪ Downloaded step counts from Fitbit Zips from both groups who were available&lt;br&gt;▪ Text messaged (2x/day) participants to remind them to wear their Fitbit Zips</td>
</tr>
<tr>
<td>Week 9</td>
<td>▪ Downloaded step counts from Fitbit Zips from both groups&lt;br&gt;▪ Text messaged (2x/day) participants to remind them to wear their Fitbit Zips</td>
</tr>
<tr>
<td>Weeks 10-12</td>
<td>▪ Both groups continued to wear designated Fitbit Zips&lt;br&gt;▪ Downloaded step counts from Fitbit Zips from both groups who were available&lt;br&gt;▪ Text messaged (2x/day) participants to remind them to wear their Fitbit Zips</td>
</tr>
<tr>
<td><strong>Post-Intervention</strong></td>
<td></td>
</tr>
<tr>
<td>Final Data Collection</td>
<td>▪ Administered CES-D&lt;br&gt;▪ Measured heights and weights for participants&lt;br&gt;▪ Downloaded step counts from Fitbit Zips from both groups</td>
</tr>
<tr>
<td><strong>Final Meeting</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>▪ Provided a party for all available participants in the study&lt;br&gt;▪ Drawings for two Fitbit Charge 2s and three $25 gift cards</td>
</tr>
</tbody>
</table>

*Note.* CES-D = Center of Epidemiologic Studies - Depression scale.<br><sup>a</sup>Final meeting for party occurred after all participants had completed the study.

Intervention week 1 of the study entailed meeting with the participants and downloading their baseline step counts from their covered Fitbit Zips (from the Fitbit
Each participant wore her covered Fitbit Zip for one week (PIN-2), prior to intervention week 1, to obtain baseline average median steps per day. Emails were assigned (PIN-2) to coincide with the participant’s unique numeric identifier. To access the Fitbit website, each Fitbit Zip had to be associated with a specific email address and then synced with the PI’s computer through a toggle device that was attached to the computer. Fortunately, to aid in the set-up procedure, the 44 Fitbit Zips could be associated with one main email account, namely Fitbitzipstepstudy@gmail.com. However, the Fitbit website required one email address for each Fitbit Zip. This was accomplished by adding a plus (+) sign and the participant’s numeric identifier to the email address for each Fitbit Zip (Ortiz, Tueller, Cook, & Furberg, 2016). For example, the first study participant would have an email address associated with the Fitbit website with the following format: Fitbitzipstepstudy+101@gmail.com. This process worked because Google did not recognize the + sign or the number following the + sign in the email address, therefore the 44 Fitbit Zips were linked to one email account, but the Fitbit website saw 44 unique email addresses (Ortiz et al., 2016).

After downloading the baseline step data, the Fitbit Zips were returned to both groups. The Fitbit-E group now had uncovered Fitbit Zips, and the Fitbit-C continued to wear their covered Fitbit Zips for the duration of the study. The PI provided written step goals for each participant in the Fitbit-E group. The step goals were based on increasing average baseline step counts over the course of the 12-week study. According to Adams, Johnson, and Tudor-Locke (2013), 60 minutes of MVPA for adolescents translated to 9,000 pedometer-scaled steps. Also, Berlin, Storti, and Brach (2006) suggested that setting incremental goals for increasing steps per day was more realistic,
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less overwhelming, and more conducive to potential changes in lifestyle than proposing an absolute goal of 10,000 steps per day right from the start. Table 3.5 provides information about the process used for increasing the steps per day for study participants.

Table 3.5
Method for Increasing Steps per Day Based on Baseline Average Median Steps per Day

<table>
<thead>
<tr>
<th>Baseline average steps per day</th>
<th>Incremental increase in steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000</td>
<td>+ 84</td>
</tr>
<tr>
<td>3,000</td>
<td>+ 72</td>
</tr>
<tr>
<td>4,000</td>
<td>+ 60</td>
</tr>
<tr>
<td>5,000</td>
<td>+ 48</td>
</tr>
<tr>
<td>6,000</td>
<td>+ 36</td>
</tr>
<tr>
<td>7,000</td>
<td>+ 24</td>
</tr>
<tr>
<td>8,000</td>
<td>+ 12</td>
</tr>
<tr>
<td>9,000+</td>
<td>maintain</td>
</tr>
</tbody>
</table>

*Note.* Number of steps added per day is calculated by the following formula: (9,000 - baseline average steps per day) divided by 84. Sample calculation for an individual with 4,000 average baseline steps per day: Step 1. 9,000 - 4,000 = 5,000; Step 2. 5,000/84 = 60; Step 3. Day 1: 4,000+60 = 4,060, Day 2: 4,060+60 = 4,120, Day 3: 4,120+60 = 4,180, Day 4: 4,180+60 = 4,240… Day 84 = 9,040.

The intervention period took place over 12 weeks. During this time, both groups wore their Fitbit Zips, either covered or uncovered. The PI met with both the Fitbit-E and Fitbit-C group study participants on several different occasions, depending upon their availability, to download their step count information from their Fitbit Zips (from the Fitbit website and assigned email addresses previously discussed). The PI met with each participant at least once per week. This frequency in data collection was done to ensure that the step counts were downloading correctly and that the Fitbit Zips were functioning properly. The PI had scheduled weekly meetings with each of the two church youth groups. For participants who could not attend the designated weekly meeting time, the PI arranged to meet them individually at a time and place convenient to them.
During the weekly meetings with participants, the PI remained at the church setting for 2-3 hours to collect data. This gave the participants opportunities to meet with the PI either before, during, or after the church youth group services. During this time, the PI was able to socialize and get to know many of the study participants and church staff. In addition to this personal face-to-face contact, the PI sent text messages to both groups twice per day (mornings and evenings). The PI sent these text messages to remind participants to wear and take off their Fitbit Zips daily and to write in their activity journals. The final data collection point was at the end of intervention week 12, whereby height, weight, and post-test CES-D survey data were collected, together with each participant’s final downloaded step counts. After the last participants finished the study, a party was held and various door prizes were awarded. All participants were invited to the party and were eligible for the door prizes.

**Human Subject Protections**

This study involved the participation of female adolescents, some who were less than 18 years old and thus were considered a vulnerable population. The human subjects review included an evaluation of participants’ risks and benefits, the selection process, and the appropriateness of the permission and assent procedures. Study approval from the University's Institutional Review Board (IRB) was obtained before the study's onset. The female adolescents had the right to withdraw at any time during the study. The permission, consent, and assent forms included a waiver of liability for the general risks of physical activity. Female adolescents who were 17 years of age or younger provided assent because they were not of legal age to provide consent (18
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years or older). Therefore, permission for these adolescents to participate in the study was obtained from their parents.

Potential risks to the participants were minimal. However, the potential to find female adolescents with high depressive symptom scores was a possibility. Therefore, the PI would report any concerns related to higher scores on the CES-D to the youth minister, who would subsequently follow-up with the parents of the participant. The eligibility requirements for the study were listed on the informed consent. Each participant was given an individually assigned numeric identifier to ensure that there would be limited identifiable information associated with the research data. The numeric identifiers were associated with all of the surveys and baseline information collected. Additionally, each Fitbit Zip was marked with the participant's personal numeric identifier.

Data Collection and Management

Data were collected from study participants using the following instruments: PAQ-A, PEPME demographics questionnaire, CES-D, Self-Efficacy scale, Social Support scale, and the CPASA. Table 3.6 presents the timeframe for data collection. The PI collected all baseline and subsequent follow-up data. All data were entered into SAS® version 9.4 for statistical analysis. The de-identified data were stored in an electronic file on a password-protected computer and were accessible only by the PI. The computer was kept in a secure location with all data voided of any personal identifiers. The University IRB and Health Insurance Portability and Accountability Act (HIPAA) policies were followed. The data and other regulatory documents will be stored
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for a length of time designated by institutional protocol. Statistical consultation was

provided by Dr. Jennifer Waller, who was a member of the PI’s dissertation committee.

Table 3.6
Data Collection Timeframe

| Instruments or Measures     | Collection Method | Collection Time
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PAQ-A</td>
<td>Self-report</td>
<td>PI-2</td>
</tr>
<tr>
<td>PEPME Demographics</td>
<td>Self-report</td>
<td>PI-2</td>
</tr>
<tr>
<td>Self-Efficacy scale</td>
<td>Self-report</td>
<td>PI-2</td>
</tr>
<tr>
<td>Social Support scale</td>
<td>Self-report</td>
<td>PI-2</td>
</tr>
<tr>
<td>CPASA</td>
<td>Self-report</td>
<td>PI-2</td>
</tr>
<tr>
<td>CES-D</td>
<td>Self-report</td>
<td>PI-2 and Intervention Week 12</td>
</tr>
<tr>
<td>Height and Weight</td>
<td>Detecto 439 Eye Level Beam Physician Scale</td>
<td>PI-2 and Intervention Week 12</td>
</tr>
<tr>
<td>Step counts&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Downloaded data from each Fitbit Zip</td>
<td>At least once/week</td>
</tr>
</tbody>
</table>

Note. PI-2 = Pre-Intervention Week 2; PAQ-A = Physical Activity Questionnaire for Adolescents; PEPME = Promoting Exercise for Physical and Mental Health; CPASA = Commitment for Physical Activity Scale for Adolescents; CES-D = Center of Epidemiologic Studies Depression scale.

<sup>a</sup>Fitbit Zip step counts were downloaded as often as the participants were available to meet with the PI, participants could not meet during spring break or Easter Sunday.

Data Analysis

All data analyses were conducted using SAS® version 9.4. Statistical significance was assessed using an alpha level of .05. Descriptive statistics were determined within the intervention or control group for all variables. Assumptions for all analyses were examined (e.g., normality or residuals, equality of variance), and if violations were found, various transformations were examined. The transformation that best met the assumptions was utilized in further analyses.

To address the research questions, mixed models analyses were performed. The benefit of using a mixed model analysis is that mixed models can utilize all the data
collected (Howell, 2015). This is especially useful in a repeated measures analysis where an individual may have data at most, but not all time points. For example, if a study design has 5 time points for data collection and an individual has data at time points 1, 3, and 5 but is missing data at time points 2 and 4, their data would be used in the estimate of the mean at time points 1, 3, and 5. However, this individual would not contribute data to the estimate of the means at time points 2 and 4. Other types of analyses (e.g. ANOVA) would eliminate this individual entirely from the analysis.

For this type of data utilization method to be valid using mixed models repeated measures analyses, all individuals must have data at their baseline measurement. All participants in this RCT pilot study had baseline data. In addition, Bell, Fiero, Horton, and Hsu (2014) recommended that a reasonable assumption be made about the missing data and for repeated measures, this assumption would be that the data was missing at random (MAR). The mechanism of MAR is “when missingness depends on the observed data and, when given the observed data, it does not depend on the unobserved data,” (Ibrihim & Molenberghs, 2011). This assumption was made for this study.

The two outcome variables of interest were the change in average median steps per day and the change in CES-D scores from baseline (pre-test) to intervention week 12 (post-test). Study group (Fitbit-E versus Fitbit-C) and measurement time were the main independent variables. The two-factor interaction between study group and measurement time was also included in each mixed model. Subject nested within group was considered a random effect. An unstructured correlation structure between measurement times was found to best fit the data and was used for the final models.
The F-test for the two-factor interaction between study group and time was the statistical test of interest. If this two-factor interaction is statistically significant, it will indicate that the change over time is different between the two study groups. Potential covariates such as baseline social support, self-efficacy, and commitment to a plan of action were examined in each model. All explanatory variables were tested for collinearity and for correlation with the outcome variables to determine the appropriate covariates to include in the final model.

To ensure accuracy of the data entry process, two-person double data entry was performed. Atkinson (2012) reported error rates for data entry in clinical studies to be as high as 26.9% from two different research databases examined, significantly affecting the studies’ statistical results. Barchard and Pace (2011) found two-person double data entry to be significantly more accurate than single person data entry or visual checking. For example, 195 undergraduate students were randomly assigned to enter information on 30 data sheets either using single data entry, double data entry, or visual checking by a single person (Barchard & Pace, 2011). The differences between the three methods were considerable. The data entry errors for the participants who used visual checking were 2,958% higher than those who utilized the double data entry method (Barchard & Pace, 2011). In addition, 77.4% of the double data entry participants experienced perfect accuracy as compared with only 17.1% of the visual checking participants (Barchard & Pace, 2011).

