Novel Exploration of Temporal Relationships Between Self-Worth and Physical Activity in Middle-Aged Women

by

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ABSTRACT

Research provides increasing support of self-worth, non-physical motives, and body image for predicting physical activity in women. However, no empirical tests of these associations have been conducted. Ecological momentary assessment (EMA) has been recognized as useful for understanding correlates of physical activity. This study tested the feasibility of a novel EMA protocol and explored temporal relationships between daily self-worth and physical activity in middle-aged women. Women aged 35-64 years (N=63; *M* age=49.2±8.2 years) received text message prompts to an Internet-based mobile survey three times daily for 28 days. The survey assessed momentary activity, self-worth (knowledge, emotional, social, physical, general), and self-efficacy. Women concurrently wore an accelerometer on their non-dominant wrist. Feasibility was assessed via accelerometer wear-time estimates, survey completion rates, and participant feedback. Multilevel models examined the predictive influence of self-worth on daily activity counts. Self-efficacy was also tested due to known relationships with self-worth and physical activity in women. Wear time was high (952.92 ± 100.99 min per day), with only 141 observations lost to non-wear. However, 449 were lost to accelerometer malfunction. Women completed 80.8% of surveys. After excluding missing physical activity data, 67.5% of observations (N=3573) were analyzed. Although women thought the survey was easy to complete, perceptions of the accelerometer were mixed. Approximately 34% of the variance in daily counts was within individuals (ICC=0.66). Average self-efficacy *(β*=0.005, *p*=0.009), daily fluctuations in self-efficacy (*β*=0.001, *p*<0.001), and daily fluctuations in general self-worth (*β*=0.04, *p*=0.003)

predicted daily activity. There were significant individual differences in relationships between daily fluctuations in emotional (β=0.006, p=0.02) and general self-worth (β=0.005, p=0.02) and daily activity. The use of text message prompts and an Internet-based mobile survey was feasible for conducting EMA in middle-aged women. Research identifying optimal methods of behavior monitoring in longitudinal studies is needed. Results provide support for small but significant associations among daily fluctuations in self-efficacy and general self-worth and daily activity in middle-aged women. The impact of emotional self-worth may differ across women. Further research examining the transient natures of self-efficacy and general self-worth, improving self-worth scales, and testing momentary strategies to increase women's self-worth and physical activity is warranted.

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TABLE OF CONTENTS

Page

LIST OF TABLES x

LIST OF FIGURES xi

OPERATIONAL DEFINITIONS xii

CHAPTER

1 INTRODUCTION 1

Statement of the Problem 1

Scope 2

Specific Aims 9

2 LITERATURE REVIEW 11

Development of the Conceptual Framework 11

Self-Worth and Physical Activity in Women 19

Evidence to Date 20

Bidirectional Relationships 22

Non-Physical Self-Worth and Physical Activity 24

Ecological Momentary Assessment 30

Definitions and Concepts 30

Justification of EMA 36

3 METHODS 40

Study Design 40

Participants 41

CHAPTER Page

Inclusion Criteria 41
Recruitment 42
Human Subjects 42
Instrumentation 42
Demographics 42
Key Predictors 43
Physical Activity 46
Usability 47
Procedures 48
Pilot Phase 48
Test Phase 51
Data Processing 54
Physical Activity 54
Mobile Surveys 55
Data Analysis 56
Baseline Data 56
Analysis for Specific Aim 1 56
Analysis for Specific Aim 2 57
Analysis for Specific Aim 3 57
4 RESULTS 63
Pilot Phase 63

CHAPTER Page

Test Phase 67
Demographics 67
Specific Aim 1 70
Physical Activity Monitor Compliance 70
Mobile Survey Completion 72
Usability Results 75
Specific Aim 2 77
Specific Aim 3 77
5 DISCUSSION 93
Summary of Findings 93
Specific Aim 1 93
Physical Activity Monitor Compliance 94
Mobile Survey Completion 98
Limitations of the Approach 104
Specific Aims 2 and 3 105
Knowledge Self-Worth 106
Emotional Self-Worth 107
Social Self-Worth 108
Physical Self-Worth 109
General Self-Worth 111
Self-Efficacy 114

CHAPTER Page

Physical Activity 115

Implications for Future Research 116

Strengths and Limitations 121

Conclusions 123

REFERENCES 125

APPENDIX

A INSTITUTIONAL REVIEW BOARD APPROVAL 136

B ADDITIONAL TABLES/FIGURES 138

C MOBILE SURVEY 147

D USABILITY SURVEYS 153

E PARTICIPANT WEAR LOG 165

F EXAMPLE PARTICIPANT HANDOUT 168

G QUALTRICS INTERFACE EXAMPLES 170

LIST OF TABLES

Table Page

1. Review of Literature Examining Relationships between Self-Worth and Physical Activity in Women 139
2. Pilot Phase and Test Phase Items for Ecological Momentary Assessments 49
3. Pilot Phase Sampling Scheme 51
4. Pilot Phase Sample Descriptive Characteristics 64
5. Pilot Phase: Between- and Within-Person Variance in Key Predictors 67
6. Test Phase Sample Descriptive Characteristics 68
7. Test Phase Baseline Assessments 70
8. Descriptive Statistics of Responses to EMA Survey (N=59) 145
9. Satisfaction Survey Results 76
10. EMA Survey Inter-Item Correlations 80
11. Preliminary Mixed Models Associated with Daily Activity Counts 81
12. Associations between Knowledge Self-Worth and Daily Activity Counts 83
13. Associations between Emotional Self-Worth and Daily Activity Counts 85
14. Associations between Physical Condition and Daily Activity Counts 87
15. Associations between Body Attractiveness and Daily Activity Counts 88
16. Associations between General Self-Worth and Daily Activity Counts 91
17. Final Mixed Models Associated with Daily Activity Counts 92

LIST OF FIGURES

Figure Page

1. Self-Worth and Physical Activity Conceptual Model 4
2. Exercise and Self-Esteem Model 16
3. Revised Self-Worth Conceptual Model for Physical Activity 32
4. Proposed Framework to Explain Relationships between Self-Worth and Physical Activity 39
5. Interface of Current Activity Item 47
6. Examples of Text Message Prompts and Qualtrics Mobile Interface 54
7. Distribution of Total Daily Activity Counts Before and After Transformation 59
8. Pilot Phase: Distribution of Daily Activity over 14 Days 66
9. Test Phase Flow of Participants 69
10. Breakdown of Daily Wear and Activity Estimates (Minutes) 71
11. Valid Observations across 28 Days 73
12. Flow of Observations 74
13. Daily Activity Counts across 28 Days 79

OPERATIONAL DEFINITIONS

Ecological momentary assessment. Range of methods and methodological traditions data are collected in real-world environments as subjects go about their lives to examine current, real-time states and the influence of time, situations, and contexts on current states (Shiffman, Stone, & Hufford, 2008).

Emotional self-worth. Self-worth related to a woman's ability to deal with life stressors and other emotional challenges associated with physical activity (e.g., happiness related to self-prioritization and access to resources, impact of physical activity on how one feels about herself, impact of feeling better about oneself on physical activity participation) (Huberty, Vener, Gao, Matthews, Ransdell, & Elavsky, 2013b).

Exercise. Subcategory of physical activity that consists of planned, structured, and repetitive movements that result in improved physical fitness (Caspersen, Powell, & Christenson, 1985). Examples of exercise include walking on a treadmill or participating in a group fitness class.

Inactive. No reported physical activity (Centers for Disease Control & Prevention [CDC], 2014).

Intrinsic motives. Goals related to social interactions, personal growth, and community contribution, and are closely associated with basic needs satisfaction (Deci & Ryan, 2000).

Knowledge (academic) self-worth. Self-worth relative to women's knowledge about physical activity (e.g., planning a physical activity program, benefits of physical activity, knowledge of injury risk) (Huberty et al., 2013b).

Leisure-time physical activity. Structured activities performed outside of one's occupation or everyday lifestyle routine (Hurd & Anderson, 2011).

Lifestyle physical activity. Bouts of light, moderate, or vigorous activity integrated into one's lifestyle. Examples of lifestyle physical activity include walking/bicycling to work or taking the stairs (Dunn, Anderson, & Jakicic, 1998).

Physical activity. Any bodily movement produced by the skeletal muscles that results in energy expenditure and includes light (e.g., general walking, light house cleaning, yoga, bowling), moderate (e.g., brisk walking, easy cycling, easy swimming), and high intensity (e.g., running, lap swimming, basketball, calisthenics) activities (Ainsworth et al., 2011; Caspersen et al., 1985).

Physical self-worth. Feelings of pride, self-respect, satisfaction, and confidence in one's physical self (Fox & Corbin, 1989).

Quality of life. Cognitive judgment of satisfaction with one's life (McAuley et al., 2008).

Regular physical activity. At least 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity per week (CDC, 2011b).

Self-concept. Person's perceptions of him- or herself (Marsh & Shavelson, 1985; Shavelson, Hubner, & Stanton, 1976).

Self-efficacy. An individual's perceived capacity to carry out a behavior (Bandura 1997, 2004).

Self-worth. One's positive perceptions of personal worth or worthiness (Fox, 1997; Rosenberg, 1965); often used interchangeably with the term self-esteem (Fox, Boutcher, Faulkner, & Biddle, 2000).

Social self-worth. Self-worth as it relates to a woman's interactions with others in the context of physical activity (e.g., support of friends and family for physical activity, having someone to be active with, asking others for help related to physical activity) (Huberty et al., 2013b).

Chapter 1

INTRODUCTION

Regular participation in physical activity has many well-known physical health benefits (e.g., weight maintenance, improved sleep quality, reduced risk of hypertension, hypercholesterolemia, Type 2 diabetes) and psychological health benefits (e.g., improved self-worth, mood, positive affect, body image, and quality of life, and reduced risk of depression and anxiety) (Centers for Disease Control & Prevention [CDC], 2011a). Despite these benefits, physical activity levels, especially among middle-aged women, remain low. According to national estimates from the CDC (2010), fewer than 50% of middle-aged women (35-64 years) participate in regular amounts of physical activity to achieve these health benefits. Further, only 25% of middle-aged women participate in regular leisure physical activity, while approximately 13% are classified as completely inactive. Sadly, national estimates of women's physical activity via objective monitoring (i.e., accelerometers) are more sobering. According to the 2003-2004 National Health and Nutrition Examination Survey (NHANES), only 3.2% of adult women currently meet federal physical activity guidelines (Troiano, Berrigan, Dodd, Mâsse, Tilert, & McDowell, 2008). As a result, middle-aged women represent one of the least active populations in the U.S., with lower rates of physical activity participation when compared with men and their younger counterparts (CDC, 2010).

Unfortunately, physical activity levels generally decrease during middle-age, while weight increases and the symptoms of aging become more apparent (Fox, 2000). Low physical activity levels during this period may lead to the emergence of chronic

disease (e.g., cardiovascular disease, cancer) during middle-age or later in life. Physical activity participation during middle-age, on the other hand, may delay the onset of these conditions and improve women's quality of life as they age, even among women who were sedentary prior to middle-age (White, Wójcicki, & McAuley, 2012). Further, middle-aged women often benefit from decreased familial responsibilities and begin to refocus on themselves and their health, making this an auspicious time to promote physical activity behavior change. Recent research also indicates there is a need to develop a better understanding of middle-aged women's physical activity behaviors in order to promote increased activity into old age (White et al., 2012). Therefore, efforts to further examine correlates of middle-aged women's physical activity participation are needed in order to design interventions that better motivate women to adopt and sustain adequate physical activity levels.

Research indicates the psychological benefits of regular physical activity, such as enhanced self-worth and quality of life, may be specifically salient among women and provide an important opportunity to better motivate women to participate in regular amounts of physical activity to achieve physical health benefits (Fox et al., 2000). Specifically, a large body of research provides unequivocal evidence that women are more likely to maintain regular physical activity if they have high levels of self-efficacy (Elavsky, 2009; McAuley, 1993; McAuley & Blissmer, 2000; McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003; White, Ransdell, Vener, & Flohr, 2005), social support (Eyler et al., 2002; Vrazel, Saunders, & Wilcox, 2008; White et al., 2005), and intrinsic motivation (Huberty et al., 2008a; Segar, Eccles, & Richardson, 2008). A

growing body of literature also supports the roles of enhanced self-worth, positive body image, and non-physical physical activity motives (e.g., enjoyment, quality of life) for predicting long-term physical activity participation in women (Huberty et al., 2008a; Segar et al., 2008; Segar, Spruijt-Metz, & Nolen-Hoeksema, 2006). Despite this recent evidence, few studies have empirically tested self-worth and non-physical motives as determinants of physical activity participation in middle-aged women (Huberty, Vener, Gao, Matthews, Ransdell, & Elavsky, 2013b; Segar et al., 2008).

Self-worth is defined as the degree to which one feels positively or negatively towards oneself and is often used interchangeably with the term self-esteem (Fox et al., 2000). Self-worth is a multidimensional construct comprised of the academic, emotional, social, and physical domains (Figure 1). Despite the contributions of all four domains to overall self-worth (i.e., general self-worth) (Shavelson et al., 1976), physical activity research has focused on the physical domain only. Indeed, a long line of research provides robust evidence that regular participation in physical activity results in improvements in physical self-worth, which mediates improvements in overall self-worth (i.e., general self-worth) (Elavsky, 2009; Elavsky & McAuley, 2007; Gothe et al., 2011; McAuley, Elavsky, Motl, Konopack, Hu, & Marquez, 2005; McAuley, Mihalko, & Bane, 1997). This research also indicates that enhancements in physical self-worth as a result of physical activity participation may result in improvements in positive affect and quality of life among middle-aged women (Elavsky, 2009; Elavsky et al., 2005), benefits of physical activity that are important to women's healthy aging (White et al., 2012). Therefore, self-worth may represent an important target for physical activity

interventions in middle-aged women. Figure 1 illustrates the current self-worth model, representing the culmination of early theoretical works in education (i.e., multidimensional and hierarchical nature of self-worth) and applied research in physical activity participation (i.e., structure of and relationships within the physical domain of self-worth).

Although earlier theoretical works have recognized self-worth as both a predictor and outcome of behavior (Shavelson et al., 1976), most research in physical activity has tested self-worth as an outcome only. However, researchers have acknowledged the need to test the bidirectionality of the self-worth/physical activity relationship (Elavsky & McAuley, 2007; Shavelson et al., 1976; Sonstroem & Morgan, 1989). In one of the few studies to test the influence of self-worth on physical activity participation, Sontroem, Harlow, & Josephs (1994) observed that self-worth in the physical subdomains predicted

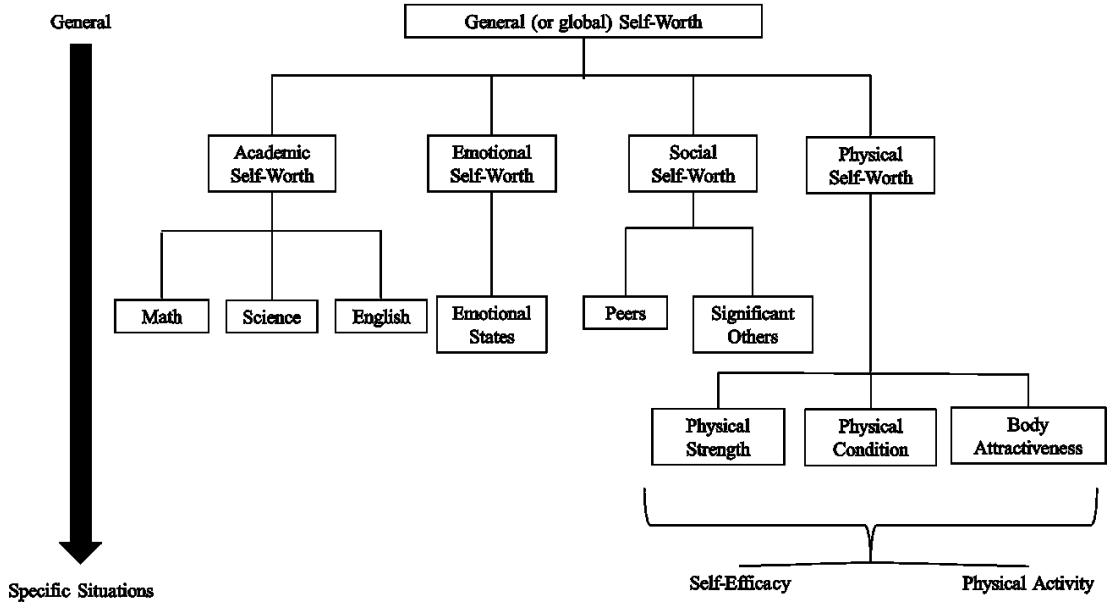


Figure 1.