For this study, the PI hand calculated each of the paper surveys (except for the PEPME demographics questionnaire, which did not require calculations) and entered the values into an Excel spreadsheet. Another individual, herein referred to as the
research assistant (RA), inputted the de-identified individual responses from the surveys onto an Excel spreadsheet and allowed the total scores to be calculated using Excel. The RA participating and aiding in the double data entry procedures possessed research experience and was affiliated with the university where the PI was studying.

After the two Excel spreadsheets had been completed, comparisons were made between them for any discrepancies. The RA had access to the PI’s de-identified version of the spreadsheet and highlighted any differing values between them. For the discrepancies encountered, the PI examined the original paper surveys and recalculated the responses to verify the correct values. The PI recorded the corrected values in the final Excel spreadsheet for data analysis. For further accuracy, the PI inspected and compared every entry in both spreadsheets for any potentially overlooked discrepancies. None were found.

**Methodological Rigor**

**Internal Validity**

Internal validity is how well one can make inferences about an effect (dependent variable) that occurs after an intervention (independent variable) and whether the effect is caused by the intervention and no other factors (Shadish et al., 2002). There are three key elements that are needed to enhance internal validity. The three key elements are randomization, manipulation of the independent variable, and control of potential confounders.

The first key element to enhance internal validity is affected by the method in which study participants are selected or assigned. In an experimental study, randomization of participants to two groups helps remove any systematic selection
Female Teens Step It Up with Fitbit Zips

differences between groups so that the remaining differences are due to chance and
differences upon completion of the study can be attributed to the experimental
conditions (Polit & Beck, 2014). This study utilized block randomization to provide
balance and reduce bias for the assignment of the participants to each group; this is
considered appropriate for studies with smaller sample sizes (Efrid, 2011). A
randomized list for 90 subjects was created, and blocks of size two were used to ensure
equal allocation to treatment and control at any time during study enrollment. The 44
female adolescent participants were randomly assigned to either the Fitbit-E or Fitbit-C
group based on the SAS® version 9.4 (Cary, NC) generated randomization table.

The second key element to enhance internal validity is having an intervention
that can be manipulated. The threat to internal validity as it applies to the manipulation
of the independent variable is called “ambiguous temporal precedence,” which proposes
the question, “what came first, the dependent or independent variable?” In this
experimental study, a Fitbit Zip (covered or uncovered) activity tracker was used as the
independent variable that was manipulated to study its effects on average median steps
per day and depressive symptoms (dependent variables).

The third key element for enhancing internal validity is controlling for potential
confounders. An experimental study design, (like a two group pre-test post-test study)
through its use of random assignment, effectively enhances internal validity and
minimizes the threats to internal validity of history, maturation, selection bias, testing,
and regression (Shadish et al., 2002; Polit & Beck, 2014). This study had female
adolescents of similar age as participants. All participants were randomized to either an
experimental or control group during similar time periods. Consequently, each group
should mature at the same rate. Also, because all participants were from the same general geographical area and were exposed to the same types of outside influences, the threat to history should be minimal. However, since the participants attended two distinctly different churches, maturation and history could potentially have been influenced, especially because Site 1 was restructuring their youth programs due to changes in leadership. In addition, a very important confounder to this study was related to the timing for the termination of the study (history and maturation). The fact that the study did not conclude for some of the participants until after the end of the academic school year could have affected the results of the study (step counts may have changed significantly based on school being out of session). Finally, all participants answered identical survey instruments at similar time intervals, thereby addressing the testing threat to internal validity.

**External Validity**

External validity is concerned with inferences that can be made about causal relationships across individuals, locations, outcomes and treatments in a research study (Shadish et al., 2002). The important considerations for external validity are how well results from a study can be generalized to other populations, environments, and conditions. For example, this study examined female adolescents from the southeastern part of the United States who attended church youth groups. Therefore, it is difficult for the results from this study to be generalized to other populations.

In RCTs, there is always a trade-off between internal and external validity (Polit & Beck, 2014). The main focus of internal validity is whether the intervention actually caused the predicted outcome, whereas external validity’s emphasis is on whether the
results can be generalized to all conditions and populations (Polit & Beck, 2014). Therefore, these two very important aspects of experimental rigor are frequently at odds with each other, raising questions such as (a) if there is no cause and effect relationship, why should there be concern over generalizing the results and (b) if the results cannot be generalized to other populations and settings, why should internal validity be of importance (Polit & Beck, 2014).

The following five main threats to external validity need to be addressed in order to consider key elements for its enhancement: interaction of the causal relationship with units, interaction of the causal relationship with settings, interaction of the causal relationships over treatment, interactions of the causal relationships over outcomes, and context-dependent mediation (Shadish et al., 2002). The first threat to external validity is the “interaction of the causal relationship with units.” This threat is related to the ability of the results of a study to be valid for other populations (Shadish et al., 2002). This experimental study targeted a convenience sample of female adolescents who attended two different church youth groups in the southeastern United States. Because the study was conducted with female adolescents in a specific geographic location and a specific social environment (church), the results cannot be generalized to all female adolescents. Additional research studying female adolescent populations with different characteristics need to be examined before results can be generalized to a wider population of female adolescents. Examples of these characteristics include female adolescents who do not attend church, do not belong to a youth organization, do not have the resources to attend non-school-based activities, and or are from a non-Christian religious background.
The second threat to external validity is “interaction of the causal relationship with settings” (Shadish et al., 2002). The concern with this threat to external validity is whether the intervention within the parameters of the study design will show a causal relationship in a different setting or environment. This study was conducted at two separate church locations in the southeastern United States. If this study had been conducted in a different setting such as a high school or possibly a youth community center, the results might have been different. To address this threat, more research on this type of intervention is needed in different types of settings. However, using two churches that were distinctly different in their religious beliefs adds strength to this study and aids in addressing this second threat to external validity.

The third threat to external validity is the “interaction of the causal relationships over treatment” (Shadish et al., 2002). This threat has to do with how the treatment/intervention is delivered or administered to the experimental group. This threat to external validity can be addressed by making sure that the intervention is delivered consistently throughout the study. The procedure for implementing the Fitbit Zip program as well as collecting all the pertinent data for the two groups needed to be consistent, both in structure and timing. Therefore, a research study protocol was established before initiation of the study. Each church location had weekly data collection times where the PI met with the study participants. For those who could not meet at the designated time, the PI made individual arrangements to meet with the participant. This procedure was done in the same manner for both church locations. Also, the PI personally delivered all the interventional materials and collected all data, which helped provide consistency and address this threat to external validity.
The fourth threat to external validity is the “interaction over causal relationship with outcome” (Shadish et al., 2002). This threat is concerned with how well the cause/effect relationship holds true for other possible outcomes not specifically considered in the study (Shadish et al., 2002). This study’s focus was on increasing physical activity in the form of steps per day and decreasing depressive symptoms through the use of Fitbit Zips and step goals in female adolescents. However, there was no cause and effect relationship found based on the results of the analysis. However, different outcomes affecting both the mental and physical health of the participants may have occurred, such as physiological changes (lower resting heart rates) or mental enhancements (increased self-esteem, decreased anxiety), but these were not assessed. Therefore, future studies need to be conducted to address these and other possible outcomes to further enhance generalizability over different outcomes.

The fifth threat to external validity is “context-dependent mediation” (Shadish et al., 2002). This threat is related to the potential for other factors that may mediate the relationship between the independent variable and the dependent variable. In this study, variables such as self-efficacy, social support, and planning for exercise were considered as potential mediators that could possibly affect the relationship between physical activity participation and depressive symptoms. Also, there are other potential mediators that could be studied such as barriers to physical activity, perceived benefits of physical activity, and immediate competing demands and preferences related to physical activity, which are additional concepts in the HPM (revised) developed by Pender et al. (2015). Therefore, future analysis could be explored through adjustments to the current PEPME model based on these other potential mediators. An additional
review of the literature would need to be conducted for these concepts to determine their applicability to a revised PEPME model.

Summary

This study used a two-group, pre-test/post-test design to determine if there was an increase in the average median number of daily steps taken by a group of female adolescents measured after 12 weeks of using Fitbit Zip activity trackers with step goals (Fitbit-E group) compared with a control group of participants who used covered Fitbit Zip activity trackers without step goals (Fitbit-C group). As a second outcome measure, depression scores were evaluated to determine if there was a decrease in depression scores for the Fitbit-E group after 12 weeks of using the Fitbit Zip activity trackers with step goals, compared with the Fitbit-C group with no step goals. To determine the study outcomes, daily step counts were extracted from the Fitbit Zip activity trackers by accessing the Fitbit website, and depressive symptoms were measured using the CES-D.

This experimental study was conducted over a 12-week intervention period. Prior to the onset of the intervention, all previously described baseline data were collected, and all participants provided signed permission from their parents (if under the age of 18 years) and either a signed consent or assent. The PAQ-A was administered to determine the physical activity levels of the female adolescent participants at baseline. Additional study instruments included the self-efficacy scale, the social support scale, and the CPASA scale, which were also administered at baseline (pre-intervention) and assessed as potential mediators. Post-test information included final step counts extracted from the Fitbit Zips and the scores from the CES-D administered after the 12-
FEMALE TEENS STEP IT UP WITH FITBIT ZIPS

week intervention. Finally, all statistical analyses were performed using SAS® version 9.4.
Chapter 4: Results

Results of the study are described in this chapter. Sample characteristics and descriptive statistics for the study are presented. Cronbach’s alphas for the survey instruments also are presented. Finally, results of the repeated measures mixed model analyses are described.

Sample Description

The participants involved in the study attended two large church youth groups (one Wesleyan and one Catholic) in the southeastern United States. A total of 44 female adolescents, 14 to 18 years of age, volunteered to participate in the research study. All participants had cell phones with text messaging capabilities and had no physical limitations related to walking. Participants were randomly assigned to one of two groups: Fitbit-C (control group) or Fitbit-E (experimental group).

Descriptive Statistics

Baseline descriptive statistics for the study participants are displayed in Tables 4.1 through 4.3. Chi-square ($\chi^2$), Fisher’s exact tests, and two sample $t$ tests were used to examine differences in percentages or means ($M$s) between the two groups (22 in each group). Table 4.1 shows the racial distribution for the study participants for each group. Most of the participants in each group were Caucasian (52%), and most were juniors or seniors in high school (66%). There were no statistically significant differences between the two groups for race ($p = .392$) or academic grade level in school ($p = .124$).
FEMALE TEENS STEP IT UP WITH FITBIT ZIPS

Table 4.1
Race and Grade Level Percentages with Number of Participants (n) in Each Category

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fitbit-C&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Fitbit-E&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total&lt;sup&gt;c&lt;/sup&gt;</th>
<th>$\chi^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>31.8 (7)</td>
<td>4.5 (1)</td>
<td>18.2 (8)</td>
<td>7.89</td>
<td>0.124</td>
</tr>
<tr>
<td>Asian</td>
<td>0.0 (0)</td>
<td>4.5 (1)</td>
<td>2.3 (1)</td>
<td>0.89</td>
<td>0.373</td>
</tr>
<tr>
<td>Caucasian</td>
<td>45.5 (10)</td>
<td>59.1 (13)</td>
<td>52.2 (23)</td>
<td>7.89</td>
<td>0.124</td>
</tr>
<tr>
<td>Hispanic</td>
<td>13.6 (3)</td>
<td>9.1 (2)</td>
<td>11.4 (5)</td>
<td>3.09</td>
<td>0.209</td>
</tr>
<tr>
<td>Native American</td>
<td>4.5 (1)</td>
<td>4.5 (1)</td>
<td>4.5 (2)</td>
<td>0.13</td>
<td>0.715</td>
</tr>
<tr>
<td>Multiracial/Other</td>
<td>4.5 (1)</td>
<td>18.2 (4)</td>
<td>11.4 (5)</td>
<td>3.95</td>
<td>0.273</td>
</tr>
<tr>
<td>Grade Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>4.5 (1)</td>
<td>18.2 (4)</td>
<td>11.4 (5)</td>
<td>3.24</td>
<td>0.392</td>
</tr>
<tr>
<td>Sophomore</td>
<td>27.3 (6)</td>
<td>18.2 (4)</td>
<td>22.7 (10)</td>
<td>1.58</td>
<td>0.209</td>
</tr>
<tr>
<td>Junior</td>
<td>36.4 (8)</td>
<td>45.5 (10)</td>
<td>40.9 (18)</td>
<td>7.89</td>
<td>0.124</td>
</tr>
<tr>
<td>Senior</td>
<td>31.8 (7)</td>
<td>18.2 (4)</td>
<td>25 (11)</td>
<td>7.89</td>
<td>0.124</td>
</tr>
</tbody>
</table>

Note. AA = African American. Parentheses indicate number of participants per specific race or grade. Numbers inside parentheses are percentages. <sup>a</sup>$n = 22$ for the Fitbit-C group. <sup>b</sup>$n = 22$ for the Fitbit-E group. <sup>c</sup>$n = 44$ for total and the numbers in the column are percentages.

Differences in baseline means for age, BMI, and average median steps per day by group were examined using pooled 2-sample $t$ tests (Table 4.2). There were no statistically significant differences in the means between the Fitbit-C and Fitbit-E groups for baseline age, BMI, or average median steps per day. Both groups had baseline measurements that were similar. The average age was approximately 16 years ($p = .518$), the average BMI was between 24 and 25 ($p = .621$), and the average median steps per day were marginally greater than 6,000 ($p = .805$) for the two groups.
Table 4.2
*Baseline Means and Standard Deviations for Age, BMI, and Median Steps per Day*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fitbit-C M (SD)</th>
<th>Fitbit-E M (SD)</th>
<th>t&lt;sup&gt;a&lt;/sup&gt;</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>16.7 (1.1)</td>
<td>16.5 (1.2)</td>
<td>0.65</td>
<td>.518</td>
</tr>
<tr>
<td>BMI</td>
<td>25.2 (5.3)</td>
<td>24.4 (6.1)</td>
<td>0.50</td>
<td>.621</td>
</tr>
<tr>
<td>Steps/day</td>
<td>6,286.6 (3,107.6)</td>
<td>6,069.7 (2,662.4)</td>
<td>0.25</td>
<td>.805</td>
</tr>
</tbody>
</table>

*Note. M = mean; SD = standard deviation; BMI = Body Mass Index. Total number of participants, n = 44. No statistically significant differences were found between the Fitbit-C and the Fitbit-E groups.

<sup>a</sup>df (degrees of freedom) = 42.

Table 4.3 shows the descriptive statistics (M<sub>s</sub> and S<sub>D</sub>s) for both groups on the survey instruments administered at baseline. The PAQ-A, CPASA, social support, and self-efficacy scales were administered only at baseline. However, the CES-D survey was administered at baseline and then again after the 12-week intervention period. There were no statistically significant differences between the Fitbit-C group and the Fitbit-E group on any of the survey instruments administered at baseline. Additionally, Cronbach’s alphas (α) for each of the survey instruments were calculated. These values are shown in Table 4.4. All instruments had Cronbach’s α coefficients greater than .7, demonstrating acceptable reliability (Tavakol & Dennick, 2011).

**Mixed Model Analysis of Specific Aims and Hypotheses**

**Specific Aim and Hypothesis One**

The first specific aim of this study was to measure whether female adolescents would show a significant increase in their average median daily step counts after 12 weeks of using Fitbit Zips together with daily step goals, as compared with the control group of female adolescents who used covered Fitbit Zips without daily step goals.
Table 4.3

*Means and Standard Deviations for Surveys at Baseline*

<table>
<thead>
<tr>
<th>Survey (Range)</th>
<th>Fitbit-C M (SD)</th>
<th>Fitbit-E M (SD)</th>
<th>t^a</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAQ-A (1-5)</td>
<td>2.3 (0.7)</td>
<td>2.1 (0.7)</td>
<td>0.94</td>
<td>.351</td>
</tr>
<tr>
<td>CPASA (0-3)</td>
<td>2.0 (0.7)</td>
<td>2.1 (0.7)</td>
<td>-0.40</td>
<td>.690</td>
</tr>
<tr>
<td>Social Support (0-3)</td>
<td>2.0 (0.7)</td>
<td>1.7 (0.8)</td>
<td>1.31</td>
<td>.196</td>
</tr>
<tr>
<td>Self-Efficacy (1-5)</td>
<td>3.8 (1.0)</td>
<td>3.8 (0.7)</td>
<td>-0.15</td>
<td>.882</td>
</tr>
<tr>
<td>CES-D (0-60)^b</td>
<td>15.5 (11.0)</td>
<td>16.1 (9.8)</td>
<td>-0.17</td>
<td>.863</td>
</tr>
</tbody>
</table>

*Note.* M = Mean; SD = Standard Deviation; PAQ-A = Physical Activity Questionnaire for Adolescents; CPASA = Commitment for Physical Activity Scale for Adolescents; CES-D = Center of Epidemiologic Studies - Depression scale. All survey instruments’ results were calculated at baseline (pre-test).

^aDegrees of freedom (df) for t statistic = 42. ^bCES-D baseline results.

Table 4.4

*Cronbach’s Alpha Coefficients for Survey Instruments*

<table>
<thead>
<tr>
<th>Surveys</th>
<th>PAQ-A</th>
<th>CPASA</th>
<th>SS</th>
<th>SE</th>
<th>CES-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach’s α</td>
<td>.79</td>
<td>.90</td>
<td>.85</td>
<td>.86</td>
<td>.90</td>
</tr>
</tbody>
</table>

*Note.* PAQ-A = Physical Activity Questionnaire for Adolescents; CPASA = Commitment for Physical Activity Scale for Adolescents; SS = Social support; SE = Self-Efficacy; CES-D = Center of Epidemiologic Studies - Depression scale.

The first hypothesis stated that there would be a statistically significant increase in the average median number of steps per day taken by the Fitbit-E group as compared with the Fitbit-C group. This hypothesis was not met. The group x time interaction term was not statistically significant (p = .678), indicating that the changes from baseline to
intervention week 12 in the Fitbit-E group were not significantly different than the changes from baseline to intervention week 12 in the Fitbit-C group. Table 4.5 shows that both groups’ average median steps per day decreased from pre-test (baseline) to intervention week 12 (post-test), while controlling for the following baseline measures: age, PAQ-A, CPASA, social support, self-efficacy, and BMI. The Fitbit-C group had 6,088.3 (SE = 668.6) average median steps per day at baseline, but only had 2,783.7 (SE = 698) average median steps per day after the 12-week intervention. The Fitbit-E group had a smaller decline with 6,279.1 (SE = 661) average median steps per day at baseline and 4,339.4 (SE = 728) average median steps per day after the 12-week intervention.

Post hoc results and assumptions for hypotheses one and two are explained herein. For post hoc analyses, Bonferroni corrections are done to reduce type I errors resulting from multiple comparisons and are calculated by dividing the original p value by the number of comparisons that are made (Lesack & Naugler, 2011). In this study, there were four post hoc comparisons conducted for each of the two outcome variables. These included comparisons between pretest and posttest results on average median steps per day between each group (n = 2) and pretest to posttest results on average median steps per day within each group (n = 2). The same four comparisons were also made for average CES-D scores. Therefore, the Bonferroni adjusted p value used in this study was calculated by taking the original p value of .05 and dividing it by four. The new adjusted p value for statistical significance was calculated as .0125.

Figure 4.1 provides a graphical representation of the decrease in the average median steps per day for both groups pre-test to post-test. Looking at the post hoc
### Repeated Measures Mixed Model Results for Average Median Steps per Day

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Effect</th>
<th>Group</th>
<th>Week</th>
<th>Adjusted LS Mean</th>
<th>SE</th>
<th>F^a</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps per day</td>
<td>Group</td>
<td>Fitbit-C</td>
<td>0</td>
<td>4328.78</td>
<td>526.34</td>
<td>0.56</td>
<td>.458</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>4887.19</td>
<td>473.25</td>
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<tr>
<td></td>
<td></td>
<td>Fitbit-E</td>
<td>0</td>
<td>6183.70</td>
<td>455.22</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>4594.23</td>
<td>455.22</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Week</td>
<td></td>
<td>8</td>
<td>4548.49</td>
<td>455.22</td>
<td>7.30</td>
<td>&lt; .001</td>
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<td></td>
<td></td>
<td></td>
<td>10</td>
<td>4152.01</td>
<td>455.22</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>3561.50</td>
<td>490.98</td>
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<tr>
<td></td>
<td>Group x Week</td>
<td>Fitbit-C</td>
<td>0</td>
<td>6088.34</td>
<td>668.55</td>
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<td>4</td>
<td>4516.64</td>
<td>668.55</td>
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<td>668.55</td>
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<td>10</td>
<td>3864.18</td>
<td>668.55</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>2783.65</td>
<td>697.98</td>
<td>0.58^a</td>
<td>.678</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fitbit-E</td>
<td>0</td>
<td>6279.05</td>
<td>661.01</td>
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<tr>
<td></td>
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<td>661.01</td>
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<td>661.01</td>
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<td>4439.84</td>
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<td>12</td>
<td>4339.36</td>
<td>728.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Analysis controlled for baseline age, PAQ-A, CPASA, social support, and self-efficacy. LS mean = Least squares mean of the median weekly step counts. ^aF (4, 165). pairwise comparisons and comparing them to the Bonferroni adjusted p value of .0125 for average median steps per day, there were no significant differences between the Fitbit-C and the Fitbit-E groups at baseline (p = .844) or at post-test (p = .135). In addition to examining differences between the two groups, comparisons were made within each group for any significant differences from pre-test to post-test. There was not
a statistically significant difference \((p = .017)\) based on the Bonferroni adjusted \(p\) value of .0125, for the Fitbit-E group’s average median steps per day from pre-test to post-test after controlling for baseline age, PAQ-A, CPASA, social support, self-efficacy, and BMI. However, there was a statistically significant decrease \((p < .001)\) in the Fitbit-C group’s average median steps per day from pre-test to post-test after controlling for the same baseline measures.

![Figure 4.1](image)

**Figure 4.1.** Fitbit-E and Fitbit-C change in average median steps per day measured at two-time points: pre-test (time = 0) and post-test (time = 12 weeks).

**Specific Aim and Hypothesis Two**

The second specific aim of this study was to measure whether female adolescents would show a significant decrease in their depressive symptoms after 12 weeks of using Fitbit Zips together with daily step goals as compared with the control group of female adolescents who used covered Fitbit Zips without daily step goals. Table 4.6 shows the CES-D mean scores and SEs for both groups at pre-test and post-test.
The second hypothesis stated that there would be a statistically significant difference in the decrease in depression scores between the Fitbit-E group and the Fitbit-C group pre-test to post-test. This hypothesis was not met (group by time interaction term $p = .425$). Table 4.6 shows how both groups’ CES-D depression scores decreased from pre-test (baseline) to post-test, while controlling for the baseline measures of age, PAQ-A, CPASA, social support, self-efficacy, and BMI. The difference between the two groups was not statistically significant.

Table 4.6
Repeated Measures Mixed Model Results for CES-D

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Effect</th>
<th>Group</th>
<th>Week</th>
<th>Adjusted LS Mean</th>
<th>SE</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CES-D Score</td>
<td>Group</td>
<td>Control</td>
<td>0</td>
<td>13.2</td>
<td>1.6</td>
<td>0.00</td>
<td>.947</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intervention</td>
<td>12</td>
<td>13.1</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group x Week</td>
<td>Control</td>
<td>0</td>
<td>15.8</td>
<td>1.2</td>
<td>29.27</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intervention</td>
<td>12</td>
<td>10.5</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group x Week</td>
<td>Control</td>
<td>0</td>
<td>15.5</td>
<td>1.7</td>
<td>0.65</td>
<td>.425</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intervention</td>
<td>12</td>
<td>11.0</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group x Week</td>
<td>Control</td>
<td>0</td>
<td>16.1</td>
<td>1.8</td>
<td>0.65</td>
<td>.425</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intervention</td>
<td>12</td>
<td>10.1</td>
<td>1.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* CES-D = Center of Epidemiologic Studies - Depression scale; LS Mean = Least squares mean of the CES-D scores. Analysis controlled for baseline age, PAQ-A, CPASA, social support, and self-efficacy.

$F(1,42)$.

Figure 4.2 illustrates the decrease in CES-D scores for both groups from pre-test to post-test. Looking at post hoc comparisons (Bonferroni adjusted $p$ value = .0125) for average CES-D scores, there were no significant differences between the Fitbit-C and the Fitbit-E groups at baseline ($p = .814$) or at post-test ($p = .722$). Comparing
differences within each group on CES-D scores from pre-test to post-test, both groups had statistically significant decreases in CES-D scores (Fitbit-C, \( p = .002 \); Fitbit-E, \( p < .001 \)) over the course of the 12-week study. All analyses were done controlling for baseline age, PAQ-A, CPASA, social support, self-efficacy, and BMI.