Self-Worth and Physical Activity Conceptual Model

women's participation in exercise. This study corroborated tenets of the self-enhancement theory and earlier research in educational settings (Marsh, 1990) indicating that individuals tend to participate in behaviors that are aligned with their self-perceptions (Sonstroem et al., 1994). Several studies by Huberty and colleagues (2008a; Huberty, Vener, Schulte, Roberts, Stevens, & Ransdell, 2009; Huberty, Ehlers, Coleman, Gao, & Elavsky, 2013a) have also suggested that middle-aged women who remain active long-term (i.e., one to three years after participating in a physical activity program) do so for reasons related to their self-worth. Thus, more research testing the predictive nature of self-worth on physical activity participation in middle-aged women is needed.

Research also suggests that the non-physical domains of self-worth (i.e., academic, emotional, social), in addition to physical self-worth, may be associated with women's physical activity participation (Huberty et al., 2008b; Segar et al., 2008). Researchers in other fields (e.g., education) have consistently examined self-perceptions relative to a particular behavior across all four domains (Marsh & Shavelson, 1985; Marsh et al., 1988, 1989); however, few physical activity researchers have adopted such an approach. A recent intervention by Huberty and colleagues (2008b, 2010) successfully utilized a non-physical self-worth approach to improve physical activity levels in multiple cohorts of middle-aged women. Additional research suggests that middle-aged women with physical motives (e.g., weight loss, body attractiveness, health) may be less likely to participate in physical activity long-term as compared to women with non-physical motives, such as enjoyment, quality of life, and stress relief (Segar et al., 2006, 2008). Physical motives may cause women to feel pressured to lose weight or change

their appearance, for example, and may weaken a woman's self-worth (Segar, Eccles, & Richardson, 2011), leading to dropout from exercise programs and limited physical activity participation. Similarly, other studies have provided evidence that intrinsic physical activity goals (e.g., improving physical activity skills, developing meaningful relationships) are not only related to improved physical activity participation among middle-aged adults, but to improvements in physical self-worth and psychological well-being as well (Sebire, Standage, & Vansteenkiste, 2009). Therefore, efforts are needed to help women adjust the focus of their physical activity motives from the physical to the non-physical. This may help women enhance their self-worth and better adhere to regular physical activity.

Because empirical research in this area is somewhat limited, further investigation of associations between the non-physical self-worth domains (i.e., academic, emotional, and social) and middle-aged women's physical activity participation is warranted. Until recently no measures existed to investigate these associations in women; however, a recent questionnaire developed by Huberty and colleagues (2013b) provides the opportunity to examine self-worth in the context of physical activity behaviors across all four domains. Findings of future research in this area may inform the design of innovative interventions that better motivate middle-aged women to participate in regular amounts of physical activity to achieve health benefits.

Ecological momentary assessment (EMA) presents a novel and potentially suitable approach for measuring unexplored associations between self-worth and physical activity, such as a potential bidirectional relationship and correlations between non-

physical self-worth and physical activity. EMA refers to a range of methods in which data are captured in real-world settings (ecological), focus on the subject's current state (momentary), and can provide information on experiences and behaviors across time and contexts. EMA utilizes multiple daily assessments across several days and is, therefore, most appropriate for measuring complex, dynamic behavioral correlates (Shiffman et al., 2008). Although general self-worth is thought to be a stable construct, self-worth at the domain level (i.e., academic, emotional, social, physical) and subdomain level (e.g., English, emotional states, significant others, physical condition) (Figure 1) varies across situations, time, and contexts (Marsh & Shavelson, 1985; McAuley et al., 1997). Physical activity research has provided some support for these theoretical suppositions, suggesting that the physical activity contexts, such as the frequency, intensity, and type of physical activity, may be related to women's physical self-worth (Elavsky & McAuley, 2007; Gothe et al., 2011; McAuley et al., 1997; Sonstroem et al., 1994). For example, interventions targeting aerobic fitness may result in better improvements in physical condition self-worth as opposed to physical strength self-worth (Elavsky & McAuley, 2007; McAuley et al., 1997). Unfortunately, studies have relied upon self-report measures of self-worth administered before and after interventions. Assessing women's self-worth states more frequently and in real time may provide a more accurate description of interactions between self-worth and physical activity. Therefore, EMA methods may be useful in uncovering useful information about the self-worth/physical activity relationship to guide future interventions for middle-aged women.

The ubiquity of mobile phone use has made EMA more available, less burdensome for participants, and more valid (Dunton, Liao, Kawabata, & Intille, 2012; Kuntsche & Labhart, 2013). Further, electronic EMA approaches, such as mobile phones, have gained popularity for assessing psychosocial correlates of physical activity (e.g., mood, affect) (Dunton, Atienza, Castro, & King, 2009; LePage & Crowther, 2010). This modest body of literature has demonstrated the feasibility of electronic EMA administration in both young and old populations (Dunton et al., 2012; Kanning, Ebner-Priemer, & Schlicht, 2013). Despite the growing popularity, EMA methodologies have not been used to examine self-worth in the context of physical activity participation. Researchers have suggested that EMA is specifically useful for better understanding the antecedents and consequences of physical activity and that research of this nature is of theoretical and practical importance (Kanning et al., 2013). Therefore, EMA may provide an exciting and innovative opportunity to investigate both the bidirectionality of the self-worth/physical activity relationship and associations between physical activity and the non-physical domains and subdomains.

This research is significant because it proposes the employment of novel assessment methods (EMA) to uncover more information about an understudied, but promising correlate of physical activity participation in middle-aged women. The findings of this study may result in important implications for future interventions aimed at improving physical activity participation and quality of life in middle-aged women. Therefore, the overall purpose of this study was to utilize EMA methods delivered via mobile phones to explore the influence of self-worth on physical activity participation in

middle-aged women (aged 35-64 years). Taken together, the following aims may provide the necessary information to not only inform the development of a subsequent ecological momentary intervention, but also to refine existing theoretical models regarding the self-worth/physical activity relationship. Such information may have important implications for helping middle-aged women to adopt a regular physical activity regimen. Improvements in regular physical activity participation during middle-age may, in turn, help women to achieve a higher quality of life as they age (CDC, 2011; White et al., 2012). The specific aims of this study were:

Aim 1: To explore the feasibility of an EMA protocol administered via text messaging and a mobile Internet-based survey for measuring physical activity and psychosocial correlates in middle-aged women (35-64 years-old).

Aim 2: To explore temporal relationships between self-worth and physical activity participation in middle-aged women (35-64 years).

Aim 3: To explore associations between self-worth in the non-physical domains (i.e., academic, emotional, social) and physical activity participation in middle-aged women (35-64 years).

In order to better understand the need to test the above aims, further literature review is provided in the next chapter. First, the review outlines in detail the theoretical background of the self-worth model currently applied within physical activity research. Next, the review examines available literature related to self-worth and physical activity participation in middle-aged women, including evidence to date and areas warranting further research in middle-aged women. The next section of the review is dedicated to a

discussion of the key aspects of EMA methods and designs. Finally, the second chapter concludes with a review of physical activity studies that have employed EMA methods.

Chapter 2

LITERATURE REVIEW

This chapter provides justification for the testing of the aims stated in Chapter 1. The first section describes the history of the development of the self-worth model. The next section provides an in-depth review of the literature related to self-worth and physical activity in women, including justification for this study based upon this literature. The third section consists of a discussion of EMA, including definitions of concepts, types of sampling designs, and evidence-based recommendations for conducting assessments. The final section provides a review of the literature that has included EMA methodologies to examine physical activity participation and contexts and/or dynamic psychosocial correlates of physical activity participation. Together, the literature reviews of self-worth and EMA informed the methods presented in Chapter 3.

Self-Worth and Physical Activity: Development of a Conceptual Framework

The term self-worth is derived from literature on self-concept (Shavelson et al., 1976) and self-esteem (Rosenberg, 1965). While self-concept is a more neutral term for how one thinks about the self, self-esteem refers to one's positive perceptions of personal worth or worthiness (Fox, 1997; Rosenberg, 1965). Such perceptions often explain and predict one's behavior, which then reciprocally can influence self-perceptions (Shavelson et al., 1976). Self-worth is often regarded as a synonym of self-esteem and, as such, is generally used interchangeably with self-esteem. Self-worth in relation to physical activity participation has been well-studied for the past 30+ years, culminating in a comprehensive body of knowledge indicating that regular physical activity participation

yields improvements in physical self-worth and, over a long period of time, general self-worth as well (McAuley et al., 2005; Sonstroem et al., 1994; Sonstroem & Morgan, 1989). The contemporary model of self-worth used by most physical activity researchers is derived from the self-concept model developed by Shavelson and colleagues' (1976) and expanded upon by Marsh (Marsh, 1990, 1992; Marsh & O'Neill, 1984; Marsh & Shavelson, 1985; Shavelson & Marsh, 1986). The model suggests that self-worth is multidimensional, hierarchical, stable, evaluative, and organized (Figure 1).

Self-worth is considered multidimensional in that an individual may have different levels of self-worth in different situations. As a result, researchers have identified four self-worth domains (i.e., academic, emotional, social, and physical), in addition to several subdomains (e.g., math, sport competence) (Figure 1). In examining the multidimensional structure of self-concept within educational settings, Marsh & Shavelson (1985) determined that the self-concept domains and subdomains were distinct, unrelated constructs. For example, an individual may have different levels of self-worth (at the domain level) in relation to academics versus exercise (academic domain v. physical domain) (Marsh & Shavelson, 1985; Shavelson et al., 1976). Likewise, an individual may have different levels of self-worth at the subdomain level in relation to aerobic exercise versus strength training (physical condition subdomain v. physical strength subdomain) (Elavsky & McAuley, 2007; McAuley et al., 1997). Therefore, measures that have the ability to assess various self-worth domains and subdomains in the context of particular behaviors (e.g., physical activity) may be critical

to our understanding of relationships between self-worth and behaviors (Marsh, 1992; Marsh & O'Neill, 1984).

The subdomains and domains contribute to the hierarchical structure of self-worth because perceptions at the lower end of the model converge to formulate a general (or global) self-worth. In other words, specific situations and interactions may, over time, contribute to an individual's overall perceptions of their self-worth. For example, the satisfaction of completing an exercise class may contribute to improved feelings of physical condition, and if repeated enough, may contribute to improved physical self-worth and ultimately improved general self-worth (Sonstroem et al., 1994).

It is at this global level that self-worth becomes stable across situations and time and is relatively impervious to intervention (McAuley et al., 1997). Because of this stability, it may not be beneficial to either target or measure general self-worth over the course of an intervention. Research recognizes, however, the less stable nature of the self-worth domains and subdomains within individuals across situations (Shavelson et al., 1976). The domains and subdomains of self-worth may, therefore, be important targets for intervention and may provide a more meaningful assessment of the contribution of interventions to changes in self-worth (Marsh, 1986, 1992; Marsh & Shavelson, 1985). However, some research suggests it may be prudent to assess the effects of long-term behavior change on general self-worth over long-term follow-up periods (McAuley et al., 2005).

Self-worth is evaluative in that its descriptive properties are not discernible from its evaluative properties (Shavelson et al., 1976). In other words, an individual cannot

describe her self-worth without evaluating her perceived worthiness. It is, in fact, this evaluative property that separates self-worth from self-concept (Marsh & Shavelson, 1985). Finally, self-worth is considered organized because individuals typically organize and reduce experiences to more understandable and usable forms of perceiving themselves (Shavelson et al., 1976; Sonstroem & Morgan, 1989). This is sometimes referred to as self-consistency (Fox, 1997).

Shavelson and colleagues' (1976) model of self-concept and corroboratory research conducted by Marsh (1990; Marsh & Shavelson, 1985; Shavelson & Marsh, 1986) provided the multidimensional and hierarchical foundation of self-worth that physical activity researchers have utilized to explain physical activity's contribution to physical self-worth and general self-worth. Findings of this foundational research also suggested that behaviors related to one domain, such as academics, may be most correlated with self-concept within that domain and less related to self-concept within the other domains (Marsh & O'Neill, 1984; Marsh & Shavelson, 1985). In other words, achievements in Math and English may be most related to academic self-concept and less able to explain emotional, social, or physical self-concept. Based on this evidence, physical activity researchers have adopted a self-worth model focusing exclusively on the physical domain.

After reviewing overwhelming evidence in support of the influence of physical activity on improved general self-worth (Sonstroem, 1984), Sonstroem and Morgan (1989) proposed the Exercise and Self-Esteem Model (EXSEM) to examine how and why enhancements in self-worth occur as a result of physical activity participation. The

EXSEM provided the first working framework to investigate the underlying mechanisms explaining this association (Figure 2). According to the EXSEM, improvements in physical self-efficacy after physical activity result in improved physical competence for physical activity, which is directly and indirectly (through physical appearance) linked to global self-esteem (i.e., general self-worth) (Sonstroem & Morgan, 1989; Sonstroem et al., 1994). Physical self-efficacy refers to an individual's perceived capacity to carry out physical activity behaviors (McAlister, Perry, & Parcel, 2008; Sonstroem & Morgan, 1989). Physical competence is defined as "a general evaluation of the self as possessing overall physical fitness" (Sonstroem & Morgan, 1989 p. 334). The model also includes physical acceptance as a result of previous research suggesting that feelings of satisfaction or dissatisfaction with one's body and appearance may be related to general self-worth.

Fox and Corbin (1989) simultaneously proposed a model of physical self-worth in which four subdomains of physical self-worth replaced the unidimensionality of physical competence and physical acceptance posited in the EXSEM. These four subdomains include: physical condition, physical strength, body attractiveness, and sport competence (Figure 1). Further, observations suggested that each self-worth subdomain may be significantly correlated with related types of physical activity and varying degrees of physical activity levels. For example, individuals with higher sport competence were more likely to participate in sports activities. These findings were subsequently corroborated by other physical activity researchers who observed differential self-worth

ratings within the physical domain based upon the type of activity promoted within interventions (Gothe et al., 2011; McAuley et al., 2000a).

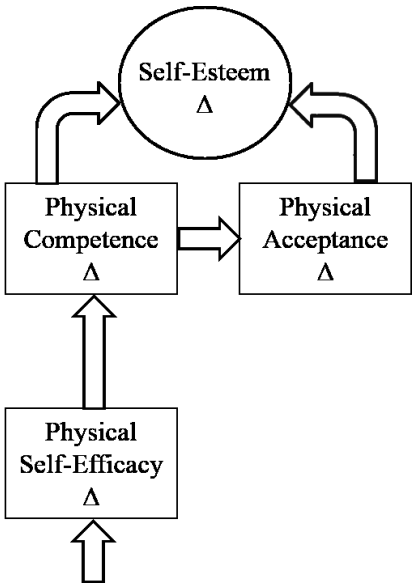


Figure 2. Exercise and Self-Esteem Model (Replicated from Sonstroem & Morgan, 1989)

Fox & Corbin's (1989) model also resulted in the development of the Physical Self-Perception Profile (PSPP), which provided the opportunity to assess physical self-worth in relation to its multidimensional and hierarchical nature. The PSPP consists of five subscales measuring the four subdomains and the overall physical domain of self-worth. This research provided an integral advancement in the knowledge base related to physical activity and self-worth because exercise psychologists now had the ability to better explore the mechanisms behind the relationship between physical activity and self-worth. Although other physical self-perception scales are available (e.g., Physical Self-Description Questionnaire [PSDQ] (Marsh, Richards, Johnson, Roche, Tremayne, 1994)), a large number of studies have utilized (and continue to utilize) the PSPP to measure

physical self-worth (Table 1, Appendix B), establishing its reliability and validity in a variety of populations, including middle-aged women (Elavsky & McAuley, 2007).

Further work by McAuley and colleagues (McAuley et al., 1997, 2000a, 2005) has both substantiated and expanded upon the theoretical perspectives proposed by the EXSEM (Sonstroem & Morgan, 1989; Sonstroem et al., 1994) and PSPP (Fox & Corbin, 1989). In the context of a 5-month exercise intervention for middle-aged adults, McAuley and colleagues (1997) confirmed the multidimensional and hierarchical structure of self-worth. Improvements in self-worth within the physical subdomains were greatest when compared with changes in the physical domain and in general self-worth. Additionally, the relationship between self-worth within the subdomains and general self-worth was mediated by physical self-worth (as posited by Fox & Corbin (1989)). Further, among the physical subdomains, physical condition and body attractiveness had the largest contributions to changes in physical and general self-worth. In line with these findings, other research in educational and physical activity settings has suggested that for many people, especially women, body attractiveness may be synonymous with general self-worth (Elavsky & McAuley, 2007; Moore, Mitchell, Beets, and Bartholomew, 2012). McAuley and colleagues (1997) provided preliminary evidence of the power influences of physical condition and body attractiveness on self-worth in the context of physical activity participation.