![Graph: CES-D Scores over Weeks for Fitbit-C and Fitbit-E](image)

*Figure 4.2.* Fitbit-C and Fitbit-E groups’ CES-D scores from baseline to 12 weeks

**Specific Aim and Hypothesis Three**

The third specific aim of this study was to determine if it would be feasible to recruit and retain (retention of 80%) female adolescents who would adhere to the study protocol for a randomized controlled pilot study using Fitbit Zips (Amico, 2009).

It was feasible to recruit and retain (based on a retention of 80%) female adolescents for this pilot RCT who adhered to the study protocol. However, it was not possible to recruit the recommended a priori sample size of 90 participants (for the original RCT, not pilot) within the limited recruitment timeframe for this project. In this study, 42 out of 44 participants (95%) completed the final CES-D survey, and 35 out of 44 (79.5%) had some final step count data at post-test. The two participants missing
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CES-D posttest survey data were the result of one participant leaving the country (control group) and one participant dropping out of the study (experimental group) prior to posttest data collection. These same two participants also did not have final step count data. The additional seven study participants who did not have final step count data resulted from the loss of their Fitbit Zips prior to final data collection.

**Mediation Analysis**

Mediation analysis was proposed to determine whether the potential covariates were mediators in the PEPME model. The covariates that were examined as potential mediators included self-efficacy, commitment to a plan of action, and social support. The product of coefficients (POC) test was used to assess for mediation (Baron & Kenny, 1986). Mediation analysis follows a four-step process:

1. Perform regression analysis to determine if there is an association (e.g., $p < .05$) between the intervention and the change in the outcome measure, controlling for the baseline measures.

2. Perform regression analysis to determine if there is an association (e.g., $p < .05$) between the intervention and the proposed mediators.

3. Perform regression analysis to determine if there is an association (e.g., $p < .05$) between the proposed mediators and the change in the outcome measure, controlling for the baseline measure.

4. Finally, determine if the relationship between the intervention and the change in the outcome measure is significantly reduced if the proposed mediators are entered into the regression analysis. Conduct the Sobel test to determine
whether the reduction in the relationship could be considered “substantial” (Sobel, 1982; Taymoori & Lubans, 2008).

The first criterion (step 1) of the four-step process for mediation analysis was not met for this study. The group by time interactions were not statistically significant for either average median steps per day or CES-D scores ($p > .05$). Therefore, no statistical mediation could occur. Table 4.5 displays the repeated measures mixed model results for the outcome variable, average median steps per day. The group x week interaction was not statistically associated ($p = .678$) with average median steps per day, indicating that a mediation analysis was not appropriate for this study.

Table 4.6 illustrates the repeated measures mixed model results for CES-D scores. Again, the analysis was done controlling for baseline age, PAQ-A, CPASA, social support, self-efficacy, and BMI. The group x week interaction was not statistically significant ($p = .365$) for CES-D scores, indicating that it was not appropriate to conduct a mediation analysis.

**Summary**

This chapter provided the results from the randomized controlled pilot study using Fitbit Zips with female adolescents. Sample characteristics and descriptive statistics for the study were presented. Cronbach’s alphas for each of the survey instruments were also presented. A summary of the results from the hypotheses testing using repeated measures mixed model’s analysis is provided in Table 4.7.

Hypothesis 1 was not met. There was not a statistically significant increase in the average median number of steps per day taken by the Fitbit-E group as compared with the Fitbit-C group over the 12-week time period of the study. Both groups had decreases
in their average median steps per day, with the Fitbit-C group exhibiting a significant
decrease from pre-test to post-test.

The second hypothesis, which examined differences in CES-D scores between
the two groups from pre-test to post-test, was not met. No significant difference between
the two groups was found for decreased CES-D scores, as the interaction was not
statistically significant. However, within each group there were significant decreases in
CES-D scores from pre-test to post-test.

Finally, hypothesis 3 was met. The study results indicated that it would be
feasible to recruit and retain at least 80% of the participants in this RCT pilot study and
that the participants would adhere to the study protocol. A thorough discussion of these
results will be presented in the following chapter.

Table 4.7

Summary of Hypotheses Testing

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fitbit Zip usage and step goals will significantly increase average median steps per day for Fitbit-E versus Fitbit-C group</td>
<td>Not met</td>
</tr>
<tr>
<td>2. Fitbit Zip usage and step goals will significantly decrease average CES-D scores for Fitbit-E versus Fitbit-C group</td>
<td>Not met</td>
</tr>
<tr>
<td>3. Feasibility of recruiting and retaining and having adherence to the protocol by the participants</td>
<td>Met</td>
</tr>
</tbody>
</table>
Chapter 5: Discussion

In this chapter, research findings for this RCT pilot study using Fitbit Zips with female adolescents are discussed. In addition, scores from survey instruments that were used are examined. Finally, strengths and limitations of the study as well as implications for public health policy, nursing theory, and nursing research are presented.

Demographics Characteristics

For this study, race was the only demographic characteristic of the participants that could be compared with their county of residence due to limitations in data available for these counties. For both participating sites, the majority of the county’s population was Caucasian, and most of the study participants were Caucasian (52%). Table 5.1 shows the comparisons of each site’s racial distribution with its county of residence.

Table 5.1
Percentage Comparisons of Racial Distribution of Participants and County Population

<table>
<thead>
<tr>
<th>Race</th>
<th>Site 1 Participants</th>
<th>Site 1 Population(^a)</th>
<th>Site 2 Participants</th>
<th>Site 2 Population(^b)</th>
<th>Total(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>12.5</td>
<td>8</td>
<td>19.4</td>
<td>28</td>
<td>18.2</td>
</tr>
<tr>
<td>Asian</td>
<td>0</td>
<td>2</td>
<td>2.7</td>
<td>12</td>
<td>2.3</td>
</tr>
<tr>
<td>Caucasian</td>
<td>62.5</td>
<td>61</td>
<td>50</td>
<td>39</td>
<td>52.2</td>
</tr>
<tr>
<td>Hispanic</td>
<td>25</td>
<td>28</td>
<td>8.3</td>
<td>21</td>
<td>11.4</td>
</tr>
<tr>
<td>Native American</td>
<td>0</td>
<td>No data</td>
<td>5.6</td>
<td>No data</td>
<td>4.5</td>
</tr>
<tr>
<td>Multiracial/Other</td>
<td>0</td>
<td>1</td>
<td>13.9</td>
<td>No data</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Note. All numbers in the table are percentages. AA = African American; Site 1 = Catholic Church; Site 2 = Wesleyan Church.
\(^a\)Racial distribution of the county for Site 1 (U.S. Census Bureau, 2016a). \(^b\)Racial distribution of the county for Site 2 (U.S. Census Bureau, 2016b). \(^c\)Total combined percentages for each race reported for Fitbit-C and Fitbit-E groups (n = 44).
Site 1 participants had a racial distribution that was representative of their respective county as follows: Caucasians (62.5% participants versus 61% county residents), Hispanics (25% versus 28%), and African Americans (12.5% versus 8%). Site 2 participants did not have a racial distribution representative of its county. Caucasians were the majority of the participants (50% participants versus 39% county residents), with both Hispanics and African Americans being underrepresented based on their corresponding county percentages. However, site 2 is considered more the norm for racial distribution among churches. Wright et al. (2015) reported that approximately 86% of church congregations in the United States attract 80% or more of their followers from one specific racial group (based on the National Congregations Study of 2007). Considering these statistics, the two church sites used for this study were more diverse than many other churches in the United States. This is especially true for site 1.

Nevertheless, the two study groups (Fitbit-C and Fitbit-E) were not statistically different from each other for race or for any other baseline measurements. As previously discussed, there were no statistically significant differences between the Fitbit-C and Fitbit-E groups for race, grade, age, BMI, or average median steps per day at baseline. Based on these results, the randomization process successfully yielded two equivalent groups.

**Instruments for PEPME Conceptual Framework**

**Fitbit Zip**

The key features of the Fitbit Zip made it a functional device for the female adolescent population in this study. Participants were not always available to have their
data retrieved on a regular schedule, and they were also not willing to keep up with charging their devices on a consistent basis. Useful applications of the Fitbit Zip were the extended battery life of six months and the fact that the step data (for each participant) were available for several months (accessible on the Fitbit partnering website) and could be retrieved in 30-day increments. Step data were easily downloaded in the form of an Excel spreadsheet after syncing the device with the PI’s secure computer. The data retrieval process of the Fitbit Zip made this specific aspect of the data collection very convenient.

However, despite the positive features discussed, one major weakness of the Fitbit Zip was that specific wear time could not be accurately assessed. In addition, there were difficulties with some participants keeping track of their Fitbit Zips. Four participants lost their Fitbit Zips and were given replacements; one participant lost her Fitbit Zip twice. One participant didn’t wear her Fitbit Zip for two weeks because she left it at work and kept forgetting to retrieve it. Another participant washed her Fitbit Zip, but it was fully functional after it had dried.

The Fitbit Zip is relatively small (about the size of a U.S. quarter), and some participants reported having difficulty keeping up with the device because of its size, while others found the size to be a positive attribute because it was discreet. Two of the participants who were seniors in high school synced their Fitbits with their smart phones in the second week, which resulted in the PI losing access to their data for that week. The PI issued new Fitbit Zips to the two seniors and reminded all participants not to use the Fitbit application on their phones or computers during the study timeframe.
Center for Epidemiologic Studies-Depression Scale

The CES-D was used to evaluate changes in depressive symptomology. Vilagut, Forero, Barbaglia, and Alonso (2016) recommended a cut-off score of 20 as an initial screening tool for depressive symptoms (scores of 20 or greater would indicate higher depressive symptomology) that would potentially require follow-up clinical assessment. Vilagut et al. (2016) based this recommendation on their meta-analysis of 28 studies with data from 10,617 adolescent, adult and elderly participants who were taken from the general and primary care population.

Baseline measures for the CES-D survey yielded an average score of 15.5 for the Fitbit-C group and an average score of 16.1 for the Fitbit-E group. Posttest CES-D average scores for the Fitbit-C and Fitbit-E groups were 11.0 and 10.1, respectively. Both time points had average CES-D scores well below the recommended cut-off point of 20 (Vilagut et al., 2016) for possible clinical assessment recommendations.

Physical Activity Questionnaire for Adolescents

The PAQ-A was completed at pretest to determine both groups’ baseline activity levels. An average PAQ-A score of 1 would indicate very low physical activity levels, and an average score of 5 would be indicative of high physical activity levels (Kowalski et al., 2004). According to Voss, Ogunleye, and Sandercock (2013), PAQ-A scores for female adolescents should be 2.7 or greater for them to be considered sufficiently active based on the CDC and WHO recommendations for physical activity in this population. The study included over 7,000 English youth from 10 to 15 years of age, with approximately 3,400 of the participants being female (Voss et al., 2013). Benítez-Porres, Alvero-Cruz, Sardinha, López-Fernández, and Carnero (2016) determined a similar PAQ-A cut-off
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score for adolescents of 2.75. Their study included 234 adolescents, with females accounting for 119 of the participants.

The Fitbit-C and Fitbit-E groups had similar scores on the PAQ-A, with no significant differences between the two groups at baseline. The Fitbit-C group’s average baseline score was 2.3, and the Fitbit-E group’s average baseline score was 2.1. The female adolescent participants from both groups in this study had physical activity levels that were below the 2.7 and the 2.75 PAQ-A cut-off points for being sufficiently active (Benítez-Porres et al., 2016; Voss et al., 2013). PAQ-A scores below 2.7 were not considered sufficiently active according to WHO recommendations of 60 minutes per day of moderate to vigorous physical activity (Benítez-Porres et al., 2016; Voss et al., 2013; WHO, 2017b).

Participants in both the Fitbit-E and Fitbit-C groups were considered not physically active based on the 2.7 cut-off score from previous studies (Benítez-Porres et al., 2016; Voss et al., 2013); however, the PAQ-A only included the prior week’s physical activities. The possibility exists that the prior week may not have been indicative of a normal week of physical activity for some of the participants. For example, the ninth item on the scale, which was not scored, asked participants if they were sick or if anything prevented them from their regular physical activity routines. Nine of the participants reported being sick the previous week, and two reported being too tired from school or homework to maintain their normal physical activity routines.

**Self-Efficacy for Physical Activity Scale**

The scale used in this study focused on self-efficacy for physical activity and overcoming barriers to participation in physical activity. Average scores ranged from 1 to
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5, with higher scores indicating higher levels of self-efficacy. Both the Fitbit-C group and the Fitbit-E group had a mean self-efficacy score of 3.8. The scale utilized was developed to measure self-efficacy for physical activity in the adolescent population.

Dishman, Dowda, McIver, Saunders, and Pate (2017) used latent growth modeling to examine changes in physical activity levels for 857 students (males and females) from the fifth to the seventh grade. One of the variables measured as a mediator was self-efficacy. The scale used to measure self-efficacy in their study was the same scale that was used for this study. Specifically, for the female participants ($n = 460$), there was a decline in self-efficacy over the three years that resulted in a subsequent decline in physical activity levels. The mean score for self-efficacy for female participants (mean age 12 years) in the study by Dishman et al. (2017) was 3.24. The mean self-efficacy score of 3.24 for participants in the Dishman et al. (2017) study was less than the 3.8 mean self-efficacy score for the participants in this study.

As suggested, the Fitbit-E and Fitbit-C groups had higher average levels of self-efficacy for physical activity than participants in the study by Dishman et al. (2017). A possible explanation for this could be related to the participants’ associations with their respective churches. For example, Thompson et al. (2013) found positive changes from pretest to posttest in self-efficacy scores for a convenience sample of 41 African American female adolescents participating in a 12-week church-based physical activity program.

**Physical Activity Exercise Social Support Scale**

Adolescents’ average scores for the Physical Activity Exercise Social Support scale in this study were comparable to the scores of female adolescents in previous
studies. For example, in the original scale validation process, Ling et al. (2014) found mean scores for social support for 506 female adolescents to be 1.9. In this study, the Fitbit-C group’s mean score on the Physical Activity Exercise Social Support scale was 2.0, and the Fitbit-E group’s mean score was 1.7. Both groups’ mean scores were similar to the mean score for female adolescents in the study by Ling et al. (2014).

**Commitment for Physical Activity Scale for Adolescents**

The Commitment for Physical Activity Scale for Adolescents (CPASA) has 11 items, and the scoring ranges from 0 (never) to 3 (often), with higher scores indicating greater commitment for physical activity (Robbins et al., 2017). This updated scale was recently developed for use with female adolescents. Therefore, there was limited information in the literature. However, Robbins et al. (2017) did an item analysis of the scale using 502 female adolescent participants. The scores for the 11 items ranged from 1.79 to 2.57, and the standard deviations ranged from 0.66 to 0.88 (Robbins et al., 2017).

For participants in this study, an average score for the 11 CPASA items for each group was used for the analysis. The Fitbit-C group had an average score of 2.0, and the Fitbit-E group had an average score of 2.1 for the CPASA, both with a standard deviation of 0.7. The mean scores for the Fitbit-E and Fitbit-C groups on the CPASA were comparable to the scores from the original factor analysis of the scale items by Robbins et al. (2017) after combining all items and then calculating an average. The overall average score on the CPASA was 2.14 for the female adolescents in the study by Robbins et al. (2017), and the overall average score for this study was 2.05.
Covariates and Mediation

The specific scales that were used in this study were based on the PEPME conceptual framework. The PEPME conceptual framework proposes that covariates such as behavior-specific cognitions and affect (self-efficacy and social support) as well as commitment to a plan of action (CPASA) have direct and indirect influences on physical activity participation. As previously mentioned, mediation analysis was planned to determine whether these covariates were potential mediators in the PEPME model.

The product of coefficients (POC) test was proposed to assess for mediation (Baron & Kenny, 1986), but the first criteria for the mediation analysis was not met for this study. The group by time interactions were not statistically significant for either average median steps per day or CES-D scores ($p > .05$), after controlling for all baseline measures. Therefore, mediation analysis was not appropriate, and no statistical mediation could occur. To clarify, there was no difference in the change in average median steps per day between the Fitbit-C and Fitbit-E groups from pretest to post-test, controlling for all covariates. For the second outcome variable of depression symptoms, there was no difference in the change in CES-D scores between the Fitbit-C and the Fitbit-E groups from pretest to post-test, controlling for all covariates. Since there was no association between the two groups for either of the outcome variables (average median steps per day or CES-D scores), there could not be any mediation from the covariates.

Specific Aims and Hypotheses

Specific Aim and Hypothesis One

The first specific aim of this study was to measure whether female adolescents would show a significant increase in their average median steps per day after 12 weeks
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of using Fitbit Zips together with daily step goals, as compared with the control group of female adolescents who used covered Fitbit Zips without daily step goals. Hypothesis one states that there will be a statistically significant increase in the average median number of steps per day taken by female adolescent participants after 12 weeks of using Fitbit Zip activity trackers together with daily step goals, as compared with a control group of female adolescents using covered Fitbit Zip activity trackers without daily step goals. Hypothesis one was not met. The Fitbit-C and Fitbit-E groups’ average median steps per day decreased from pre-test (baseline) to post-test, while controlling for the following baseline measures: age, PAQ-A, CPASA, social support, self-efficacy, and BMI.

For the Fitbit C group, the mean decrease in steps from week 0 to week 12 was 3,304.6 steps (SE = 685.3, 95% CI: 1942.3 – 4667.1). For the Fitbit E group, the mean decrease in steps from week 0 to week 12 was 1,939.7 steps (SE = 797.6, 95% CI: 353.5 – 3525.9). The difference in the decrease in steps between the two groups was not statistically significant.

However, there is clinical significance to this decline in steps for both groups based on what is considered “too few steps per day” and the health consequences associated with this low number. Tudor-Locke, Craig, Thyfault, and Spence (2012) proposed that a cut-off value of less than 5,000 steps per day, which comes with several negative health consequences, should be considered sedentary for adults. Some of the health risks associated with sedentariness (< 5,000 steps per day) are higher values for the following: BMI, systolic blood pressure, lipids and fasting blood glucose (Tudor-Locke et al., 2012). Moreover, a lower health-related quality of life and an overall
decreased energy level have been reported for this lower level of steps per day (Tudor-Locke et al., 2012). In addition, McKercher et al. (2009) reported that for women, the prevalence of depression is 50% greater for those who have less than 5,000 steps per day as compared with those with 7,500 or more steps per day.

Both groups decreased their steps to levels below the 5,000 steps per day considered to be sedentary. Some evidence has been found proposing cut-off scores for female adolescents (to be considered sedentary) of less than 7,000 steps per day, which makes the decrease in steps per day and posttest averages more concerning for this study (Craig, Cameron, & Tudor-Locke, 2013; Tudor-Locke, Craig, Thyfault, & Spence, 2012). The Fitbit-C group’s posttest average median steps per day was 2,783.3, with a decrease from baseline of 3304.6 steps per day; this equates to approximately a 1.7-mile decrease in distance per day (Temple University, 2018). The Fitbit-E group’s posttest average median steps per day was 4,339.4, with a decrease from baseline of 1939.7 steps per day; this equates to approximately a one-mile decrease in distance per day (Temple University, 2018).

There are several possible explanations for the decline in average median steps per day for both groups. The first explanation involved the timing of the conclusion of the study (depending upon when the participants initially enrolled). Most of the female adolescents finished the 12-week intervention near the end of the academic school year or shortly after the end of the school year. During the regular school year, several of the female adolescents participated in extracurricular school activities that were highly step intensive, such as basketball, lacrosse, soccer, and track, to name a few. These activities were completed before the end of the 12-week study, which could have
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partially accounted for the decrease in average median steps per day at posttest. Second, the length of time of the study may not have been long enough to see an effect of the intervention, but long enough for the novelty of having the Fitbit Zip to wear off. Third, the sample size was small, resulting in not having statistically suitable power for the study.

Manley et al. (2014) found similar results in their study of 115 middle school students (11 to 13 years of age). All participants (both intervention and control groups) had declines in their average daily steps after a 12-week intervention using pedometers. Unexpectedly, the intervention group had greater declines in average daily steps than the control group (Manley et al., 2014). One explanation suggested was that the time of year the study was conducted may have affected the final step data collection. In the study by Manley et al. (2014), the intervention started in August and concluded in October, suggesting that cooler temperatures and daylight savings time (less daylight for after school activities) may have decreased physical activity levels for participants. Also, some of the students had PE during the intervention, and some did not. Only those students who did not have PE were used in the analysis, thus reducing the sample size (Manley et al., 2014). Finally, Manley et al. (2014) reported that the length of time for the intervention may not have been long enough, and many participants seemed less enthusiastic about wearing their pedometers toward the end of the study (e.g., many misplaced their pedometer).

However, many studies have found that interventions using pedometers have increased steps per day. For example, Bravada et al. (2007) conducted a systematic review of the literature to determine if the use of pedometers was associated with
increased physical activity and improvements in health outcomes. The population for the review by Bravada et al. (2007) was mainly adults in the outpatient setting. Results suggested that the use of pedometers was significantly associated with increased steps and decreased blood pressure and BMI (Bravada et al., 2007).

Ho et al. (2013) found an association between pedometer wear and increased physical activity (measured by accelerometer) for female adolescents who wore pedometers compared with those who did not wear pedometers. This did not prove true for the male adolescent participants. The study included 345 adolescents (average age 14.5 years old), with 191 of the participants being of the female gender. Interestingly, for both the male and female adolescents who wore an accelerometer for the required four consecutive days, there was a significant decrease in physical activity levels (Ho et al., 2013).

Lastly, there were several possible explanations for the decrease in steps for both groups. Based on the small sample size, the study could be considered inconclusive (Pocock & Stone, 2016). However, there was a lesser decrease in steps within the experimental group (Fitbit-E) as compared with the control group, which could be a possible signal of some type of effect related to the experimental condition that may warrant future investigation.

**Specific Aim and Hypothesis Two**

The second specific aim of this study was to measure whether female adolescents would show a significant decrease in their depressive symptoms after 12 weeks of using Fitbit Zips together with daily step goals as compared with the control group of female adolescents who used covered Fitbit Zips without daily step goals.
Hypothesis two states that there will be a statistically significant decrease in depression scores, as measured by the 20 items in the CES-D, for the female adolescent participants after 12 weeks of using Fitbit Zip activity trackers together with daily step goals as compared with a control group of female adolescents using a covered Fitbit Zip without daily step goals. Both groups’ CES-D scores decreased (indicating an improvement in depressive symptoms) from pre-test (baseline) to post-test, while controlling for the baseline measures of age, PAQ-A, CPASA, social support, self-efficacy, and BMI. Despite the decrease in CES-D scores, the difference between the two groups was not statistically significant.

However, looking at post hoc results within the two groups, there were significant decreases in depressive symptoms from pretest to posttest. The Fitbit-C group’s average CES-D scores decreased from 15.8 to 11.0, and the Fitbit-E group’s average scores decreased from 16.1 to 10.1. However, based on a cut-off score of 20 for the CES-D scale, both groups’ change in scores may not have been clinically significant (Vilagut et al., 2016).

In Table 4.3, the means and SDs for the CES-D scores for both groups are reported. There were wide variations in SDs for the CES-D scores, suggesting that there were participants with high CES-D scores (greater than 20) at baseline. According to Schulz et al. (2002), a 6-point decrease on the CES-D scale was considered clinically significant. Approximately 23% of the participants whose scores were 20 or greater on the CES-D at baseline had a 6-point or more decrease in their CES-D score at posttest. Overall there were improvements in depressive symptomology for many of the participants.
For both groups, this study (based on the protocol) involved a substantial amount of individual contact with the participants both in person and through twice-daily text messaging. There is some evidence from other studies that this individual contact may have been enough to decrease the depressive symptoms in both groups. For example, Rathbone and Prescott (2017) conducted a recent systematic review on the use of mobile phone apps and text messaging (short message service or SMS) for mental and physical health interventions. They found promising results for the efficacy and feasibility of using SMS and mobile phone apps to improve many aspects of mental and physical health, to include depression and physical activity (Rathbone & Prescott, 2017).