Recent research has further supported the validity of the EXSEM and the impact of subdomains on self-worth in a variety of populations, using the PSPP (Elavsky & McAuley, 2007; Gothe et al., 2011; McAuley et al., 2000a, 2005; Opdenacker, Delecluse,

& Boen, 2009) and other measures of physical self-worth (Moore et al., 2012). For example, Moore and colleagues (2012) examined the EXSEM using Marsh and colleagues' (1994) PSDQ model of self-concept comprised of nine subdomains including: physical strength, physical attractiveness, physical endurance, athletic ability, physical flexibility, body fat, coordination, physical activity, and physical health. Findings of this study provided further evidence in support of the EXSEM. Results indicated that the physical self-worth subdomains mediated the association between physical activity and physical self-worth, and physical self-worth mediated the association between the subdomains and general self-worth. This study also provided additional support for the role of body attractiveness (i.e., physical attractiveness) as a predictor of physical self-worth (Elavsky& McAuley, 2007; Hayes, Crocker, & Kowalski, 1999; McAuley et al., 2005; Opdenacker et al., 2009).

McAuley and colleagues (1997, 2000a, 2005) also demonstrated that self-efficacy may not mediate associations between physical activity participation and self-worth as proposed by the EXSEM (Sonstroem et al., 1994). Specifically, changes in self-efficacy and physical parameters (e.g., VO_2 max, percent body fat) related to physical activity participation each had direct effects on the self-worth subdomains and physical self-worth (McAuley et al., 1997, 2000a). These results have been confirmed by other studies assessing longitudinal pathways within free-living environments between self-efficacy and physical activity and self-worth constructs (Elavsky, 2009; Gothe et al., 2011; McAuley et al., 2005; Moore et al., 2012). Together the above research has culminated in a physical self-worth model (Figure 1) in which physical activity and self-efficacy may

simultaneously improve physical condition, physical strength, body attractiveness, and sport competence, which, in turn, influence improvements in physical self-worth and, over a long period of time, general self-worth. This research also suggested that, among the physical self-worth subdomains, physical condition and body attractiveness may be most relevant to self-perceptions among middle-aged women (Elavsky, 2010; Elavsky & McAuley, 2007). The following sections expand upon the evidence that has informed the self-worth model to further illuminate important model components related to women's physical activity and to propose potential new areas of emphasis for improving self-worth and physical activity in middle-aged women.

The Self-worth Model and Physical Activity: Applications to Women

Table 1 (Appendix B) presents a review of the literature related to self-worth and physical activity including: self-worth in the context of physical activity in adult women generally, women in comparison with men, and middle-aged women specifically. Further detail related to the latter is presented in the following sections. According to the literature, self-worth may be an important predictor and outcome of physical activity adoption and adherence in middle-aged women (Elavsky & McAuley, 2005, 2007; Elavsky, 2009, 2010; Huberty et al., 2008a, 2008b, 2009, 2010, 2013a). Research also indicates that some physical activity motives and expectations (e.g., guilt, weight loss, physical appearance) that have been associated with self-worth may be counterproductive to women's continued participation in physical activity (Elavsky, 2009; Huberty et al., 2008a, 2013a; Segar et al., 2006, 2008; Segar et al., 2011). The following provides discussion of the major findings related to self-worth and physical activity in women, the

potential bidirectionality of the self-worth/physical activity relationship, and the potential relevance of the non-physical self-worth domains and subdomains to general self-worth and women's physical activity participation.

Evidence to date. Most of the research examining self-worth and physical activity in women has used the EXSEM (Sontroem & Morgan, 1989; Sonstroem et al., 1994) and PSPP (Fox & Corbin, 1989) to understand the relationship between self-worth and physical activity. For example, Elavsky & McAuley (2007), in a sample of middle-aged women, demonstrated that the effects of physical activity and self-efficacy on women's physical and general self-worth were mediated by the physical subdomains (i.e., physical condition, body attractiveness) both at baseline and as a result of a physical activity intervention. Body attractiveness was the strongest predictor of physical self-worth among the participants. This finding has, in fact, been quite consistent across studies examining populations of women (Hayes et al., 1999). Further, self-efficacy operated in parallel with physical activity to improve self-worth. These findings confirmed the theoretical propositions of the EXSEM and PSPP, in addition to refinements related to the stronger influence of particular subdomains, such as body attractiveness, and the independent role of self-efficacy as evidenced by McAuley and colleagues' (2000a, 2005) research.

In a two-year follow-up to the aforementioned study, Elavsky (2009) also demonstrated the long-term impact of physical activity and self-efficacy on physical self-worth in middle-aged women. Activity levels and self-efficacy at post-intervention and follow-up were not only concurrently associated with physical self-worth, but greater

increases in physical activity and self-efficacy were also associated with greater increases in self-worth at follow-up. These findings related to self-efficacy have also been supported by qualitative data from research by Huberty and colleagues (2010, 2013a) in which women reported that long-term improvements in their self-worth were due to increased confidence for physical activity.

Elavsky (2010) also observed that women's perceptions of their physical condition and body attractiveness contributed to their physical self-worth, with the influence of body attractiveness being greatest. Additionally, this study provided evidence that improvements in physical self-worth may also impact positive changes in middle-aged women's quality of life. Other research supports the link between self-worth and quality of life, suggesting that middle-aged women often explain their self-worth in terms of their quality of life (Huberty et al., 2008a). Therefore, given the changes that women experience during and immediately following middle-age (e.g., menopause, altered physical mobility), self-worth enhancement may be particularly important to women's healthy aging (i.e., quality of life during old age) (McAuley et al., 2008).

The research discussed above has provided empirical support for the EXSEM and the parallel interaction of self-efficacy and physical activity. However, this research has also provided additional information specific to middle-aged women, including the particular role of body attractiveness in explaining women's self-worth and the influence of self-worth on other important health outcomes, such as quality of life. More recent research has further built upon this evidence to provide justification for the examination

of the bidirectionality of the self-worth/physical activity relationship and the non-physical self-worth domains (i.e., academic, emotional, social).

Bidirectionality of the self-worth/physical activity relationship. Despite early theories distinctly recognizing the bidirectional nature of self-concept in relation to behavior (Shavelson et al., 1976), most physical activity researchers have assessed self-worth as an outcome of physical activity only, with few acknowledging the possible existence of a reciprocal relationship (Elavsky & McAuley, 2007; Sonstroem & Morgan, 1989) (e.g., improved physical activity as an outcome of enhancements in self-worth). In one of the few studies to empirically test the reverse relationship, Sontroem and colleagues (1994) observed that self-worth in the physical subdomains predicted women's participation in exercise. This study corroborated tenets of the self-enhancement theory and earlier research in educational settings (Marsh, 1990) indicating that individuals tend to participate in behaviors that are aligned with their self-perceptions (Sonstroem et al., 1994). Despite this evidence within the EXSEM, additional research examining predictive and/or causal relationships between self-worth and physical activity is limited.

Recent work by Huberty and colleagues (2008a, 2008b, 2009, 2010, 2013a, 2013b) provides some of the only work illuminating the potential bidirectionality of the self-worth/physical activity relationship in middle-aged women. In a qualitative follow-up with middle-aged women who participated in a physical activity intervention one to three years prior, Huberty and colleagues (2008a) observed that women who failed to adhere to physical activity after the program ended attributed their inactivity to low levels

of self-worth. Nonadherers also had more negative body image perceptions, which may have also contributed to their lack of motivation to participate in physical activity. Adherers, on the other hand, reported feeling good about themselves and prioritizing themselves and their need for a high quality of life, and were more accepting of who they were and what they looked like. Huberty and colleagues (2008a) noted that "participants' self-worth was associated with almost all factors related to adherence or nonadherence" (p. 7). This study illuminates the role of self-worth as a possible determinant of middle-aged women's physical activity participation and justifies additional testing of models proposing this relationship.

The results of the follow-up study informed the design an 8-month, theory-based book club intervention targeting self-worth to help middle-aged women improve their physical activity participation (Huberty et al., 2008b, 2010). Self-worth enhancing strategies included encouraging women to value and prioritize themselves and to let go of guilt related to prioritizing their physical activity participation over other commitments/responsibilities. Huberty and colleagues (2008b, 2010) utilized a holistic approach in targeting women's self-worth by including all four of the self-worth domains (i.e., academic, emotional, social, physical). For example, women were encouraged to adopt physical activity motives related to quality of life or the opportunity to socialize with others, as opposed to motives related to their physical appearance. Additional discussion about the non-physical emphasis of the book club's self-worth promotion strategies is presented in the next section. As a result of the book club, women not only demonstrated improvements in their general self-worth and physical activity immediately

following the program, but their self-worth continued to improve one year after the program ended as well. Additionally, women who maintained their activity at one year follow-up attributed their continued physical activity participation to enhancements in their self-worth (Huberty et al., 2009, 2013a). Results of the book club suggest that self-worth may be an important target for interventions aimed at helping women improve their physical activity participation. More research examining the predictive influence of self-worth on middle-aged women's physical activity participation is needed. This relationship is grossly understudied, and findings may have important implications for the design of future physical activity promotion strategies for women.

The non-physical self-worth domains and physical activity participation in women. Although much of the research focusing on the influence of non-physical determinants of women's physical activity participation has only recently become more recognized, early models testing the EXSEM support the findings of recent physical activity researchers. For example, in testing the PSPP, Fox and Corbin (1989) observed that the body attractiveness subdomain was less successful in predicting participants' physical activity levels, indicating that physical activity participation may not necessarily lead to satisfaction with appearance. Despite the strong influence of physical appearance on middle-aged women's self-worth (Elavsky, 2010; Elavsky & McAuley, 2007; Hayes et al., 1999; Moore et al., 2012), this early evidence, in addition to more recent research targeting middle-aged women, suggests that physical activity motives related to appearance may be counterproductive to positive changes in women's self-worth and physical activity (Segar et al., 2006, 2008).

For example, Hayes and colleagues (1999), observed an overwhelming influence of body attractiveness on women's self-perceptions of their physical self-worth; however, body attractiveness was not associated with their physical activity participation. Further research suggests that appearance motivations may actually be negatively associated with women's body satisfaction, body esteem, and overall self-esteem (Strelan et al., 2003) and their participation in physical activity (Segar et al., 2006, 2008). Unfortunately, many women's main reason for participating in physical activity is their appearance (Huberty et al., 2009, 2013a; Segar et al., 2007; Strelan et al., 2003). Segar and colleagues (2006) observed that middle-age women with non-body shape motives reported more physical activity as compared to women with body shape motives, such as body shape, toning, and losing weight. In another study, Segar and colleagues (2008) also observed that goals related to the health benefits of physical activity or weight loss were negatively associated with middle-aged women's physical activity participation over time when compared with physical activity goals related to sense of wellbeing or stress reduction. As a result, Segar et al. (2006, 2007, 2008) have argued that physical goals for physical activity may reflect pressure to achieve sociocultural norms for appearance or pressure from important individuals within women's social networks (e.g., family, healthcare providers). In turn, women with these types of goals may not be intrinsically or autonomously motivated to participate in physical activity (Segar et al., 2007, 2008). Non-physical goals, on the other hand, may promote increased self-worth and motivation for physical activity in middle-aged women because of the freedom of choice and enjoyment associated with such goals (Segar et al., 2008). Together, the above research

suggests that although women may evaluate their self-worth in terms of their physical appearance, such perceptions may not have a positive influence on their overall self-worth or participation in physical activity.

The book club intervention implemented by Huberty and colleagues (2008b, 2010) specifically employed a non-physical self-worth approach in which the academic, emotional, and social self-worth domains were targeted, in addition to the physical domain, to improve women's physical activity participation. For example, women were encouraged to value and prioritize themselves, change their perceptions about their bodies and their reasons for being active, address their appearance in relation to their quality of life and overall wellness, develop strategies to access increased social support for physical activity, and give up on guilt related to prioritizing their physical activity participation over other commitments/responsibilities (Huberty et al., 2008b). As a result, women in the first cohort demonstrated increases in self-reported physical activity, pedometer-measured steps, and general self-worth from baseline to post-intervention (8 months) (Huberty et al., 2008b). In a second cohort, women who participated in the book club had greater increases in general self-worth and perceived benefits relative to barriers of physical activity in relation to a comparison group (Huberty et al., 2010). Pedometer-measured steps, although only assessed in the intervention group, also increased significantly from baseline to the end of the 8-month intervention. Although the above studies provide promising evidence of the predictive role of self-worth on physical activity, Huberty and colleagues' (2009, 2013a) mixed-methods follow-up studies have

provided more meaningful insight into the utility of a non-physical approach for improving women's self-worth and physical activity participation.

Although women's physical activity levels did not increase at one-year follow-up, Huberty and colleagues (2009, 2013a) observed continued increases in women's general self-worth. Interestingly, in spite of the non-physical approach of the book club, women generally cited the physical benefits of physical activity as their main motivating factors. In line with previous research (Segar et al., 2008), these results suggest that the lack of change in women's physical activity goals from physical to non-physical may have contributed to the lack of change observed in women's physical activity participation over the follow-up period. However, some women mentioned their self-worth, quality of life, and stress reduction as benefits of physical activity (Huberty et al., 2013a). For example, women expressed a "renewed interest in themselves", in addition to fewer judgments of themselves based on their "body shape" (Huberty et al., 2013a, p. 373-4). Despite promising quantitative and qualitative outcome data, these follow-up studies were limited by their assessments of general self-worth only. Conclusions related to the contributions of the non-physical domains to improvements in physical activity and general self-worth are, therefore, somewhat limited. Nonetheless, findings from these studies substantiate further investigation of relationships between academic, emotional, and social self-worth and physical activity participation in middle-aged women.

Research by Marsh and colleagues (1984, 1985, 1990, 1992) has, over the years, significantly contributed to our knowledge about the multidimensional and hierarchical nature of self-worth. This research has led to universally accepted recommendations that

studies measure self-worth at the domain and subdomain level as opposed to the general level to best understand relationships between self-worth and specific behaviors, in addition to how interventions impact these relationships (Marsh & Shavelson, 1985). Marsh's (1990) research within the academic setting has also provided evidence that more specific self-worth model components and measures may be needed to explain self-worth within various subdomains. For example, academic self-worth within the core subjects (i.e., subdomains) indicated in Figure 1 may not adequately explain self-worth in other subject areas, such as physical education and art. Therefore, Marsh (1990) has recommended that researchers utilize scales specific to particular subject areas in order to most effectively examine self-worth in these areas. In physical activity research, the PSPP (Fox & Corbin, 1989) has aimed to accomplish this goal, but has considered only the physical domain as relevant to physical activity participation. Given increasing evidence to support non-physical self-worth correlates of physical activity participation in women, measures targeting the academic, emotional, and social self-worth domains within the context of physical activity participation may be useful.

For many years only the Self-Description Questionnaire (1992; Marsh & O'Neill, 1984) was available to measure self-worth in the non-physical domains, in addition to the physical domain. However, this questionnaire was developed for adolescent and young adult populations within academic settings and may not adequately measure self-worth in the context of physical activity participation (Marsh, 1990). As a result, Huberty and colleagues (2013b) developed and validated the Women's Physical Activity Self-worth

Inventory (WPASWI) to address self-worth for physical activity participation within the non-physical domains.

The WPASWI validation study resulted in a 37-item scale measuring the knowledge, emotional, and social self-worth domains specific to women's participation in physical activity. The *academic* domain was renamed *knowledge* self-worth and operationally defined as self-worth relative to women's knowledge about physical activity, (e.g., planning a physical activity program, benefits of physical activity, knowledge of injury risk). The emotional domain was defined as self-worth related to one's ability to deal with life stressors and other emotional challenges associated with physical activity (e.g., happiness related to self-prioritization and access to resources, impact of physical activity on how one feels about herself, impact of feeling better about oneself on physical activity participation). Finally, the social domain was defined as an individual's self-worth as it relates to her interactions with others in the context of physical activity (e.g., support from friends and family for physical activity, having someone to be active with, asking others for help related to physical activity) (Huberty et al., 2013b). Figure 3 illustrates the physical activity self-worth model based upon the findings of Huberty and colleagues (2008a, 2008b, 2009, 2010, 2013a, 2013b). Amidst growing evidence of the potential importance of knowledge, emotional, and social self-worth for improving physical activity in women, the WPASWI (in conjunction with the PSPP) provides an exciting opportunity to empirically examine associations between the non-physical self-worth domains and physical activity participation in middle-aged women.

Ecological Momentary Assessment (EMA)

Definitions and concepts. EMA refers to a range of methods in which behaviors and behavioral correlates are examined as they unfold within the real world (Shiffman et al., 2008). EMA methods generally utilize multiple daily assessments across several days or weeks. EMA traditions have been used for many years to study various behaviors, such as smoking cessation and alcohol abuse, in addition to their antecedents and consequences. Such correlates of behavior that have been studied with EMA methods include, but are not limited to, mood, anxiety, social support, relationships, and self-esteem (Shiffman et al., 2008). EMA methods have also been used in conjunction with ambulatory monitoring, such as objective physical activity or heart-rate monitoring (Dunton et al., 2012; King, Oka, & Young, 1994). However, researchers have traditionally relied upon global and retrospective self-report of experiences, behaviors, cognitions, and emotions. Unfortunately, this approach has limited our ability to understand the dynamic changes that occur within individuals over time and across situations. Similarly, objective physical activity measures alone are unable to provide this rich information about correlates of physical activity and physical activity contexts (Dunton et al., 2012).

Compared to global, retrospective reports, EMA provides researchers the opportunity to study the dynamic changes in behavior over time and across situations. This in turn can help researchers to better understand situational antecedents that influence behavior and individual differences in behavior, and to design tailored ecological momentary interventions (EMIs) that promote behavior change in real-time as

(or before) behaviors occur. Therefore, the goals of EMA are often twofold: 1) to examine and understand behaviors and contexts that influence behaviors, and 2) design interventions based upon relationships observed (Shiffman et al., 2008). EMA is uniquely suited to accomplish these goals because findings can be directly translated to interventions that anticipate behaviors and have increased external validity as a result of behavioral assessments within real-world settings. Although usually employed separately, EMA and EMI can be used together to identify behavioral triggers and individually tailor health promotion strategies based upon those triggers (Heron & Smyth, 2010).

EMA can also mitigate recall bias associated with global, retrospective self-report measures. First, a participant's state or situation at the time of reporting can influence what they report. Second, extremes may be more memorable, and participants' reports of general states may be influenced by these memorable moments (e.g., structured versus lifestyle physical activity, extreme pain levels in proximity with measurement). Third, individuals have a tendency to organize their memories into more usable and meaningful forms and in ways that may be consistent with theoretical predictions of events (Shiffman et al., 2008). This limitation of retrospective self-report may be especially risky when measuring self-worth because of its organized nature (i.e., self-consistency (Fox, 1997)). Therefore, assessments of self-worth in real-time may provide a more accurate representation of individuals' perceptions of themselves before and after physical activity participation.

Notably, EMA is most valuable for understanding dynamic, unstable behavioral correlates and less valuable for investigating stable constructs, such as general self-worth.

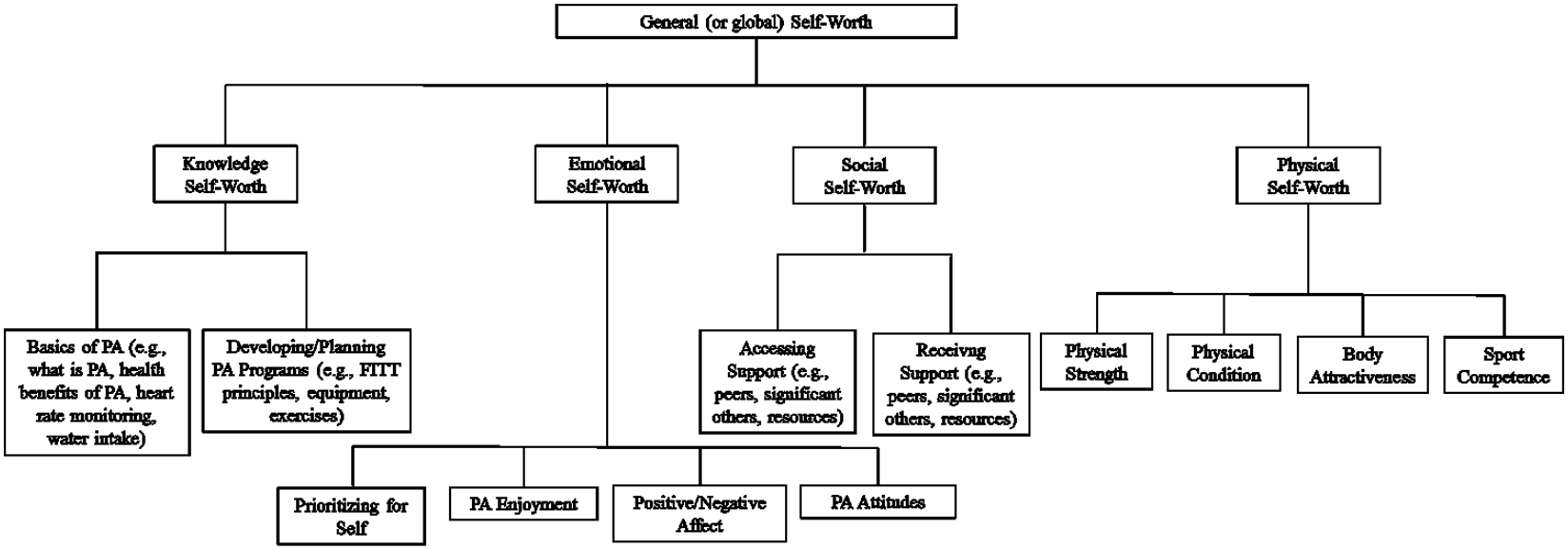


Figure 3. Revised Self-Worth Conceptual Model for Physical Activity (PA)

Self-worth theorists have emphatically recommended that assessments of self-worth in the context of behaviors and interventions occur at the domain and subdomain levels (Marsh & Shavelson, 1985; McAuley et al., 1997). Self-worth at the lower end of the hierarchy is thought to be more dynamic and less stable and may, therefore, be more permeable to change. Further, research suggests that general self-worth becomes more defined with age, causing its association with specific behaviors to become weaker (Marsh & Shavelson, 1985). As such, EMA presents a novel and potentially useful approach for measuring domain and subdomain level self-worth and physical activity. To date, no studies have investigated associations between self-worth and physical activity participation using EMA methods. Further, middle-aged women are an understudied population within the self-worth/physical activity literature, and EMA provides an exciting opportunity to contribute valuable empirical evidence in this area and population.

EMA has been delivered via a variety of methods, including written diaries, electronic personal data assistants (PDAs), and, more recently, mobile (i.e., cell) phones (Atienza, Oliveira, Fogg, & King, 2006; Dunton et al., 2012; Kuntsche & Labhart, 2013). The ubiquity of cell phone use worldwide has contributed to the availability of EMA, mitigations in participant burden, and improvements in data quality (Dunton et al., 2012; Kuntsche & Labhart, 2013). Cell phone networks and constantly improving technology also make it easier to deliver more sophisticated assessments (e.g., applications, cameras, built-in movement sensors) and to time-stamp participant entries. A number of studies have successfully utilized cell phones to deliver different types of assessments (e.g.,

automatic versus manual, short message service (SMS), internet-based, mobile applications). Further, research has demonstrated electronic EMA's utility in both young and old populations, suggesting that age-related digital literacy is not a barrier to collecting data using electronic EMA methods (Kanning et al., 2013).

Despite the strengths of cell phones for EMA research, researchers should be cognizant of some important limitations. First, in spite of the improved convenience cell phones provide participants, the frequency and duration of data collection associated with EMA may introduce additional burden to participants. Second, more advanced EMA methods often require that participants have access to the Internet and/or mobile applications on their cell phones in order to participate. Third, although EMA applications are slowly becoming more available, many are expensive and few open-source applications are available across platforms (e.g., Android, iOS). Fourth, limited network coverage in certain areas (e.g., rural locations) may inhibit researchers' ability to reach intended participants. Finally, although cell phone use has burgeoned, wide variations in contracts across individuals may introduce cost challenges to participants and researchers (Kuntsche & Labhart, 2013; Shiffman et al., 2008). More research utilizing participant's personal cell phones to collect EMA data is warranted to better understand the feasibility of such methods.

Other challenges in EMA research independent of delivery methods are the need for 1) intricate sampling schemes and 2) large, complex longitudinal data analysis methods. Two major sampling schemes have been identified in EMA research: event-based sampling (i.e., event-contingent) and time-based sampling (i.e., interval-contingent

or signal-contingent). Each can be employed independently or in combination with each other (LePage & Crowther, 2010; Shiffman et al., 2008; Smyth & Heron, 2014). Event-based sampling schemes do not intend to characterize a participant's entire experience, but instead focus on particular events. Examples of event-based sampling may include asking smokers who are trying to quit about their mood immediately following a lapse, or asking young women about their body dissatisfaction immediately following an exercise bout. Event-based sampling requires researchers to provide participants with specific instructions for reporting and relies upon participant honesty that an event actually occurred. Time-based sampling schemes, on the other hand, typically aim to characterize experience more broadly and do not focus on distinct events. Examples of time-based sampling may include asking smokers who are trying to quit about variations in their mood over time or asking young women about their body dissatisfaction across time. Time-based sampling designs vary in scheduling, frequency, and timing (Shiffman et al., 2008). For example, a recent review by Kanning and colleagues (2013) indicated that across 22 studies examining positive/negative affect in the context of physical activity participation, measurement points per day ranged from 1 to 30, and the study durations ranged from 12 hours to 70 days. Because sampling schemes vary depending upon study goals and because a large amount of data is captured within and across days, complex data analysis methods are needed draw meaning from data. Researchers must have a grasp on more sophisticated analysis frameworks, such as random effects models, multilevel analyses, generalized estimating equations, and time-varying effects models, in addition to an understanding of how to handle varying and potentially large amounts of

missing data (Shiffman et al., 2008). Despite these challenges, the advantages of EMA far outweigh these limitations when studies are carefully designed.

Justification of EMA for assessing the self-worth/physical activity relationship. With the increasing feasibility and popularity of electronic EMA administration, a growing body of physical activity literature has begun to explore its utility for examining physical activity participation and dynamic physical activity correlates and antecedents, including self-efficacy, mood, energy, fatigue, social interactions, stressful events, activity contexts, positive/negative affect, and body satisfaction (Dunton et al., 2009, 2012; Kanning & Schlict, 2010; LePage & Crowther, 2010). Findings of this research provide support for the use of EMA to investigate the relationship between self-worth and physical activity in middle-aged women. First, studies have demonstrated the utility of electronic EMA methods for measuring physical activity and physical activity correlates, and 2) many of the correlates assessed have been previously linked to self-worth. Dunton and colleagues (2012) recently established the feasibility, acceptability, and validity of mobile phones for assessing physical activity participation and sedentary behavior among adults (72.5% female). For example, participants answered 82% of the electronic EMA surveys prompted, and responses regarding self-reported activity at the time of the prompt were highly correlated with concurrent objective physical activity measurement via accelerometry. A recent review of physical activity studies by Kanning and colleagues (2013) also demonstrated that electronic EMA methods have been successfully used in a variety of populations, including men and women and young and old adults.

In addition to determining the utility of electronic EMA methods for measuring physical activity, recent research has also added important information to the physical activity literature on self-efficacy and psychological states closely linked to self-worth, particularly quality of life, affect, mood, and body satisfaction (Dunton et al., 2009; Kanning & Schlicht, 2010; Kanning et al., 2013; LePage & Crowther, 2010; Maher et al., 2013). Dunton and colleagues (2009) found that, among middle-aged adults, self-efficacy predicted physical activity over short periods of time (e.g., a few hours); however, self-efficacy's impact on other factors associated with physical activity, such as self-worth, were not assessed. A large body of research has also provided consistent evidence of a positive association between positive affect and physical activity participation, but recent EMA research has also provided additional information about how this association is influenced by other factors not traditionally measured, such as physical activity contexts, autonomous regulation, and variations in other states (e.g., mood). For example, Dunton, Liao, Intille, Wolch, & Pentz (2011) found, in a sample of children, that positive affect was greater when participants were active outdoors or with friends. Carels and colleagues (2007) also found that morning mood was associated with an increased likelihood of exercising, and mood ratings were higher after exercise bouts of increased duration and intensity.

Another study among female college students provided additional support of recent findings related to the non-physical self-worth domains (LePage & Crowther, 2010). Specifically, women with appearance and weight motives experienced increased body dissatisfaction and negative affect after exercise. Interestingly, fitness and health

motivations, in addition to appearance and weight motivations for exercise, also negatively impacted body satisfaction and positive affect among women with higher levels of trait body dissatisfaction. Perceptions of appearance have been previously linked to physical activity participation, self-worth, affect, and quality of life longitudinally in middle-aged women (Elavsky, 2009); however, this research has not examined variations in self-worth states within individuals and across physical activity contexts.

Like affect, mood, and body satisfaction, self-worth is known to vary within individuals across time and situations, suggesting that EMA may provide a promising opportunity to uncover important information about relationships between self-worth domains and subdomains and physical activity participation in middle-aged women. Importantly, such research may not only provide rich information related to the relationship between self-worth and physical activity, but may also extend recent findings related to the acute effects of self-efficacy on physical activity and self-worth (Dunton et al., 2009). Given the dearth of literature empirically examining the predictive influence of self-worth and potential associations between non-physical self-worth and physical activity in middle-aged women, research testing new models of self-worth in the context of physical activity participation (Figure 4) is needed. Recent research suggests that EMA is specifically useful for better understanding the antecedents and consequences of physical activity and that research of this nature is of theoretical and practical importance (Kanning et al., 2013). For example, Kanning and colleagues (2013) recommended researchers use EMA to answer questions, such as: *Do I feel better about myself after being physically active? Or am I more physically active when I feel good about myself?*

EMA may, therefore, be specifically useful for accomplishing the aims of this study. This exploratory study, utilizing a novel approach, may contribute important knowledge that may inform physical activity promotions strategies to more effectively foster increased physical activity participation in middle-aged women. The purpose of this study was to utilize EMA methods delivered via cell phones to explore the influence of self-worth on physical activity participation in middle-aged women (aged 35-64 years). Figure 4 illustrates the proposed role of self-worth, across all four domains, for predicting physical activity participation in middle-aged women. This study explored both the feasibility of the EMA approach and temporal relationships between self-worth (across all four domains) and physical activity participation in middle-aged women.

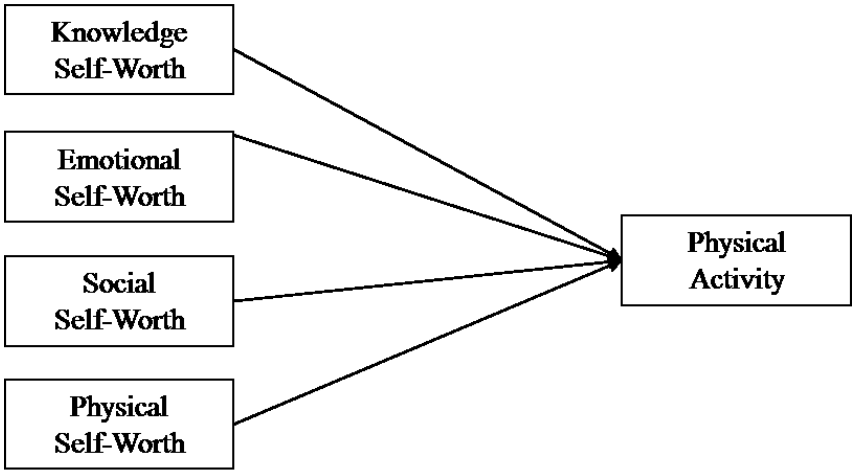


Figure 4. Proposed Framework to Explain Relationships between Self-Worth and Physical Activity

Chapter 3

METHODS

Study Design

This study employed an intensive longitudinal design using EMA sampling methods in which women were sampled two to three times per day over the course of 28 days. Intensive longitudinal designs are particularly useful for examining temporal changes in behavioral patterns and include frequent and comprehensive assessments of individual behaviors and accompanying psychological and/or contextual states (Tan, Shiyko, Li, Li, & Dierker, 2011; Walls & Schafer, 2006). EMA is commonly employed in health behavior research, such as smoking cessation, eating behaviors, and physical activity (Shiyko, Lanza, Tan, Li, & Shiffman, 2012; Stone & Shiffman, 2002). This study occurred in two phases, an initial pilot phase to test the EMA questions and procedures and a test phase to officially administer the assessments with the full sample. Assessments measured women's general self-worth, knowledge (academic) self-worth, emotional self-worth, social self-worth, physical self-worth, self-efficacy, and current activity. Full item scales, a demographics questionnaire, and an exercise motivation questionnaire were administered at baseline. An 11-item scale derived from the full scales was administered as part of the EMA design. Physical activity was measured objectively throughout the sampling period, and data gathered were used to investigate possible associations between key predictors and physical activity.