The continuous and consistent personal contact could have been construed as a means of social support that may have affected the participants’ depressive symptoms in a positive manner. Gariépy, Honkaniemi, and Quesnel-Vallée (2016) conducted a systematic review on social support to investigate its association with depression and depressive symptoms. For younger females (8 to 20 years of age), social support, especially from parents, teachers, and family members, was found to be a protective factor against depression (Gariépy et al., 2016). Both the text messaging and the frequent interaction of the PI with the participants may have been viewed as social support and thus improved depressive symptoms in both groups. Furthermore, the fact that these participants, who overall were a non-clinical, non-depressed church-going group of female adolescents, had significant decreases in depressive symptoms from baseline to posttest was a finding of interest for potential future inquiry.
Specific Aim and Hypothesis Three

The third specific aim of this study was to determine if it would be feasible to recruit and retain (retention of 80%) female adolescents who would adhere to the study protocol for a randomized controlled pilot study using Fitbit Zips. In this study, 42 of the 44 participants (95%) completed the final CES-D survey, and 35 out of 44 participants (79.5%) had usable final step count data at post-test. Hypothesis three states that it will be feasible to recruit and retain (retention of 80%) female adolescents who will adhere to the study protocol for a randomized controlled pilot study using Fitbit Zips. The primary reason for the decrease in the number of participants with final daily step count data was because the participants either lost their Fitbit Zip prior to posttest data collection or they did not attend the posttest data collection meeting.

In addition, it was feasible to recruit female adolescent participants for the study; however, it was difficult to get the required numbers to power the study adequately within the designated recruitment timeframe. One of the two sites had leadership changes during the study recruitment phase, which resulted in decreased youth group participation for that site. Also, the recruitment period was limited because it needed to be closely tied to the academic calendar of the participants. It was reasoned that during summer break, many participants would be unavailable for data collection due to personal obligations or travels out of state. Therefore, the last participants needed to be enrolled no later than 12 weeks prior to the end of the academic school year.

Furthermore, the study was extremely time intensive, even with the smaller numbers, both prior to and during the experimental procedure. Working with a vulnerable population such as female adolescents requires extensive IRB
documentation such as permissions, consents, and assents. Securing all the necessary paperwork in a timely manner was one of the first major challenges of this study.

After the initial paperwork was acquired, there were several difficulties that were encountered with some of the participants. For example, parents were often too busy to bring their daughters to the weekly scheduled church meetings for data collection. Consequently, the PI would have to schedule additional meeting times at alternate locations to download step data from participants’ Fitbit Zip. Participants sometimes forgot their Fitbit Zip at school, home, or work, resulting in data collection being delayed because they were not wearing their Fitbit Zip. Also, a few of the participants (n = 3; two in the experimental group and one in the control group) did not have their cell phones for brief periods of time due to technical issues or disciplinary problems. Therefore, these participants did not receive some text communications.

Furthermore, text messaging twice a day was time sensitive and time intensive. For example, participants attended three different school systems that started at three distinct times in the mornings. Therefore, the PI sent text messages each morning at 5:30, 6:30, and 7:00 a.m. Also, the three schools that were attended by the participants had two different spring break sessions, during which several of the participants went out of the country to serve their churches on missionary trips. No text messaging or data collection could be done during those weeks. During this time, some participants left their Fitbit at home for fear of losing them while they were away. Although the participants on a mission trip (n = 15) could not receive text messages for the one week while they were away, their posttest data collection was not affected because they had returned and were present for final data collection. However, Fitbit Zip wear time and
compliance may have been affected. For example, participants may have gotten out of the habit of wearing their Fitbits regularly. Lastly, the experimental protocol, in general, was time and labor intensive for only one researcher.

**Strengths of the Study**

This study has three major strengths. First, this is the first RCT pilot study to use EAMs (Fitbit Zips) in an intervention with female adolescents from church youth groups to determine whether they would increase physical activity (steps per day). Both the experimental and control groups had a decrease in their average median steps per day over the course of the 12-week intervention. The decline in physical activity for this population is evident from the literature review and from the results of this study, verifying the importance of investigating the problem of physical inactivity in female adolescents. More experimental research needs to be conducted to establish cause and effect relationships. Correspondingly, prior studies examining different types of interventions and their impact on physical activity levels of the adolescent population have concluded that more experimental studies are needed in this area (Brown et al., 2013; Dobbins et al., 2013; Pearson et al., 2015).

Second, this is the first study to examine how participation in a Fitbit Zip intervention could potentially affect depressive symptoms in female adolescents. There were no significant differences between the Fitbit-E and Fitbit-C groups for depressive symptoms. Yet within the two groups, there were significant decreases in depressive symptoms from pretest to posttest. Additional research is needed to investigate what caused the decrease in depressive symptoms, despite the decreased average median steps per day experienced by both groups.
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Third, this is the first study to use Fitbit Zips with female adolescents as a valid, reliable, and objective measure of physical activity in the form of steps per day (Schneider & Chau, 2016; Tully et al., 2014). In addition, the Fitbit Zip is cost effective, and the data from the Fitbit Zip can be tracked and stored for several months. The availability and ease of acquiring the data were invaluable features of the Fitbit Zip.

Limitations of the Study

There were several limitations of the study. The first was the sample size. It was determined that a sample size of 36 per group (72 subjects) was needed to show the difference in change in average median steps per day between the intervention and control groups with 80% power. Taking into consideration a potential loss-to-follow-up rate of 20%, 45 subjects in each group (90 subjects) was the target for enrollment. However, due to time limitations of the recruitment period, only 44 participants were enrolled. Therefore, the a priori sample size of 90 participants to achieve 80% power was not met.

Second, the timing of the study with respect to when participants were out of school for the summer was a very important confounder that potentially affected the study results. The fact that the study did not conclude for some of the participants until after the end of the academic school year could have affected the results of the study such that daily step counts may have changed significantly. For example, some of the female adolescents participated in extracurricular school activities that were step intensive such as basketball, lacrosse, soccer, and track. These activities ended before the termination of the study, which could partially account for the decreased average median steps per day at posttest.
Third, even though the Fitbit Zip was a valid and reliable instrument for measuring the number of steps taken per day, there was no way to determine the total amount of time each day that the participants wore their device. Participants were given and asked to complete a daily journal that included wear time and placement of their Fitbit Zip, but only 13 of the 44 participants completed this task. Various studies have reported that wear times of at least 10 hours per day are required to yield valid daily results (Gaudet et al., 2017).

Fourth, the baseline data collection timeframe may not have been long enough, and merely wearing the Fitbit Zip could have impacted the participants’ baseline step counts. A possible solution to this problem could be to acquire baseline step information from the participants’ health applications that are constantly running in the background of their smart phones. In addition, they could wear the covered Fitbit Zip for two weeks prior to the intervention, rather than the one-week timeframe for this study. Part of the new inclusion criteria could be that the participants would have to own smart phones and they would have to allow the PI access to the health application from their smart phones to get a more accurate account of their baseline steps.

Finally, the findings from this study cannot be generalized to female adolescents from other churches, schools, areas of the country, or around the world. The female adolescent study participants were members of church youth groups, were from the southeastern United States, and were selected by convenience sampling, rather than by random sampling. To address this limitation, additional studies in different geographical areas and with individuals of different ages and demographic characteristics need to be conducted.
Implications for Nursing Theory

There are two implications for nursing theory. The first implication is that the use of the PEPME conceptual framework may prove beneficial for future health promotion research. This conceptual framework is based on Nola Pender’s revised HPM, which has been used in numerous health promotion studies over the past several years. Viewing the individual from a holistic perspective with an emphasis on promoting health, rather than just the absence of disease, is the essence of Pender’s revised HPM and also represents the purpose of the PEPME conceptual framework (Pender et al., 2015; Peterson & Bredow, 2013).

The second implication for nursing theory is that the instruments used in this study to measure the concepts of commitment to a plan of action, self-efficacy for physical activity, and social support for physical activity may be useful for other health promotion studies. These instruments were developed based on Pender’s revised HPM or various parts of her model and had female adolescents as their target population (Bajamal et al., 2017; Mirghafourvand et al., 2014; Mohamadian & Arani, 2014; Robbins et al., 2006; Taymoori et al., 2008; Taymoori et al., 2010; Taymoori & Lubans, 2008; Teerarungsikul et al., 2009). These instruments include the CPASA, social support for physical activity, and self-efficacy for physical activity scales.

Concepts borrowed from Nola Pender’s HPM (revised) benefitted this study by providing a conceptual framework (PEPME) that allowed for exploration into the social cognitive variables of self-efficacy, social support, and commitment for physical activity, which had proposed effects on physical activity participation for female adolescents. Although there were no mediation effects of commitment for physical activity, self-
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efficacy for physical activity, or social support for physical activity, other studies have
found mediation effects for these variables (Beets et al., 2007; Casey, Harvey, et al.,
2014; Dishman et al., 2009; Dowda et al., 2009; Eime et al., 2013; Maglione & Hayman,
2009; Motl et al., 2007; Robbins, Pender, Ronis, Kazanis, & Pis, 2004; Verloigne et al.,
2016).

Therefore, using nursing theory could benefit future studies in health promotion
research with female adolescents through further exploration of relevant social cognitive
variables from the PEPME conceptual framework or other frameworks based on
Pender’s HPM (revised). Nola Pender’s HPM (revised) views individuals holistically
while focusing on promoting health and healthy practices rather than on the prevention
of disease (Pender et al., 2015; Peterson & Bredow, 2013). This perspective would
benefit future nursing research studies aimed at promoting physical activity and
decreasing depressive symptoms in the female adolescent population.

**Implications for Nursing Practice**

This study has two major implications for nursing practice. The first involves the
prevalence of physical inactivity in the female adolescent population and how it affects
their future healthcare. The results of this study showed a significant decline in physical
activity in the form of steps per day for the female adolescent participants in both the
experimental and control groups. Nurses are in key positions to influence this negative
trend through education and social support (Young, 2012).

According to Bélanger et al. (2011), Eime et al. (2015), and Knowles et al.
(2011), social support for physical activity is important for female adolescents, and it
impacts their willingness to participate in physical activity. Social supporters for
adolescents are peers, parents, teachers and others, to include nurses, who can provide emotional or physical support for them (Bandura, 2004; Pender et al., 2011). The downward trend in physical activity for female adolescents is supported by the results from this study and by the research literature (Kimm et al., 2002; WHO, 2017a, 2017b). Pediatric nurses have a unique opportunity to promote the value of being active to their patients and families starting from early childhood and continuing into the adolescent years. In addition, school nurses could find ways to encourage students to remain or become more physically active by focusing on educating their students about the lifelong health benefits of exercise.

The second major implication for nursing practice involves the importance for nurses to recognize and provide treatment recommendations related to depressive symptomology in youth. The U.S. Preventive Services Task Force (2016) recommends that adolescents aged 12 to 18 years be screened for MDD. According to Young (2012), pediatric nurses and nurse practitioners are in key positions to screen their adolescent patients for depressive symptoms and provide them with appropriate resources needed to promote their mental health and well-being.

For this study, the CES-D was used to evaluate changes in depressive symptoms for the female adolescent participants. The CES-D has been found in this study and in other studies to be a reliable and easy to use instrument for assessing depressive symptomology in the adolescent population (Carnevale, 2011). Although there were no significant differences between the two groups, there were substantial decreases in depressive symptomology within each group. Assessing for depressive symptoms in female adolescents and making the necessary treatment referrals are
important steps toward improving the mental health of female adolescents. Also, encouragement for physical activity participation from parents, teachers, and healthcare providers may help all adolescents experience healthier lifestyles well into adulthood.

**Implications for Public Health Policy**

This study has two major implications for public health policy. The first major implication involves the problem of physical inactivity in the female adolescent population. Female adolescents in both groups in this study had clinically significant decreases in average median steps per day from baseline to posttest. The problem with physical inactivity is worldwide and includes most all countries and populations.

Emphasizing the magnitude of physical inactivity in the general population, Ding et al. (2016) recently reported on the substantial economic burden related to the physical inactivity pandemic. The report was based on information gleaned from 142 countries that represented over 93% of the global population in 2013. As a conservative estimate, $53.8 billion was spent by healthcare organizations for the health-related consequences of physical inactivity. The five major non-communicable diseases responsible for this cost were coronary heart disease, stroke, type 2 diabetes, breast cancer, and colon cancer (Ding et al., 2016). More alarmingly, in a recent publication by the CDC (2017) called *Active People, Healthy Nation*, physical inactivity in the United States alone resulted in 10% of all premature deaths and had an associated annual healthcare cost of $117 billion.

In Georgia, it became mandatory in the 2011 academic year for all public schools to implement the Student Health and Physical Education (SHAPE) initiative (GaDOE, 2016). This initiative requires public schools to conduct an annual physical assessment...
on K-12 students who were enrolled in physical education (PE) classes. These assessments (called FITNESSGRAM) provided statistics for the state on specific health indicators that could be tracked year to year and shared with the students’ parents or guardians. This program has been in place for over five years.