Participants

Middle-aged women who met the following eligibility criteria were recruited for the pilot phase of this study: 1) 35-64 years-old; 2) able to read/understand English, 3) able to ambulate as determined by Item 5 on the Past-Week Modifiable Activity Questionnaire (PW-MAQ) (Gabriel et al., 2010), 4) owned a mobile phone through which they could access short text messages and the Internet; and 5) agreed that user rates would apply when receiving text messages and completing assessments (i.e., text messages and data usage related to this study would not be "free to end user"). During the pilot phase, eligibility related to criterion number 3 above was determined using the Physical Activity Readiness Questionnaire (PAR-Q) (American College of Sports Medicine [ACSM], 2010). The research team found that the PAR-Q was too conservative of an assessment of women's ability to participate in physical activity. Therefore, the PW-MAQ replaced the PAR-Q during the test phase. Personal mobile phones were used in this study to limit costs and because research suggests that utilizing participants' personal devices may increase both the feasibility of sampling and validity of results. First, adoption of mobile technologies, including text messaging and mobile Internet, continues to flourish among younger and older populations alike (Pew Internet & American Life, 2014). Additionally, behavioral and Information Systems research indicate that participants' perceived ease of use related to an electronic system improves and their reactivity to research processes is mitigated when they have increased familiarity with devices (Venkatesh, Morris, Davis, & Davis, 2003; Walls & Schafer, 2006). Women living locally within the Phoenix metropolitan area, in addition to women

living in other regions of Arizona or the United States, were included in this study. Procedures were modified as needed for remote participants (see Procedures section). A convenience sample of twelve women was recruited to pilot test the EMA items and procedures, and a sample of 67 women was recruited to participate in the test phase of the study. Women were recruited from an existing database of potential research participants, organizational listservs, flyers, social media posts (e.g., Facebook), electronic newsletters, and word of mouth. All women signed an informed consent form approved by the Arizona State University Institutional Review Board prior to their participation in the study (Appendix A).

Instrumentation

Demographics. A general demographics questionnaire assessing women's age, race, ethnicity, household income, education level, marital status, current chronic condition(s) (if any), and height and weight was administered at baseline. Self-reported height and weight have been validated in adult populations (Spencer, Appleby, Davey, & Key, 2002). Twelve women did not provide their date of birth on the demographics survey. The eligibility screening questionnaire in which participants were asked their age in years was used to determine age (rounded down to current years of age) for these participants.

Reasons for exercise. The Reasons for Exercise Inventory (REI; Silberstein, Striegel-Moore, Timko, & Rodin, 1988) was included at baseline only to measure women's reasons for participating in physical activity. This questionnaire was included because recent research indicates physical motives for physical activity may be related to

decreased physical activity and psychosocial physical activity outcomes closely related to self-worth (e.g., body satisfaction) (LePage & Crowther, 2010; Segar et al., 2008, 2011; Strelan et al., 2003). The REI contains 24 items that measure women's reasons for engagement in physical activity across four categories: Fitness/Health Management, Appearance/Weight Management, Stress/Mood Management, and Socializing. The reliability of the scale has been established in populations of adult women (α=0.83-0.88) (LePage & Crowther, 2010).

General self-worth. The general self-worth subscale of the Adult Self-Perception Profile (Messer & Harter, 1986) was selected to measure general self-worth. The general self-worth scale contains six items to measure individuals' overall perceptions related to how they feel about themselves. Responses are scored on a scale of 1 to 4, with a 4 signifying high level of self-worth. Respondents are asked to report which part of a statement is "really true for me" or "sort of true for me". The general self-worth subscale has been determined reliable (α=0.83) and valid in middle-aged women (Huberty et al., 2013a; Messer & Harter, 1986). The item used in this study was chosen based on existing data from the general self-worth subscale (Huberty et al., 2013b). The contribution of each of the six items was assessed by calculating the scale's Cronbach alpha when items were deleted. The item that yielded the lowest alpha after deletion was chosen for this study. The overall alpha from the dataset was 0.835 (N=307), and the deletion of the item, "Some adults are dissatisfied with themselves BUT other adults are satisfied with themselves," yielded the lowest alpha of 0.787. Due to this item's incompatibility with

the mobile interface, it was reworded to ensure participant's comprehension of the question (Table 2).

Non-physical self-worth. Three questions from the Women's Physical Activity Self-Worth Inventory (WPASWI) (Huberty et al., 2013b) were selected for the EMA survey to assess knowledge, emotional, and social self-worth, respectively. The full WPASWI has been established as reliable and valid among adult women, with test-retest reliability being acceptable for the knowledge self-worth, emotional self-worth, and social self-worth scales (*r*'s = 0.79, 0.70, 0.81, respectively; Huberty et al., 2013b). According to the WPASWI, respondents are asked to rate their agreement with statements along a 4-point Likert scale from "strongly disagree" to "strongly agree". Items for this study were chosen based upon two criteria: 1) Infit and Outfit statistics from the validation study's Rasch analyses, and 2) each item's overall relevance to the respective domain generally. Infit and Outfit statistics greater than 1.3 or less than 0.7 are considered a misfit, while values close to 1.0 are considered a good fit (Huberty et al., 2013b). The Infit and Outfit statistics were considered in conjunction with the second criterion to include an item that broadly covered each self-worth domain. For example, in the knowledge domain, "I value that I know how to plan a physical activity program for myself" has a perfect fit; however, because it emphasizes a specific component of physical activity knowledge (i.e., planning a program), a more general item with an almost equally good fit was chosen for this study. Items that assessed knowledge, emotional, and social self-worth in this study are presented in Table 2. Following the pilot phase, other items were chosen for the mobile survey used in the subsequent test

phase (described below). The WPASWI has been established as reliable and valid among adult women. The person-level intraclass correlations in this sample were 0.90, 0.87, and 0.72 for knowledge self-worth, emotional self-worth, and social self-worth, respectively.

Physical self-worth. The Physical Self-Perception Profile (PSPP) (Fox & Corbin, 1989) was selected to measure self-worth within the physical domain. The PSPP includes five subscales assessing physical self-worth and its four subdomains (body attractiveness, physical condition, physical strength, and sport competence). Each subscale contains six items to which respondents are asked to rate their agreement from "not true at all" to "completely true". The full PSPP has been established as reliable (α=0.87) and valid in middle-aged women (Elavsky & McAuley, 2007). The item used in the pilot phase was chosen based upon its broad relevance to physical self-worth overall. Based upon the results of the pilot phase and previous research indicating that physical strength and sport competence may not be relevant to middle-aged women (Elavsky, 2009), one body attractiveness item and one physical condition item were chosen for the test phase. Psychometric statistics were not used in choosing the EMA items because the original validation study did not provide such information (Fox & Corbin, 1989) and the researcher did not have access to pilot data utilizing the PSPP. Response choices were modified to match those of the WPASWI items (i.e., "strongly disagree" to "strongly agree") in order to improve the readability of the EMA survey.

Self-efficacy. A modified version of the Exercise Self-Efficacy Scale (McAuley, 1993) was used to assess women's self-efficacy for participating in physical activity. This scale includes eight items that assess an individual's confidence (0-100%) in her ability

to exercise at least five times per week at a moderate intensity for 30+ minutes without quitting for the next week, two weeks, three weeks . . . eight weeks. The full measure has been established as valid and reliable in women (α=0.99) (Elavsky & McAuley, 2007; McAuley, 1993). The item chosen for this study was modified to include the option "I have already been active today" because activity may precede one or more of the daily assessments (e.g., the evening assessment). For this study the item read: "I am able to participate in physical activity at a moderate intensity for 30+ minutes today without quitting." Assessments prompted in the evening replaced the word "today" with "tomorrow" and did not include the additional response option.

Current activity. Current activity was measured using an item modified from a recent EMA study by Dunton and colleagues (2012). This item assessed the activity in which the participant was engaged immediately before receiving the prompt (Figure 4, Screen 1). Screen 1 was modified to include the option "Sleeping/Napping", and Screen 2 was modified to include "Group Fitness Class" and examples of each type of physical activity. This approach has demonstrated good construct validity with physical activity objectively measured by accelerometers (Dunton et al., 2012). Table 2 illustrates all of the EMA items tested in the pilot phase and revised in the test phase. The full EMA survey is available in Appendix C.

Physical activity. Physical activity was measured objectively for the duration of the assessment period (28 days) using the GENEActiv accelerometer. The GENEActiv is a lightweight, water-proof micro-electromechanical sensor that utilizes selectable

frequency-based (10-100Hz) raw, waveform data collection. Women were instructed to wear the GENEActiv on their non-dominant wrist throughout the entire 24-hour period

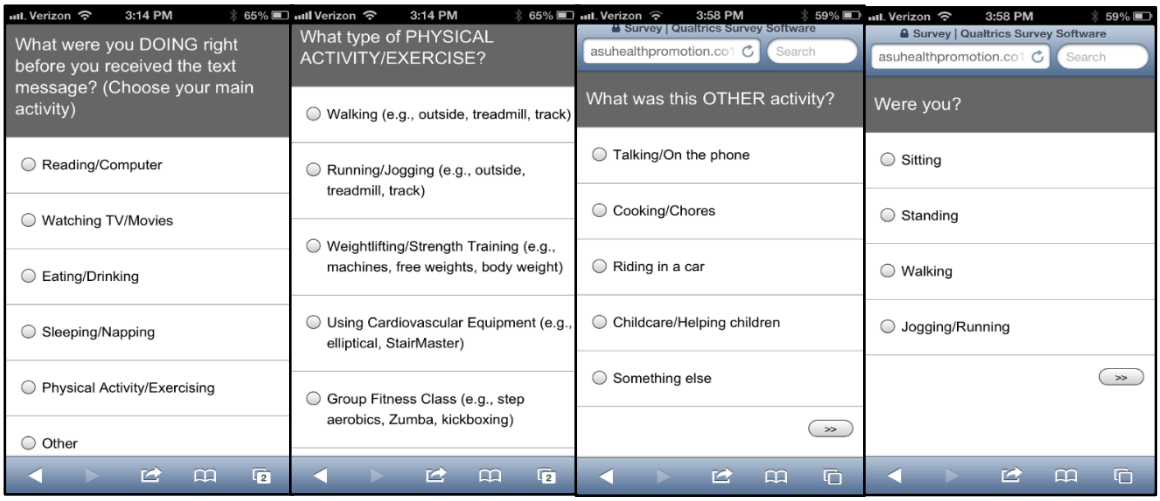


Figure 5. Interface of Current Activity Item

for 28 days. Women were initially instructed to wear the monitor during water-based activities. Although the GENEActiv is advertised as waterproof, some of the devices malfunctioned from water damage. Therefore, participants enrolled later in the study were instructed to remove the GENEActiv during water-based activities. Monitors were initialized to sample movement at 20Hz, and raw data were aggregated into 60-second epochs prior to analysis (Esliger, Rowlands, Hurst, Catt, Murray, & Eston, 2011). At baseline only, women also completed the PW-MAQ (Gabriel et al., 2010). The PW-MAQ provides respondents with a list of leisure activities and asks them to check which activities they participated in for at least ten minutes over the last seven days and to provide the duration of activity in minutes for each participation day.

Usability. Women in both phases of the study were asked to complete a satisfaction survey to gain feedback on the usability of the mobile survey and activity

monitor, length of the study, and incentive structure. The usability surveys for each phase are included in Appendix D.

Procedures

Pilot Phase. This study began with an initial pilot phase to examine the feasibility of the sampling scheme, the usability of the assessments, and the incentive structure. During the pilot phase a convenience sample of 12 middle-aged women (35-64 years) was recruited to pilot test the EMA-based procedures for two weeks. Three women were withdrawn due to inabilities receiving the text message prompts. At baseline women received detailed instruction on accessing and completing the surveys, completed the validated questionnaires from which the assessments were derived (see *Instruments*), and provided their typical daily wake times and bedtimes to guide the sampling schedule (Table 3). Next, women were asked to complete a 7-item mobile survey when prompted via text messaging for a two-week period. Text messages were scheduled and sent with Opt It text messaging software (Chicago, IL) and included a link to a mobile-compatible Qualtrics survey (Provo, UT) containing the questions illustrated in Table 2. Unique surveys were created for each participant so that women would not have to enter their participant ID each time they completed a survey. Finally, women were asked to complete a survey at the end of the two-week pilot phase (Appendix D) to inform the final protocol for the test phase.

A signal contingent sampling scheme was tested during the pilot phase, including the frequency (i.e., number of times per day), timing (i.e., time of day), and intensity (i.e., number of questions per assessment) of the prompts. Women were asked to answer seven

Table 2

Pilot Phase and Test Phase Items for Ecological Momentary Assessments

Construct (Reference)	Pilot Tested Items	Test Phase Items
Self-efficacy (McAuley, 1993)	I **am able to** participate in physical activity at a moderate intensity for 30+ minutes today without quitting.	I **will** participate in physical activity at a moderate intensity for 30+ minutes today/tomorrow without quitting.
General Self-worth (Messer & Harter, 1986)	Which of the following statements is most true of how you feel RIGHT NOW? • It is REALLY TRUE that I am dissatisfied with myself • It is SORT OF TRUE that I am dissatisfied with myself • It is SORT OF TRUE that I am satisfied with myself • It is REALLY TRUE that I am satisfied with myself	Which of the following statements is most true of how you feel RIGHT NOW? • It is REALLY TRUE that I am dissatisfied with myself • It is SORT OF TRUE that I am dissatisfied with myself • It is SORT OF TRUE that I am satisfied with myself • It is REALLY TRUE that I am satisfied with myself
Knowledge Self-worth (Huberty et al., 2013b)	My knowledge about physical activity affects the way I feel about myself.	RIGHT NOW - My knowledge about physical activity affects the way I feel about myself. RIGHT NOW - Thinking about exercising/physical activity makes me happy.
Emotional Self-worth (Huberty et al., 2013b)	I am happy when I prioritize my own needs by taking the time to be physically active.	RIGHT NOW – I feel it is important to take time to be physically active today. RIGHT NOW - I feel I will be a better mother, wife, friend, and daughter if I take time to take care of myself.
Social Self-worth (Huberty et al., 2013b)	I need friends or family to support my commitment to exercise in order to feel good about myself.	RIGHT NOW - I need to know I have friends or family to support my commitment to exercise in order to feel good about myself. RIGHT NOW - Thinking about taking time away from my family to exercise makes me feel bad about myself.
Physical Self-worth (Fox & Corbin, 1989)	I am extremely satisfied with the kind of person that I am physically.	RIGHT NOW - I feel confident about the appearance of my body. RIGHT NOW - I am confident in my level of physical conditioning and fitness.
Current Activity (Dunton et al., 2012)	What were you doing right before you received the text message? (Choose your main activity)	What were you doing right before you received the text message? (Choose your main activity)

questions (Table 2) twice per day for one week and three times per day for one week. Five women were assigned to the twice per day condition during the first week and four women were assigned to the twice per day condition during the second week of the pilot phase. The proposed sampling scheme is illustrated in Table 3. Women were prompted to complete assessments 1) 15 minutes after their typical wake time reported during their intake appointment and 2) 90 minutes prior to their typical bedtime. Women sampled

three times per day were prompted one additional time during the afternoon (random time between 2:00 and 3:00pm). During the morning and afternoon, women were given up to three hours to respond to each prompt at which time non-response was recorded. During the evening, non-response was recorded when the survey was completed after the participant's self-reported bed time (as recorded on a log) (Appendix E). Women's responses to the pilot phase survey, examination of the contribution of the afternoon assessment to the overall objectives of the study, and the feasibility of the procedures from the researcher's perspective were used to determine the sampling frequency and definition of non-response used for the second phase of the study. To determine the usability of the assessments, women were asked to provide feedback related to the ease of use, readability, duration, and burden of the assessments (Venkatesh et al., 2003) via the pilot phase survey.

Each time a participant completed a survey, her name was entered into a drawing to receive one $50 cash award at the end of the pilot phase. Therefore, each woman had up to 35 chances to be entered into the drawing, depending on the number of surveys completed. Participants were also given comprehensive feedback on their daily physical activity participation at the end of the study. An example handout for one week is included in Appendix F.

Women were asked questions on the pilot phase survey regarding the incentive structure (e.g., did it motivate them, was compensation reasonable). The researcher also examined survey completion rates to determine the appropriateness of the incentive structure and the definition of non-response, and to make any needed modifications for

the test phase. Feedback participants provided via open-ended questions on the usability survey also informed modifications to the assessments and/or procedures for the test phase.

Table 3

Pilot Phase Sampling Scheme

Prompt Schedule	Morning	Afternoon	Evening
Week 1			
2 prompts (participants 1-5)	15 minutes after wake		90 minutes before bed
3 prompts (participants 6-10)	15 minutes after wake	Random time 2-3pm	90 minutes before bed
Week 2			
2 prompts (participants 6-10)	15 minutes after wake		90 minutes before bed
3 prompts (participants 1-5)	15 minutes after wake	Random time 2-3pm	90 minutes before bed

Test Phase. Based on results of the pilot phase (see Chapter 4), modifications to the EMA survey, sampling scheme, and method by which the surveys were delivered were made. First, due to low rates of perceived burden among pilot phase participants, in addition to inconclusive results regarding daily variability in predictor variables, EMA survey items were modified and more items were added. Table 2 includes the final items used for the test phase.

The three times daily sampling scheme was adopted for the test phase of the study. Text message prompts were sent to women three times per day for 28 consecutive days. The morning prompt was delivered 15 minutes after each participant's self-reported typical wake time, the afternoon prompt was delivered at a random time between 2:00pm

and 3:00pm, and the evening prompt was delivered 90 minutes prior to each participant's self-reported typical bedtime.

While unique surveys were created in Qualtrics for each participant in the pilot phase, a more sophisticated approach was taken in the test phase. One survey was created for the entire sample, and participants received unique links to the survey at each prompting interval. Qualtrics includes a paneling system in which individual links that include embedded data can be generated. Data embedded into each link included the participant's ID, study day, and time of day. For example, participant number 59 had a link specifically assigned to her participant ID on Day 16, Time 3 (evening). This allowed the research team to make adjustments to the survey based on the time of day (e.g., the evening self-efficacy item referenced "tomorrow" instead of "today"), more easily organize the Qualtrics output at the end of the study, and identify missing data.

Women enrolled in the test phase of the study participated in an intake appointment with the primary investigator in order to review and sign the consent form, receive instruction on accessing and completing the baseline questionnaires and EMA surveys, and receive their GENEActiv activity monitor and instructions on how to use it. Intake appointments with women who did not live in the Phoenix metropolitan area were conducted over the phone. Consent forms, activity monitors, and instructions were mailed to remote participants with postage paid business reply envelopes to return the consent form and activity monitor.

Text messages were scheduled and delivered with Opt It text messaging software as per each participant's unique sampling schedule. Each text message included a unique

link to a Qualtrics survey containing eleven items assessing current activity, self-efficacy, general self-worth, and self-worth in the four domains (Table 2). Women were instructed to respond to as many prompts as possible. Figure 5 provides an example text message and an example of the Qualtrics mobile interface. Additional examples are available in Appendix G.

Women were also asked to concurrently wear a GENEActiv accelerometer to objectively measure their physical activity over the course of the 28-day assessment period. Women were instructed to complete a log to record their daily wake times and bedtimes, in addition to any periods of time during which they did not wear the monitor and the reason for not wearing the monitor. The monitor instructions and wear-time log are included in Appendix E.

An incentive structure similar to that of the pilot phase was adopted for the test phase. Due to the increased burden placed on test phase participants, ten $100 cash awards were distributed. Participants' names were entered into the drawing for as many times as they completed a survey (maximum entries = 84). One drawing was conducted after each of five waves of participants, and the remaining five drawings were conducted with the full sample at the end of the study. At the end of the study, participants were also emailed a link to the test phase usability survey (Appendix D).

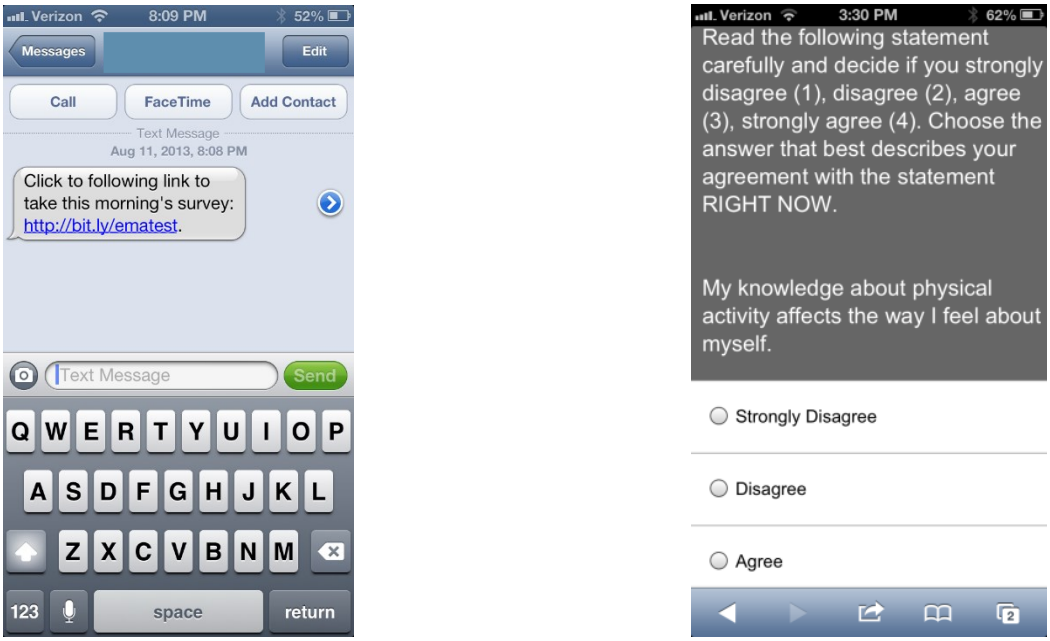


Figure 6. Examples of Text Message Prompts and Qualtrics Mobile Interface

Data Processing

Objective physical activity monitoring. GENEActiv data were processed in SAS 9.4 (Cary, NC). After filtering out sleep windows, non-wear periods were defined as ≥60 consecutive epochs with a 20-epoch forward-moving standard deviation ≤ 0.05 for activity counts. This method was used in lieu of the zero-count method because the GENEActiv does not register absolute zero counts when the unit is not in motion (verified by comparing to wear-time logs of participants). Only days with valid activity estimates (i.e., 600+ minutes of wear time) were included in analyses. Activity data were scored using Esliger and colleagues' (2011) methods for scoring 60-sec epoch data and activity cut point classifications from Welch et al., 2013. Activity was summarized as daily activity counts (summed) and daily minutes of sedentary, light, moderate, and

vigorous activity. Moderate and vigorous activity levels were condensed into one variable – moderate to vigorous physical activity.

Mobile survey completion. Data were exported from Qualtrics Research Suite to SPSS 22 (Chicago, IL) after each of five waves of participants completed the study to monitor data for compliance and issue a $100 cash award. After the last participant completed the study, the full dataset of completed surveys was exported for data processing. Skeleton datasets including participant ID, study day (1-28), time of day (1-3), raw time (0-84), time each text message was sent, daily wake time, and daily bedtime were created for participants who completed at least ten days of the study (n = 63). All datasets were aggregated into one skeleton dataset that included all potential observations (63 participants*84 observations per participant yielding N = 5,292 observations). The skeleton dataset was merged with the Qualtrics output (N = 4,680 observations) to create a dataset with each row corresponding to either a valid, invalid, or missing observation. Data were defined as missing if the participant did not complete the survey after receiving the prompt or did not complete the survey according to specific criteria for each time of day.

In the morning, a response was invalid if (a) the survey was completed beyond a three-hour reporting window from the time of the prompt or wake time (whichever was later), (b) the participant responded "Physical Activity/Exercising" on the current activity item, or (c) the participant responded "I was already active today" on the self-efficacy item. These criteria were chosen because the goal of the morning survey was to capture participants' self-worth as soon after their wake time as possible and before they

participated in any type of physical activity. The only exclusion criterion applied to the afternoon response was completion of the survey beyond a three-hour reporting window from the time of the prompt. During the evening, surveys completed more than 60 minutes after the self-reported bedtime were recoded as missing. This grace period was applied because of error in participant self-reported bedtimes, and almost 50 percent of post-bedtime responses occurred within the first hour of self-reported sleep time. Survey completion was described in the following ways: elapsed time between the text message prompt and start of the survey, missing responses, invalid responses, and total valid observations out of 5,292 potential observations. The median time and interquartile range (IQR) of time elapsed are reported because time elapsed was positively skewed at each time of day.

Data Analysis

Due to the low number of dropouts, Fisher's Exact tests and Wilcoxon Signed Rank tests were used to examine differences in baseline characteristics between women included in the dataset and women excluded from the dataset due to dropout or GENEActiv device malfunction. For the mobile survey, Cronbach's alphas were run for each self-worth domain to examine the internal consistency of the items. Correlations among items were examined to preliminarily identify relationships among self-worth variables, self-efficacy, and physical activity.

To assess Aim 1, accelerometer wear time estimates, mobile survey completion rates, total number of valid observations, and participant feedback from the satisfaction survey were summarized. Preliminary results of the pilot phase were also used to test

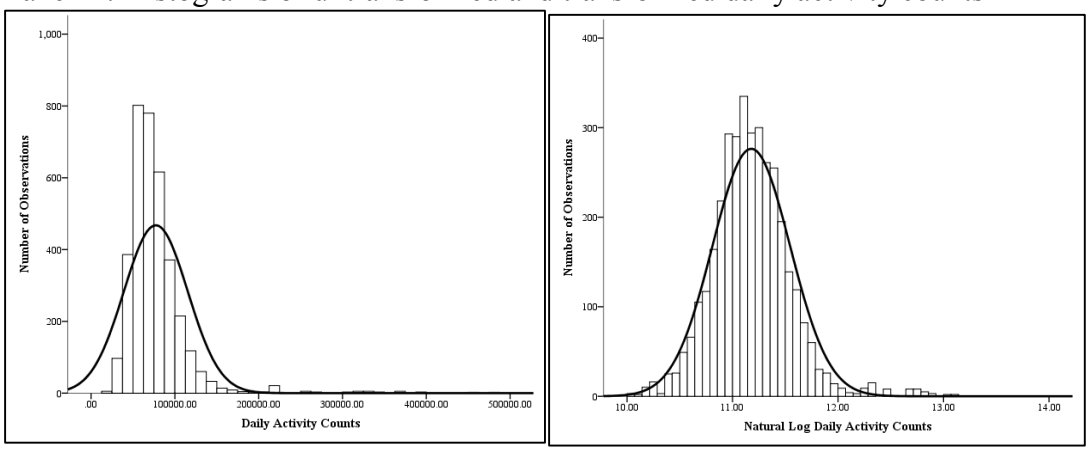
Aim 1. Given the inherently hierarchical structure of the data from intensive longitudinal designs, with repeated measurements over time (first level) being nested within persons (second level) (Walls, Jung, & Schwartz, 2006), multilevel models (Singer & Willett, 2003) were used to examine associations between mean levels and daily fluctuations in key predictors (i.e., knowledge, emotional, social, physical, and general self-worth) and objectively measured daily activity (Aims 2 and 3). Moreover, participants invariably failed to complete one or more daily assessments in accordance with the inclusion criteria for valid response. Multilevel models have been shown to be more robust in unbalanced datasets and can, therefore, provide better estimates despite missing data when compared with general linear models (Levy, Buman, Chow, Tillman, Fournier, & Giacobbi, 2010; Singer & Willett, 2003).

The analyses were conducted using the restricted maximum likelihood (REML) estimation. REML provides unbiased estimates of variance components, particularly when sample sizes are small (Singer & Willett, 2003). Models were constructed using a hierarchical approach by first including only the fixed effects of average levels of key predictor variables, followed by adding fixed effects of daily fluctuations in key predictor variables, and then finally random effect components corresponding to daily fluctuations in key predictor variables. Outcome (dependent) variables were daily moderate to vigorous physical activity during the pilot phase and natural log-transformed daily activity counts (summed) during the test phase. Daily fluctuations in key predictors were captured by mean-centering variables (i.e., subtracting the person-specific mean score from each observed score) prior to analysis. Fixed effects models assume that the

relationship between predictor variables and the dependent variable is constant across subjects, while random effects models account for and test the extent to which these relationships vary randomly across individuals (Singer & Willett, 2003). Moderate to vigorous physical activity was positively skewed, *z*(skewness) = 100.66, *z*(kurtosis) = 263.76, and transformation techniques (square root, natural log, and inverse) did not sufficiently normalize the data (determined by statistical tests and visual inspection). Therefore, total daily activity counts was used as the dependent variable. Like moderate to vigorous physical activity, daily activity counts was positively skewed, *z*(skewness) = 105.32, *z*(kurtosis) = 364.52, and was natural log transformed prior to analysis. Natural log transformation improved the distribution of daily activity counts, but did not fully normalize the data, *z*(skewness) = 18.51, *z*(kurtosis) = 34.04. Figure 7 illustrates histograms (Panel A) and Q-Q plots (Panel B) for daily activity counts before and after transformation.

The fixed effects models of average level self-worth examined relationships between person-level mean self-worth (up to 84 observations) and mean activity counts (up to 28 days) across participants. The fixed effects models for daily fluctuations in each self-worth variable examined the acute influence of self-worth domains on daily activity counts. For example, a positive association between daily knowledge self-worth and daily activity would indicate that on days of increased knowledge self-worth, women participated in more activity. The random effects models for daily fluctuations in each self-worth domain examined the extent to which the observed relationships between self-worth and activity counts varied across individuals.

Panel A: Histograms of untransformed and transformed daily activity counts



Panel B: Q-Q plots of daily activity counts before and after transformation

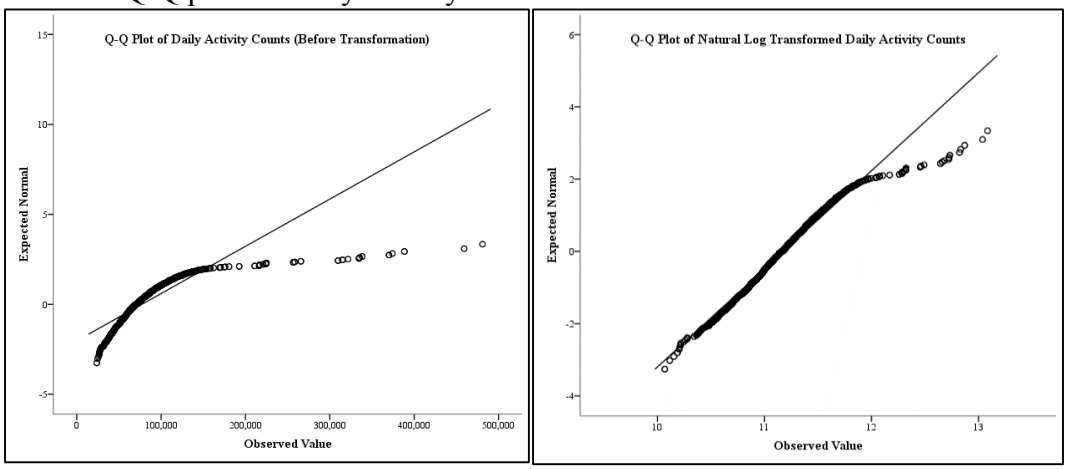


Figure 7. Distribution of Total Daily Activity Counts Before and After Transformation

Diagnostic tests were conducted to test the assumptions of linear regression specific to intensive longitudinal designs. To explore the data, self-worth and daily activity counts were plotted across persons and time to examine individual variability. Intraclass correlations were calculated for key predictors and daily activity counts to estimate the between- and within-person variance in each predictor variable and daily activity counts. Correlations between daily self-worth and daily activity counts were also examined. To test the assumptions, residual values were analyzed to test the normality and constant variance in the error terms at the daily and person levels. The independence

assumption is not plausible within intensive longitudinal data because of the frequency of observation (Walls et al., 2006) and was, therefore, not considered a criterion for analysis. Further preliminary analyses were conducted to examine the unconditional means model (UMM), unconditional growth model (UGM), and predictive influence of person-level self-efficacy on daily activity counts. The UMM included only the dependent variable (daily activity counts) and provided a baseline model for comparison. The UGM included only time in order to examine the pattern of change in daily activity over the 28-day study. Self-efficacy was included in preliminary analyses because it is a known predictor of both self-worth and physical activity in middle-aged women (McAuley, 1993; Elavsky, 2009; Elavsky & McAuley, 2007).

The UMM yields baseline estimates of the variance in activity at the between-persons and within-person levels as well as model goodness of fit as assessed using the model -2 log likelihood (-2LL) and Bayesian information criterion (BIC). Chi-square tests at $p < 0.05$ level of significance were used to assess improvements in the -2LL model fit at each stage in the hierarchical model building approach. BIC values were examined in conjunction with the -2LL to assess the model fit. Pseudo R-squared (pseudo-R^2) values were also used to examine the model fit, namely the parsimony of each model, in addition to the strength of association between predictor variables and daily activity counts. Between- and within-person pseudo-R^2 values were calculated based on changes in intercept-related variance and residual variance, respectively, at each model building stage. Specifically, pseudo-R^2 estimated from the ratio of random intercept variance to total variance represented the amount of between-persons variance

in daily activity counts explained by predictor variables. Pseudo-R^2 estimated from the ratio of residual variance to total variance represented the amount of within-persons variance in daily activity counts explained by predictor variables. Total variance refers to the total variation in the outcome variable (daily activity counts) that is explained by the statistical model plus unexplained variance (including error). Although pseudo-R^2 provides an interpretable measure of effect size, it has known limitations. Because observations are not independent in intensive longitudinal designs, the addition of predictor variables can sometimes increase the magnitude of the variance components and yield negative pseudo-R^2 statistics. This may be particularly problematic when the majority of variance in the outcome variable is between persons. Singer and Willett (2003) in recognizing these limitations have cautioned researchers when computing and interpreting pseudo-R^2 statistics.