The most recent report available from the Georgia SHAPE network and the governor’s office was from the 2015-2016 school year. According to the Georgia Department of Education (GaDOE, 2016), for all students enrolled in the state’s public schools, 74% participated in PE classes. The breakdown per school level was as follows: elementary schools (94% of students were enrolled in PE), middle schools (71% were enrolled), and high schools (49% were enrolled) for the 2015-2016 school year.

The five components measured for the FITNESSGRAM report were aerobic capacity, flexibility, muscular strength, muscular endurance, and body composition (GaDOE, 2016). Healthy Fitness Zones (HFZs) for each of the five components of the FITNESSGRAM assessment were determined using criterion-referenced standards and were associated with levels of fitness indicative of better health (GaDOE, 2016). Aerobic capacity was measured using the Progressive Aerobic Cardiovascular Endurance Run (PACER) test or the mile run. The results for female students (grades 9 to 12) who were enrolled in PE in Georgia’s public schools from 2012 to 2016 are shown in Table 5.2.
Table 5.2

Percentages of Female Students in the Healthy Fitness Zone (HFZ) for Aerobic Capacity

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Aerobic Capacity (Percentage in HFZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>2012</td>
</tr>
<tr>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>11</td>
<td>36.7</td>
</tr>
<tr>
<td>12</td>
<td>31.3</td>
</tr>
</tbody>
</table>


^aFirst full school year for fitness assessments in all Georgia public schools. ^bFemales in grades 9 and 12 had the lowest percentage of students in the HFZ for 2016.

Even with the implementation of fitness testing (FITNESSGRAM) and the emphasis on physical activity for all Georgia public schools, percentages of female adolescents in the HFZ for aerobic capacity per grade level have not shown significant improvements over the past five years. For example, 35% of ninth grade females in the year 2012 were in the HFZ for aerobic capacity. However, in 2016, there were still only 35.5% of ninth graders in the HFZ for aerobic capacity, demonstrating very little progress being made toward increasing physical activity. Looking at the results in Table 5.2 in another way, females in 2012 who were in the ninth grade would be in the twelfth grade in 2015. Therefore, the female students in the HFZ for aerobic capacity would have dropped from 35% in the ninth grade to 31.7% in the twelfth grade. These results
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are consistent with other findings which report that as female adolescents progress through their high school years, their attitudes toward physical activity worsen and their activity levels decrease (Burns et al., 2014; Kimm et al., 2002).

To further evaluate Georgia’s progress, a national report from the Society of Health and Physical Educators (2016), also with the abbreviation of SHAPE, provided information about physical education in the state of Georgia. The following details were reported concerning physical education in Georgia public schools: (a) elementary schools were not required to provide time for recess, (b) there was no requirement for PE in middle or junior high schools, (c) to graduate from high school, there was only a one course (one credit) PE requirement, and (d) there was no specific curriculum required for PE at the middle/junior or high school level (Society of Health and Physical Educators [SHAPE], 2016).

From a national perspective, elementary schools and middle schools in Oregon and the District of Columbia are the only places that meet the national recommendations for time spent in PE per week (SHAPE, 2016). Numerous publications have been written and research studies have been conducted over the public health consequences of physical inactivity (CDC, 2017; Dumith et al., 2016; Lee et al., 2012; WHO, 2017a, 2017b). This research study exposes the consequences of physical inactivity for most populations, but more specifically for the female adolescent population (WHO, 2017a, 2017b). In addition, the results from this RCT pilot study found that physical activity levels (average median steps per day) decreased over the 12-week intervention period for both the experimental and control groups of female adolescent participants, despite having Fitbit Zips and step goals as potential motivators for the intervention group.
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Habits (positive or negative) related to physical activity start in youth and are further developed in school, and these habits follow our children into adulthood (Troiano et al., 2008).

The second major public health policy implication of this study involves depressive symptomology in the female adolescent population and its effect on future mental health. For this study, there were significant differences within each group on depressive symptomology. Both groups had decreases in their depressive symptoms as measured by the CES-D from pretest to posttest. This improvement in depressive symptoms was not clinically significant on the average scores for each group. However, approximately 23% of the participants whose scores were 20 or greater on the CES-D at baseline had a 6-point decrease or more in their CES-D scores from baseline to posttest. According to Schulz et al. (2002), a 6-point drop in depression scores on the CES-D is considered a clinically relevant change.

Female adolescents are twice as likely as their male counterparts to have symptoms of MDD (Cohen et al., 1993; Essau, Lewinsohn, Seeley, & Sasagawa, 2010). This gender difference typically has its onset in puberty, with the largest increases occurring between the ages of 15 and 18 years (Cohen et al., 1993; Essau et al., 2010; Hankin, 2006). Depression is considered a significant contributor to the world’s burden of disease and is the number one cause of illness and debility (WHO, 2017e). In 2015, Georgia was granted a five-year, $10.2 million grant by SAMHSA to develop mental health services for children in their local communities (GaDOE, 2016). Three Georgia public school districts were awarded funds for the Advancing Wellness and Resilience Education (AWARE) project that was a product of the SAMHSA grant (GaDOE, 2016).
The following are some alarming statistics reported by the GaDOE (2016), underscoring the need for mental health services for school-aged children. First, 22% of children under 18 years of age have mental health disorders that could be identified by qualified health care providers. Mental health problems have negative consequences on grades, and as many as 44% of students do not finish high school due to mental health difficulties. Additionally, 10% of children experience severe emotional complications related to mental health disorders that in turn affect their functional and developmental capacity. In 2016, there was a 200% increase in the rate of suicides for females 10 to 14 years of age, and in 2015, nearly 25,000 students in Georgia tried to physically injure themselves on more than one occasion (GaDOE, 2016).

This research study and review of the literature underscore the widespread problems of depressive symptoms and physical inactivity in the female adolescent population. Both physical inactivity and mental health problems are of great public health concern, and female adolescents are especially vulnerable to both of these deleterious conditions (Baldursdottir et al., 2017; Bennik et al., 2014; Essau et al., 2010; Terzian & Moore, 2009). Unfortunately, current public health policies do not adequately address these problems (limited PE requirements and mental health care in schools). Nurses have the ability to influence public policy to make changes. These changes can be accomplished by aiding in the creation and promotion of policies that will increase physical activity and provide access to mental health resources in the public schools and communities of our youth.
Implications for Future Research

Finally, this study has four implications for future research. The first implication is that the timing of the study needs to be carefully determined based on the participants’ school schedules. The timing for the termination of the study may have affected physical activity levels of the participants. During the regular school year, several of the female adolescents participated in extracurricular school activities that were highly step intensive, such as basketball, lacrosse, soccer, and track. Most of the participants in the study finished the 12-week intervention near the end of their spring semester of high school. This time of year was occupied with exams, and very few extra-curricular school activity programs were still in progress. For future studies, a longer timeframe for the study is recommended, e.g., beginning after school starts in the fall and ending before spring break. Manley et al. (2014) found that participants in both the intervention and control groups had declines in their average daily steps after a 12-week intervention using pedometers, with the intervention group having greater declines than the control group. A possible explanation offered for the decline in steps was that the time of year the study was conducted may have affected the final step counts (Manley et al., 2014). Specifically, the study started in August, when the weather was warmer and possibly more conducive to outdoor activities (more steps per day) and ended in October, when the weather was colder and fewer outdoor activities occurred, resulting in fewer steps per day (Manley et al., 2014).

The second implication for future research involves the location of the study. Future studies may be more feasible if they are conducted in a school setting because schools are where adolescents spend a majority of their time, the population is more
diverse, and there are greater numbers of potential participants. This study was conducted at two large churches, which limited the sample population with respect to size and diversity. One site had leadership changes which may have potentially affected recruitment numbers. Based on previous research recommendations, school-based studies were found to have the greatest potential for success (Camacho-Minano, LaVoi, & Barr-Anderson, 2011; Larson, Hannon, & Brusseau, 2015; Owen, Curry, Kerner, Newson, & Fairclough, 2017). In a recent systematic review and meta-analysis, Owen et al. (2017) found 17 studies meeting their inclusion criteria of being school-based interventions to promote physical activity in female adolescents with a self-report or objective measure of physical activity. Owen et al. (2017) found a small, but significant treatment effect for interventions geared toward increasing physical activity in female adolescents in the school setting ($k = 17, g = 0.37, p < .05$).

The third implication for future research involves the use of Fitbit Zips as an effective tool for measuring physical activity in the form of steps per day. In this study, the Fitbit Zip was an inexpensive and easy-to-use device used to measure physical activity for female adolescents. The participants reported liking the Fitbit Zip because of its size and the various color options. The data were easily downloaded from the partnering website into an Excel spreadsheet, which was practical for data analysis proposes. Although there were a few drawbacks of the Fitbit Zip, such as its small size making it easier to lose and its inability to measure wear time, the benefits of using the Fitbit Zip outweighed the barriers for this study.

The fourth major implication for nursing research involves evaluating aspects of social support that may positively impact depressive symptoms in female adolescents.
Specifically, for this study, there were no significant differences between the Fitbit-C and Fitbit-E groups on depressive symptoms, but within each group (from pretest to posttest), there were significant decreases in depressive symptoms. This study involved a significant amount of personal contact between the PI and all participants. This contact could have served as a type of social support that accounted for the decrease in depressive symptoms for each group. Gariépy et al. (2016) found social support to be a protective factor against depression for younger females. In this study, because of the significant personal contact between the PI and the participants, non-specific factors need to be considered. For example, the relationships that formed between the participants and the PI during the intervention period is an example of a non-specific factor, specifically called a common factor, which may have impacted the results of the study (Donovan, Kwekkeboom, Rosenzweig, & Ward, 2009).

Designing and implementing effective interventions to increase physical activity in female adolescents is a challenging endeavor (Owen et al., 2017). School-based interventions seem to be the best choice for potential success because of the amount of time adolescents spend each week in school (Gorely, Nevill, Morris, Stensel, & Nevill, 2009; Larson et al., 2015; Olive et al., 2017). Important elements for successful interventions for female adolescents should include different physical activity choices and female only PE classes. Also, it is important to promote a school culture conducive to physical activity with incentives for participation and appropriate education on the benefits of physical activity (Dewar et al., 2014; Huberty et al., 2014; Pate et al., 2005; Robbins et al., 2006; Taymoori et al., 2008; Webber et al., 2008). Using the information that was gleaned from this pilot study, a future study would include the aspects
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previously mentioned and the use of the Fitbit Zip as an objective measure of physical activity. Also, more emphasis would be placed on wear time documentation using activity journals.

Conclusions

This research study utilized a RCT pilot study design to examine use of the Fitbit Zip for promoting physical activity participation and decreasing depressive symptoms. The participants in the study were 44 female adolescents who attended two different church youth groups in the southeastern United States. There were three specific aims and hypotheses for this study.

For hypothesis one, there were no statistically significant differences between the Fitbit-E and Fitbit-C groups on average median steps per day. Both groups’ average median steps per day decreased from pre-test to post-test. The 12-week intervention timeframe may not have been long enough to see a difference between the two groups, but may have been long enough for the novelty effect of the Fitbit Zip to wear-off. Additionally, the sample size was small for this study, which may have affected the ability to detect a significant difference between the two groups on average median steps per day through mixed methods analyses.

For hypothesis two, there were no statistically significant differences between the Fitbit-E and Fitbit-C groups on depressive symptoms. Both groups’ CES-D scores decreased from pretest to posttest, indicating improvements in depressive symptomology. Post hoc analyses uncovered statistically significant decreases in depressive symptoms from pretest to posttest within each group, although the results may not have been clinically relevant based on a cut-off score of 20 for the CES-D
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scale. Frequent interactions between the PI and study participants may have had positive effects on depressive symptoms through non-specific factors. There were wide variations in the depressive scores for both groups, suggesting that some of the participants had high depression scores (greater than 20) at baseline. Almost a quarter of the participants whose scores were 20 or greater on the CES-D at baseline had a 6-point decrease in their scores at posttest, which would be considered a clinically significant improvement in their depressive symptoms.

For hypothesis three, it was determined that it was feasible to retain female adolescents who participated in the study and who followed the protocol. However, due to limitations of this study regarding the recruitment timeframe, acquiring enough participants to sufficiently power the study was very difficult. In addition, the entire study process was extremely time intensive.