The UGM included tests of the fixed followed by the random effects of linear time on the daily activity counts. Quadratic trends in the relationship between time and activity were also tested. A residual value of quadratic time was created prior to analysis using ordinary least squares regression to ensure that quadratic and linear time would remain orthogonal during analyses. Self-efficacy was entered into the model after the UGM and prior to testing any of the self-worth independent variables. Sequential steps included testing (in the following order): (a) fixed effect of average level self-efficacy, (b) fixed effect of daily fluctuations in self-efficacy, and (c) random effect of daily fluctuations in self-efficacy.

Each domain of self-worth (knowledge, emotional, social, physical) and general self-worth were tested separately using the hierarchical model building approach, and all nine self-worth items were treated as separate predictors of activity. Model building steps included testing: (a) fixed effects of average level self-worth, (b) fixed effects of daily fluctuations in self-worth, and (c) random effects of daily fluctuations in self-worth. After estimating a model with the main effects of the person-level average and mean-centered daily values of each self-worth item, significant predictors were entered into a single model together to examine the independent contribution of each predictor variable. Variables that were significant predictors at the $p < 0.10$ level in the item-specific models were retained and were considered significant predictors at $p < 0.05$ in the overall model. Changes in -2LL, BIC, and pseudo-R^2 values were also examined to determine predictor retention in the model. Data were reduced and cleaned in SAS 9.4 and analyzed in SPSS 22.

Chapter 4

RESULTS

PILOT PHASE

Participants in the pilot phase were nine educated Caucasian women (*M* age = 46.2 ± 8.2 years; *M* BMI = 25.1 ± 8.4). Further description of the participant characteristics is presented in Table 4. Of the 15 women contacted to participate, three were ineligible (did not own a smartphone: n=1; answered "yes" to at least one item on the PAR-Q: n=2) and three were withdrawn (could not receive text messages: n=3). No significant differences in age or BMI were observed between women who completed the study and those who were withdrawn; however, of the baseline characteristics, women who were withdrawn had lower self-efficacy for physical activity (t = -3.64, p = 0.005), higher body attractiveness self-worth (t = 2.59, p = 0.03), and lower social self-worth (t = -4.38, p = 0.001).

Of the 315 total possible mobile surveys (9 participants*35 surveys each), 304 were completed (*M* = 33.78 (96.5%) of 35 possible surveys per person). Ten additional surveys were marked as non-response due to completion exceeding a 3-hour window or self-reported bed time, resulting in 93.3% completion rate. Average time to complete each survey was 1.52 minutes (±1.03 minutes; Range: 24 seconds to 8.35 minutes). Nine of the completed surveys were excluded from this average due to completion time exceeding ten minutes, suggesting that women did not immediately finish those surveys. Activity data from one woman were excluded due to GENEActiv device malfunction,

resulting in complete data from eight participants and 260 surveys (82.5% of observations valid).

Table 4

Pilot Phase Sample Descriptive Characteristics

	Baseline	Ongoing
	M ± SD	M ± SD
Age (years)	46.2. ± 8.20	n/a
BMI (kg/m^2)	25.1 ± 8.40	n/a
Surveys Completed	n/a	33.78 ± 1.47
Completion Time (Min:Sec)	n/a	1:31 ± 1:02
General Self-Worth	3.48 ± 0.47	3.01 ± 1.18
Knowledge Self-Worth	3.01 ± 0.49	2.99 ± 0.66
Emotional Self-Worth	3.31 ± 0.58	3.21 ± 0.65
Social Self-Worth	3.06 ± 0.21	2.53 ± 0.67
Physical Self-Worth	2.57 ± 0.61	2.41 ± 0.58
Physical Condition	2.59 ± 0.69	n/a
Body Attractiveness	2.38 ± 0.47	n/a
PA Self-Efficacy (%)	42.92 ± 26.14	60.06 ± 30.71
Daily Wear Time (Hr:Min)	n/a	15:53 ± 1:09
Activity Levels (Hr:Min)		
Sedentary	n/a	10:59 ± 1:54
Light	n/a	4:32 ± 1:35
Moderate	n/a	0:17 ± 0:16
Vigorous	n/a	0:04 ± 0:10

Seven out of the nine women completed the satisfaction survey. Women agreed the survey was easy to complete (100%), did not take up too much of their time (100%), and was easy to read on their phones (100%). None of the participants thought completing the survey twice per day was too much, while three (42.9%) thought three times per day was too much. Most women (71.5%) agreed that completing surveys daily for two weeks was not too long. The majority of participants also thought that all three assessment points were convenient (Morning: 100%; Afternoon: 71.5%; Evening: 95.8%) and agreed that the text message prompts reminded them to complete the surveys (85.7%).

Most of the negative responses were related to the GENEActiv. Only three (42.9%) women thought the monitor was easy to wear, one liked the placement on the wrist (14.3%), and two (28.6%) agreed that the monitor was comfortable during sleep. Four (57.1%) thought wearing the monitor for 24 hours a day was too long; however, five (71.4%) liked that they did not have to remove the monitor for showering or water-based activities. Additionally, when asked to provide any additional comments about the study, most women only mentioned the activity monitor. One women wrote, "Overall, nothing which was required of me in this study was particularly difficult. The thing which bothered me the most was the monitor. I never got used to it and I was very relieved when the time came to take it off." Another stated, "The wrist monitor did become a little uncomfortable throughout the day at times. I like to wear a watch all the time, so having something on both wrists was awkward." Despite these responses, women wore the GENEActiv an average of 958.55 ± 69.03 minutes per day and did not wear the GENEActiv an average of 2.04 ± 14.57 minutes per day during waking hours. Across 112 potential days (8 participants*14 days), only one day was classified as invalid due to non-wear.

Results from the unconditional means model (UMM) (N = 112) indicated that approximately 54% of the total variance in daily activity counts was within individuals (ICC = 0.46). Figure 8 illustrates the distribution of daily activity counts over the 14-day pilot phase. Within- and between-persons variance estimates for each predictor variable are listed in Table 5. Overall, self-worth, across all domains, did not vary over time.

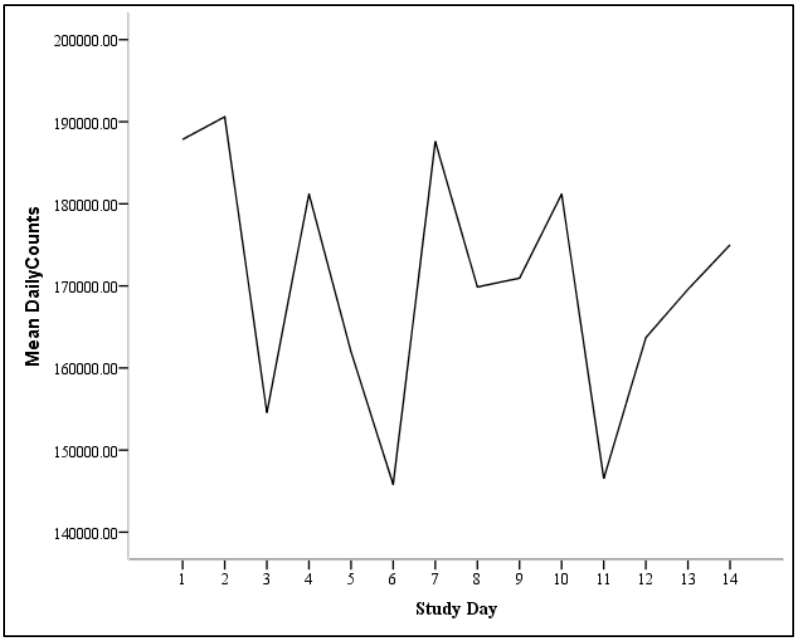


Figure 8. Pilot Phase: Distribution of Daily Activity over 14 Days

Results of the pilot phase suggested that the EMA protocol was feasible. Women thought that the mobile survey was easy to complete and did not take too long. Additionally, compliance rates related to the survey and wearing the accelerometer were high despite dissatisfaction with the monitor. Results of the multilevel models were inconclusive in examining the overall and daily relationships between self-worth and physical activity likely due to the small sample size and poor psychometric properties of some of the items. To best capture potential within-day variability and to ensure enough observations, the three times daily sampling scheme was adopted and the 7-item survey was expanded to an 11-item survey that included two items per self-worth domain, a general self-worth item, a current activity item, and a self-efficacy item.

Table 5

Pilot Phase: Between- and Within-Person Variance in Key Predictors

	Between-Persons Variance (ICC)	Within-Persons Variance
Knowledge Self-Worth		
AM	0.85	0.15
Mid	-	-
PM	0.88	0.12
Emotional Self-Worth		
AM	0.88	0.12
Mid	0.86	0.14
PM	0.92	0.08
Social Self-Worth		
AM	0.74	0.26
Mid	0.71	0.29
PM	0.77	0.23
Physical Self-Worth		
AM	0.71	0.29
Mid	0.78	0.22
PM	0.77	0.23
General SW		
AM	0.51	0.49
Mid	0.35	0.65
PM	0.38	0.62
Self-Efficacy		
AM	0.33	0.67
Mid	0.14	0.86
PM	0.49	0.51

Note: No ICC included if model did not converge

TEST PHASE

A total of 67 middle-aged women were enrolled in the test phase, six of whom withdrew from the study. Two of the women who withdrew contributed at least ten days of data, which were retained, yielding a sample of 63 participants who were considered to have valid survey data. Four of these 63 women had completely missing PA data (due to device malfunction) and were not included in multilevel models, leaving a final sample size of N=59 women. The flow of participants is presented in Figure 9. Characteristics of

the sample, including age, body mass index (BMI), ethnicity, race, household income, education level, and marital status are summarized in Table 6. Table 7 summarizes the responses to the baseline questionnaires, while Table 8 (Appendix B) summarizes responses to the EMA survey. No differences in age, BMI, race, ethnicity, income, education level, or marital status were observed between participants whose data were used in multilevel models (n = 59) and those whose data were not used (n = 8).

Table 6

Test Phase Sample Descriptive Characteristics (N=58)

	N	(%)
Age, M ± SD	49.03	± 8.3
Body mass index, M ± SD	25.08	± 4.4
Hispanic/Latino ethnicity	7	(12.1)
Race		
Caucasian	54	(93.1)
African American	1	(1.7)
Other	3	(5.2)
Household Income		
<$20,000 per year	2	(3.4)
$20,001 - 40,000 per year	7	(12.1)
$40,001 - 60,000 per year	21	(36.2)
>$60,000 per year	28	(48.3)
Education		
High school diploma	2	(3.5)
Some college/Associate's degree	21	(36.8)
4-year college degree or more	34	(59.6)
Marital Status		
Married or partnered	41	(70.7)
Single	8	(13.8)
Separated/Divorced	9	(15.5)

Note. Baseline questionnaires missing from one participant

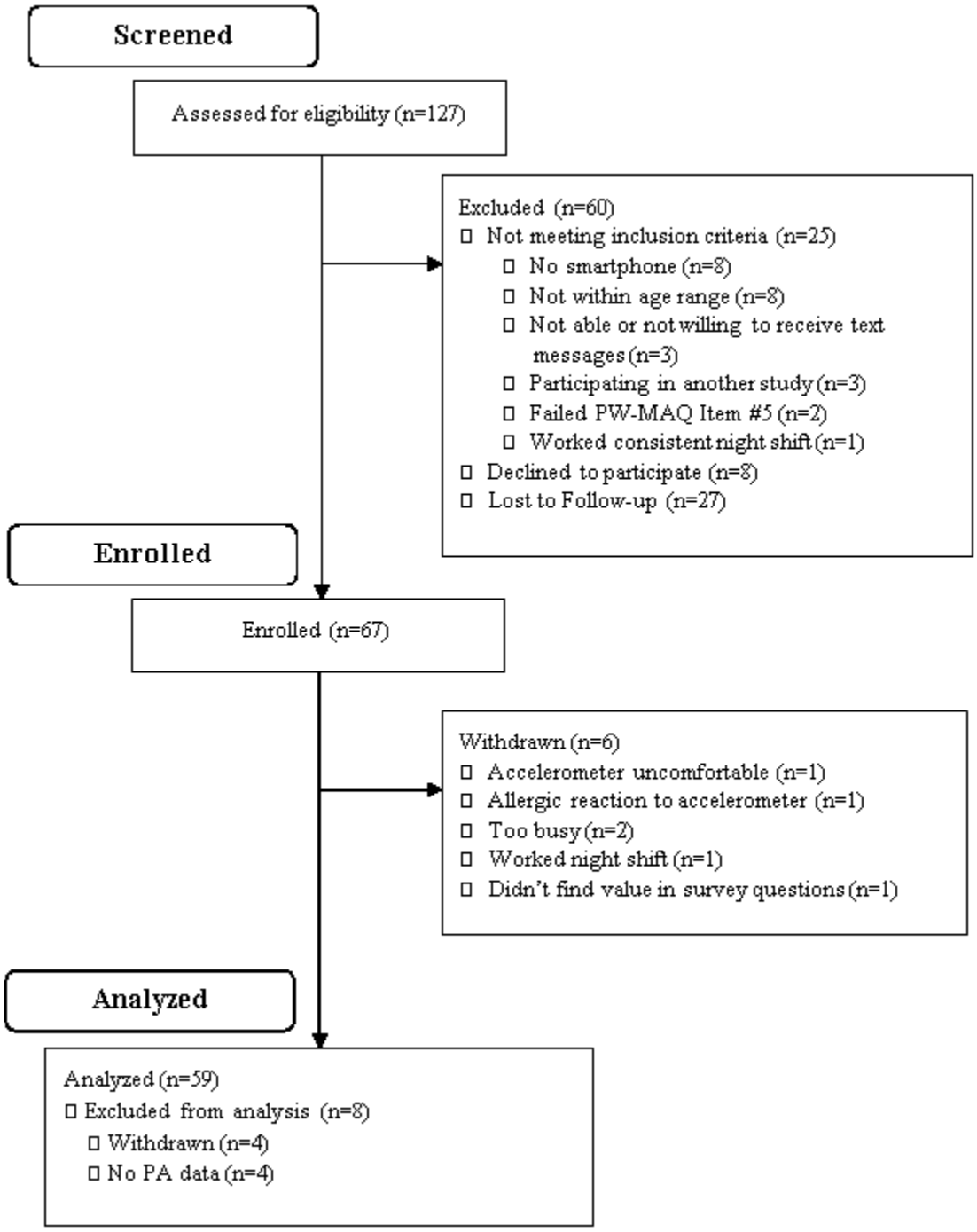


Figure 9. Test Phase Flow of Participants

Table 7

Test Phase Baseline Assessments

	Scale	M ± SD	
General Self-Worth	1 - 4	3.12	± 0.58
Knowledge Self-Worth	1 - 4	3.05	± 0.39
Emotional Self-Worth	1 - 4	3.29	± 0.42
Social Self-Worth	1 - 4	2.89	± 0.52
Physical Self-Worth	6 - 24	15.15	± 4.51
Body Attractiveness	6 - 24	14.81	± 4.86
Physical Condition	6 - 24	15.61	± 4.71
Lifestyle Self-Efficacy	0 - 100	66.34	± 31.12
Reasons for Exercise Inventory	1 - 7		
Weight Control		5.42	± 1.19
Fitness		5.87	± 0.78
Mood		5.47	± 1.26
Health		6.24	± 0.84
Attractiveness		5.19	± 1.22
Enjoyment		4.21	± 1.28
Tone		5.21	± 1.22
Physical Activity[a]			
Self-reported (MAQ; MET-hrs per week)		21.38	± 16.17
Self-reported (MAQ; min per week)		230.53	± 174.51
Number of women reporting ≥150 min MVPA, *N* (%)		37	(63.8)

[a]Physical activity is defined as ≥4.0 METs as defined by the Compendium of Physical Activities (Ainsworth et al., 2011) for self-reported activity

Specific Aim 1: Feasibility

Participant compliance with objective physical activity monitoring (N=59).