The findings of this study have implications for nursing practice, policy, and future research. All nurses need to recognize physical inactivity and depressive symptoms as significant problems in the female adolescent population. Pediatric nurses need to find ways to encourage physical activity, assess for depressive symptoms, and provide follow-up recommendations for their adolescent patients. Additionally, nurses can influence public health policy by lobbying for changes in physical activity programs in public schools and for increased availability of mental health screenings for all children and adolescents. The present study serves as a preliminary investigation into these problems. Future nursing research should include experimental studies with larger sample sizes that take place in school settings with longer timeframes. Lastly, exploring various types of social support for physical activity and investigating effects of the Fitbit
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Zip on physical activity participation and depressive symptoms in more diverse samples of female adolescents is warranted.
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Appendix A: SAS® Generated Randomization Table

<table>
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<th>Subject</th>
<th>Treatment Assignment</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Control</td>
</tr>
<tr>
<td>2</td>
<td>Intervention</td>
</tr>
<tr>
<td>3</td>
<td>Intervention</td>
</tr>
<tr>
<td>4</td>
<td>Control</td>
</tr>
<tr>
<td>5</td>
<td>Intervention</td>
</tr>
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<td>Control</td>
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<td>Intervention</td>
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<td>9</td>
<td>Intervention</td>
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<td>10</td>
<td>Control</td>
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<td>Control</td>
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<td>Control</td>
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<td>15</td>
<td>Control</td>
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<td>16</td>
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<td>17</td>
<td>Intervention</td>
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<tr>
<td>18</td>
<td>Control</td>
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<tr>
<td>19</td>
<td>Intervention</td>
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<td>20</td>
<td>Control</td>
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<td>21</td>
<td>Control</td>
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<tr>
<td>22</td>
<td>Intervention</td>
</tr>
<tr>
<td>Subject</td>
<td>Treatment Assignment</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
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<tr>
<td>23</td>
<td>Control</td>
</tr>
<tr>
<td>24</td>
<td>Intervention</td>
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<tr>
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<td>43</td>
<td>Intervention</td>
</tr>
<tr>
<td>44</td>
<td>Control</td>
</tr>
</tbody>
</table>
Appendix B: PEPME Demographic Questionnaire

Identification Number: _____________________

PEPME Demographic Questionnaire

Directions: Please fill in your birth date and check the circle that most closely describes you?

1. What is your birthday?
   ____/____/_________

2. Are you …?
   O African American
   O Asian
   O Caucasian
   O Hispanic/Latino
   O Pacific Islander
   O Native American
   O Alaskan Native
   O Multiracial
   O Prefer not to specify

3. What is your current grade level?
   O Freshman – 9th grade
   O Sophomore – 10th grade
   O Junior – 11th grade
   O Senior – 12th grade
Appendix C: Center for Epidemiologic Studies Depression Scale (CES-D)

These questions ask how often you have had certain feelings or experiences during the last week.

<table>
<thead>
<tr>
<th>Item</th>
<th>Less than 1 Day</th>
<th>1 - 2 Days</th>
<th>3 - 4 Days</th>
<th>5 - 7 Days</th>
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<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
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<td>3</td>
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<tr>
<td>20</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Scoring Instructions: Sum of 20 items, four of which are reverse scored (4, 8, 12, & 16). Possible range of scores is zero to 60, with the higher scores indicating the presence of more depressive symptoms. Scale is freely available.
Appendix D: Physical Activity Questionnaire (High School)

**Physical Activity Questionnaire (High School)**

We are trying to find out about your level of physical activity from the last 7 days (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:

3. There are no right and wrong answers — this is not a test.

4. Please answer all the questions as honestly and accurately as you can — this is very important.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7 times or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipping</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Rowing/canoeing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In-line skating</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Tag</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Walking for exercise</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Bicycling</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Jogging or running</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Aerobics</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Swimming</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Baseball, softball</td>
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<td>☐</td>
<td>☐</td>
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<tr>
<td>Dance</td>
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<tr>
<td>Football</td>
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<td>Street hockey</td>
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<td>Basketball</td>
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<tr>
<td>Other</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

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234
2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don’t do PE ........................................ O
Hardly ever ........................................ O
Sometimes ........................................ O
Quite often ........................................ O
Always ........................................ O

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only.)

Sat down (talking, reading, doing schoolwork)........ O
Stood around or walked around ....................... O
Ran or played a little bit ................................ O
Ran around and played quite a bit .................... O
Ran and played hard most of the time ............... O

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)

None ............................................... O
1 time last week ................................... O
2 or 3 times last week ................................ O
4 times last week ................................... O
5 times last week ................................... O

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)

None ............................................... O
1 time last week ................................... O
2 or 3 times last week ................................ O
4 or 5 times last week ................................. O
6 or 7 times last week ................................. O

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

None ............................................... O
1 time ............................................... O
2 — 3 times ......................................... O
4 — 5 times ......................................... O
6 or more times .................................... O
7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

F. All or most of my free time was spent doing things that involve little physical effort .................................................................

G. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics) ....................

H. I often (3 — 4 times last week) did physical things in my free time ................

I. I quite often (5 — 6 times last week) did physical things in my free time ........

J. I very often (7 or more times last week) did physical things in my free time ....

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week:

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Little bit</th>
<th>Medium</th>
<th>Often</th>
<th>Very often</th>
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<td>☐</td>
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<td>Sunday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes ........................................

No ........................................

If Yes, what prevented you? ________________________________
Physical Activity Questionnaire (High School) Scoring Instructions: Overall process –
Find an activity score between 1 and 5 for each item (excluding item 9)

1) Item 1 Spare Time Activity
- Take the mean of all activities (“no” activity being a 1, “7 times or more” being a 5) on
  the activity checklist to form a composite score for item 1.

2) Item 2 to 7 (PE, lunch, right after school, evening, weekends, describes you best)
- The answers for each item start from the lowest activity response and progress to the
  highest activity response.
- Use the reported value that is checked off for each item (the lowest activity response
  being a 1 and the highest activity response being a 5).

3) Item 8
- Take the mean of all days of the week (“none” being a 1, “very often” being a 5) to form
  a composite score for item 8.

4) Item 9
- Can be used to identify students who had unusual activity during the previous week,
  but this question is NOT used as part of the summary activity score.

5) How to calculate the final PAQ-A activity score
- Once you have a value from 1 to 5 for each of the 8 items (items 1 to 8) used in the
  Physical Activity composite score, you simply take the mean of these 8 items, which
  results in the final PAQ-A activity summary score.

- A score of 1 indicates low physical activity, whereas a score of 5 indicates high
  physical activity.

Scale is free for research purposes per Dr. Kent Kowalski.
**Self-Efficacy Scale**

For each statement below, select the response which best represents how much you 'disagree' or 'agree' with the statement. Mark your response by filling in the circle in the correct column.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree a lot</th>
<th>Disagree a little</th>
<th>Neither agree nor disagree</th>
<th>Agree a little</th>
<th>Agree a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can be physically active during my free time on most days.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I can ask my parent or other adult to do physically active things with me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I can be physically active during my free time on most days even if I could watch TV or play video games instead.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I can be physically active during my free time on most days even if it is very hot or cold outside.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I can ask my best friend to be physically active with me during my free time on most days.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I can be physically active during my free time on most days even if I have a lot of homework.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I have the coordination I need to be physically active during my free time on most days.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I can be physically active during my free time on most days no matter how busy my day is.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MMSO

Scoring - Add the scores and divide by number if items, the higher the score the greater the self-efficacy. Permission granted by Dr. Rodney Dishman.
Appendix F: Social Support for Physical Activity

Think about how much people in your life help you to exercise, be active, or do sports by doing things for or with you.

Never (0) Rarely (1) Sometimes (2) Often (3)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Someone takes me to play sports or exercise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone exercises or plays active games or sports with me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone encourages me to exercise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone watches me exercise, play active games, or do sports.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone congratulates or tells me I am doing well with my exercise,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>physical activity, or sports.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone plans things to help me be physically active (brings friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>over; sets up car pool).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone pays money for physical activities or sports for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone buys clothes or equipment for me so I can be physically active</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or do sports.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now, choose who helps you to exercise, be active, or do sports by doing things for or with you.

You may choose as many people as you want to show who helps you.

- Father
- Step-father
- Mother
- Step-mother
FEMALE TEENS STEP IT UP WITH FITBIT ZIPS

☐ Brother
☐ Step-brother
☐ Sister
☐ Step-sister
☐ Gym teacher, other teacher, or coach
☐ Friends or others close to my age
☐ Other family member (cousin; uncle or aunt; grandparent)
☐ Other non-family member, such as doctor or nurse

Scoring: Add the scores and divide by number of items, the higher the score - the greater the social support for physical activity. Provided as a Word document and permission granted to use the scale by Dr. Lorraine Robbins on October 7, 2016.
Appendix G: Commitment for Physical Activity Scale for Adolescents (CPASA)

Commitment for Physical Activity Scale for Adolescents (CPASA)

Directions: CIRCLE how often you do each of the following activities related to physical activity (never, rarely, sometimes, or often).

1. I try to get better at doing physical activity.
   Never                  Rarely Sometimes               Often

2. If I stop doing physical activity, I can start up again.
   Never                  Rarely Sometimes               Often

3. I try to make physical activity fun.
   Never                 Rarely       Sometimes             Often

4. I change my physical activity to avoid getting bored.
   Never                  Rarely Sometimes               Often

5. I think about the fun I have when I do physical activity.
   Never                  Rarely Sometimes               Often

6. I like thinking about doing physical activity.
   Never                  Rarely Sometimes               Often

7. Physical activity is one of the best parts of my day.
   Never                  Rarely Sometimes               Often

8. I would change my schedule so I can do physical activity.
   Never                  Rarely Sometimes               Often

9. My day is better when I am physically active.
   Never                  Rarely Sometimes               Often

10. I make time for physical activity.
    Never                  Rarely Sometimes               Often

11. I get my clothes, shoes, or other items ready as needed for physical activity.
    Never                  Rarely Sometimes               Often
FEMALE TEENS STEP IT UP WITH FITBIT ZIPS

Scoring: Add the scores and divide by number of items, the higher the score - the greater the commitment to be physically active. Provided as a Word document and permission granted to use the scale by Dr. Lorraine Robbins on October 7, 2016.
FEMALE TEENS STEP IT UP WITH FITBIT ZIPS

Appendix H: Activity Journal

Directions:

Please write in your activity journal once per day. Also, please try to remember to wear your Fitbit Zip every single day, for the whole day. If you forget, just know that it is important to wear your Fitbit Zip at least four days each week and for at least 8 hours per day.

1. Fill in the date
2. Fill in the activity and the amount of time it took or none if you didn’t do any activities
3. Fill in where (on your clothes) you wore your Fitbit Zip – you can leave the entry blank if the Zip placement doesn’t change
4. Fill in about how long you wore your Fitbit Zip

<table>
<thead>
<tr>
<th>Date</th>
<th>Amount of Other Activity*</th>
<th>Fitbit Zip Placement</th>
<th>Fitbit Wear Times**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/17</td>
<td>None</td>
<td>Right hip</td>
<td>9:00 AM 10:00 PM</td>
</tr>
<tr>
<td>1/2/17</td>
<td>None</td>
<td></td>
<td>7:00 AM 10:00 PM</td>
</tr>
<tr>
<td>1/3/17</td>
<td>Biked – 20 minutes</td>
<td></td>
<td>7:00 AM 9:00 PM</td>
</tr>
<tr>
<td>1/4/17</td>
<td>None</td>
<td>Left bra strap</td>
<td>4:00 PM 10:00 PM</td>
</tr>
<tr>
<td>1/5/17</td>
<td>Swim – 30 minutes</td>
<td>Right hip</td>
<td>7:00 AM 11:00 PM</td>
</tr>
<tr>
<td>1/6/17</td>
<td>None</td>
<td>Forgot</td>
<td></td>
</tr>
<tr>
<td>1/7/17</td>
<td>Tennis – one hour</td>
<td></td>
<td>10:00 AM 9:00 PM</td>
</tr>
</tbody>
</table>

*Name of activity and the amount of time spent at the activity

**Please use AM for morning and PM for evening. Write forgot if you didn’t wear it that day.

This first page is an example of a week’s worth of entries into your activity journal.

This information is important because some activities do not get measured accurately (in steps) with the Fitbit Zip. For example, activities such as bicycling, swimming, skating, etc. are not based on step counts. Please make sure to include these activities in this journal.

Thank you!
Appendix I: Examples of Text Messages

Examples of text messages (added various Emojis):

Good morning! Please remember to wear your Fitbit Zip today. I hope you have a great day!

Good night! Please remember to take off your Fitbit Zip and write in your activity journal. Thank you!