Due to GENEActiv device malfunctions, no physical activity data were available for four participants (*n* = 112 missing days), and only partial data were available for another six participants (*n* = 76 missing days). Causes of device malfunction included water damage, cracked exterior, insufficient memory capacity, and undetermined causes. Among women with partial data, total days recorded ranged from 10 to 26. A total of 188 days (10.7% of 1764 possible days) were logged as ineligible (i.e., missing data due to device

malfunction) and were not included in wear time estimates. Wear time on the 1576 days logged as eligible was high, with participants wearing the monitor at least 10 hours per daily wake period on 1464 days (92.9% compliance). This corresponded with 952.92 ± 100.99 minutes of wear and 26.94 ± 69.23 minutes of non-wear per valid day. Participants wore the GENEActiv for 10+ hours on 24.90 ± 5.56 days (25.40 ± 4.95 days when excluding the two dropouts who returned their monitors after Day 11). The number of participants with invalid wear time was greatest on Day 26 of the study (8 of 55 observations), $\chi^2 = 41.57$, $p = 0.036$. No differences were observed by day of the week, $\chi^2 = 6.26$, $p = 0.395$. After adjusting for the varying number of eligible wear days (due to device malfunction for six participants with partial data), wear time compliance per participant was 93.3 ± 16.8%. Figure 10 provides a breakdown of daily wear and non-wear.

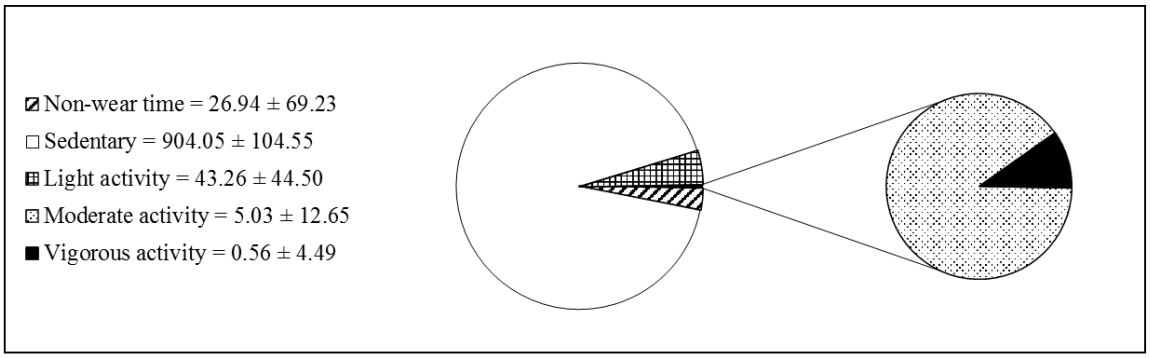


Figure 10. Breakdown of Daily Wear and Activity Estimates (Minutes)

Participant compliance with mobile survey completion (N=63). After excluding ineligible prompts, a total of 5,155 surveys (of 5,292 possible surveys, i.e., 84 surveys*63 participants) were eligible for completion. Prompts ineligible for response were comprised of (a) 96 surveys representing Days 13 through 28 for the two dropouts during which no text message prompts were sent, and (b) 41 prompting errors (8 researcher errors, 33 text message processing errors). Among eligible surveys, 485 surveys were not started ($M = 7.70 \pm 8.58$ per participant, Range = 0-42), 45 were started but not completed, and 4,625 (89.7%) were completed. The majority of missing responses occurred during the evening ($n = 192$), on Saturdays ($n = 86$), and between the 18th and 26th days of the study (M n = 27 ± 4 per day). The raw dataset was aggregated to the daily level of activity estimates. Data for four participants were removed from the dataset due to completely missing physical activity data, resulting in N = 4,956 potential person*time observations (i.e., N = 59 participants*84 prompts).

The median time between text message prompt or wake time and start of the morning survey was 23 minutes ($n = 1573$; IQR = 4 – 65 minutes). The median time between text message prompt and start of the afternoon survey was 18.5 minutes ($n = 1566$; IQR = 2 – 82 minutes). The median time between start of the evening survey and self-reported bedtime was 86 minutes ($n = 1391$; IQR =132 – 42 minutes before bed). Among evening surveys completed after participants' self-reported bedtimes, the median time after bed was 68.5 minutes ($n = 140$; Interquartile Range = 16 – 474 minutes). Based upon the exclusion criteria set for each time of day, 252 morning responses, 183

afternoon responses, and 72 evening responses were coded as invalid and removed from the dataset. The final mobile survey dataset included 4,163 valid observations (response rate = 80.8%). Although more surveys were missed during the evening when compared with the morning or afternoon, the total number of missing observations was greatest during the morning due to a greater number of invalid responses (*n* = 380 morning, 348 afternoon, 264 evening). Missing physical activity data accounted for an additional 590 missing observations. The final dataset included 3,573 valid observations (67.5%). Figure 11 illustrates the percentage of valid observations across days. Figure 12 diagrams the flow of data from text message prompt to data analysis.

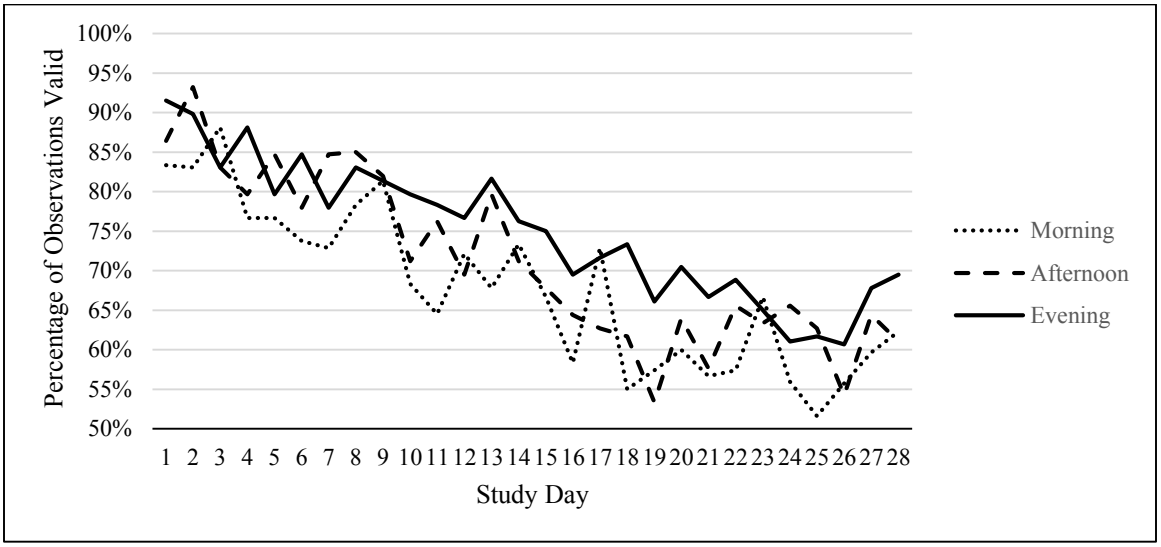


Figure 11. Valid Observations across 28 Days

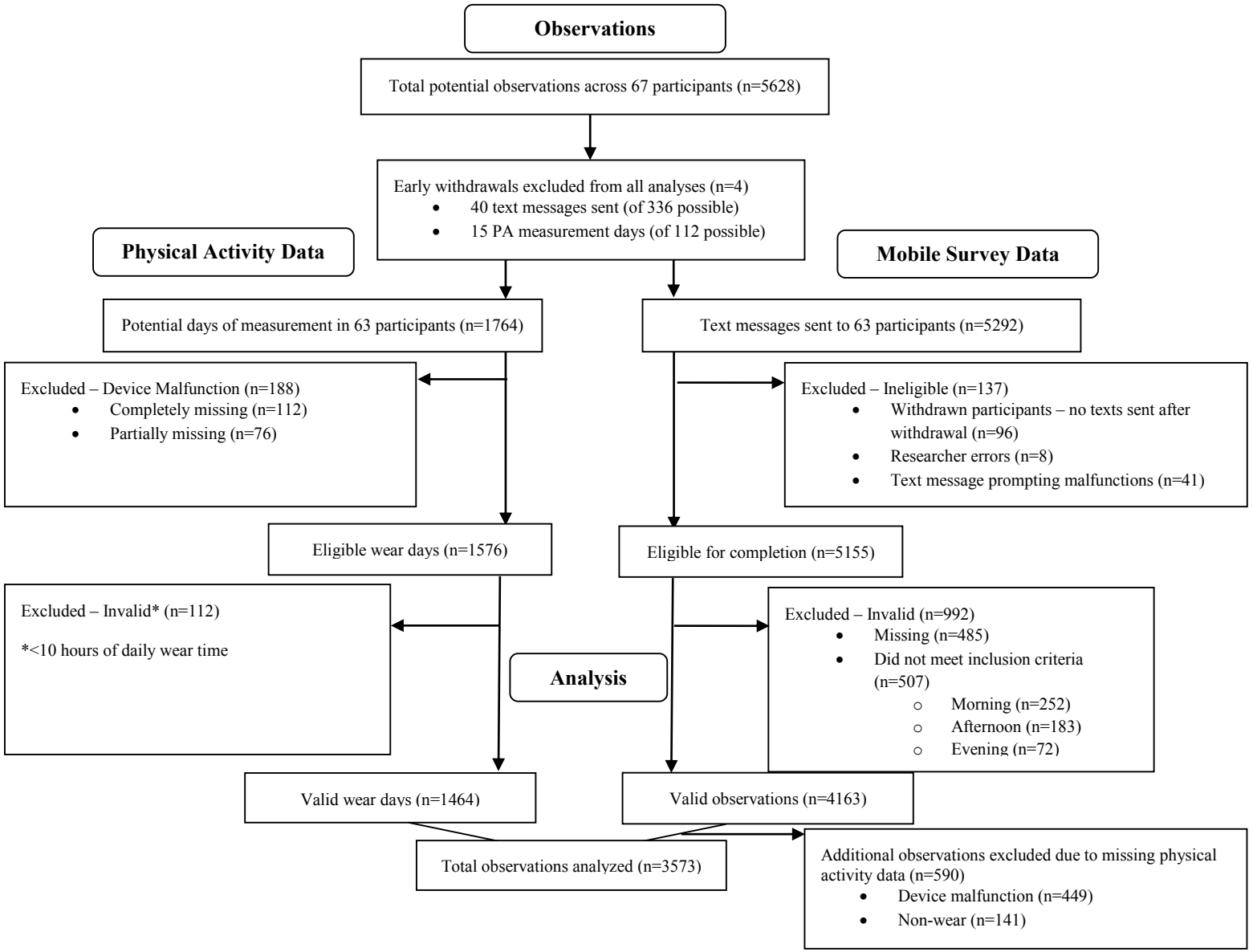


Figure 12. Flow of Observations

Usability. Of the 63 satisfaction surveys sent, 37 (58.7%) were completed. No women disagreed that the mobile survey was easy to complete, with 94.6% agreeing that it was easy to complete. Women especially thought it was easy to read on their smartphones. One woman commented, "I loved that I could do it on my phone and didn't need to go find a PC." Although only 45.9% of women disagreed that the survey contained too many questions, 78.4% disagreed that the survey took too long to complete. By time of day, 89.2% thought the morning (15 minutes after typical wake) was a convenient time to complete the survey, 78.4% thought the afternoon time (2:00 – 3:00pm) was convenient, and 91.9% thought the evening time (90 minutes before typical bed) was convenient. Approximately half of respondents felt three daily surveys was too much; yet, only 27.0% felt the 28-day study period was too long. Almost all women agreed the text message prompts helped them to remember to complete each survey. Women also agreed that they were motivated by the incentives provided in this study (Table 9).

Results related to the GENEActiv were more mixed when compared with those related to the mobile survey. Despite finding the monitor easy to start wearing, only half of respondents thought it was easy to wear overall and liked the placement of the monitor on their wrist. Less than half thought it was comfortable during sleep, and most disagreed it was easy to remember to press the event marker at wake and bed times. Many women were also disappointed in the informational feedback the GENEActiv provided; therefore, women's responses related to the benefits of and value in wearing the monitor

Table 9

Percentage of women who positively endorsed acceptability items*

	N	(%)
N	37	(58.7)
Survey Acceptability		
Easy to complete	35	(94.6)
Easy to read	34	(91.9)
Clear and understandable questions	25	(67.5)
Morning prompt convenient	33	(89.2)
Afternoon prompt convenient	29	(78.4)
Evening prompt convenient	34	(91.9)
3 times per day too much	17	(45.9)
Effort required to complete surveys was acceptable	28	(75.6)
Survey contained too many questions	12	(32.4)
Survey took too long to complete	3	(8.1)
Completing survey for 28 days was too much	10	(27.0)
Prompts helped me to remember to complete survey	35	(94.6)
Activity Monitor Acceptability		
Easy to wear	21	(56.7)
Like placement on the wrists	20	(54.0)
Wearing during sleep was comfortable	14	(37.8)
Wear 24 hours per day was too long	16	(43.2)
Effort to start using monitor was acceptable	26	(70.2)
Wearing the monitor was valuable to me	19	(51.3)
Easy to remember to press event marker	7	(18.9)
Recording bedtime was inconvenient	13	(35.1)
Recording wake time was inconvenient	9	(24.3)
Responding to prompts and wearing the monitor was inconvenient	12	(32.4)
Incentives		
Receiving activity feedback at end of study motivated me to respond to prompts	23	(62.1)
The chance to receive $100 motivated me to respond to prompts	25	(67.5)

*Positively endorsed = women agreed or strongly agreed

were mixed (Table 9). A majority of the additional comments (n=15) received at the end of the survey pertained to the GENEActiv. One woman wrote, "Quite frankly, the monitor was horrible …There was no confirmation when you pressed the button, it gave you absolutely no feedback to whether or not it was working and I wondered half the time if I wasn't wearing a placebo." Another commented, "I really was disappointed with the results of this monitor because I am such an active person and not with biking or walking, but activities that use my arms overhead, and this monitor did not pick up my activity." Two women also commented that the monitor irritated their skin, making it difficult to wear continuously for 24 hours per day.

Several women recommended the paper log for recording wake and bed times be distributed electronically or somehow integrated with the mobile surveys. One woman wrote, "The paper log was difficult for me to keep track of, even though it was on my nightstand. I would have preferred to enter this information directly onto a survey of some sort on my phone. I would have even preferred to get more frequent text prompts to do this than to have to deal with paper." Another wrote, "Doing a written log sucks. I would recommend you try to integrate it in with the questionnaire so there are less areas of completion."

Aims 2 and 3: Multilevel Models

Preliminary Analyses. Cronbach's alphas for each of the four self-worth domains were as follows: 0.47 (knowledge), 0.53 (emotional), 0.62 (social), and 0.76

(physical). Intraclass correlations for predictor variables and daily activity counts and inter-item correlations are presented in Tables 8 and 10, respectively.

Results from the unconditional means model (UMM) indicated that approximately 33% of the total variance in daily counts was within individuals (ICC = 0.67) (Table 8 in Appendix B). Figure 13 presents the distribution of daily activity counts over time. Unconditional growth models (UGMs) were explored with linear and quadratic time as predictors. Although the fixed effect of quadratic time was significant, $t(3521.02) = 2.31$, $p = 0.02$, the random effects model did not converge and the fixed effect became non-significant, $t(36885.39) = 1.21$, $p = 0.23$. While time was a significant predictor of within-person variations in daily activity counts (pseudo $R^2 = 0.12$), it was not a good predictor of between-person variations (pseudo $R^2 = -0.46$), as evidenced by the substantial increase in intercept-related variance between the UGM and step 3. The fixed effect of average daily self-efficacy, and fixed of daily fluctuations in self-efficacy were significant. A small, but significant random effect of daily fluctuations in self-efficacy was also observed. The final base model included linear time and self-efficacy (Table 11). This model explained an additional 19.1% of the variance within persons, but explained 32.1% less variance between persons when compared with the UMM. This decrease in between-subjects explained variance was primarily due to the random effect of linear time.

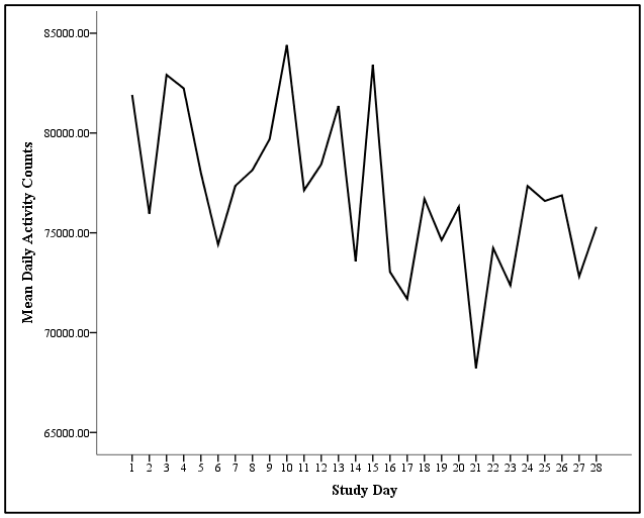


Figure 13. Daily Activity Counts across 28 Days

Knowledge self-worth. Neither the fixed effect of mean knowledge self-worth from item 1 nor daily fluctuations in knowledge-self-worth from item 1 were significant predictors of daily activity counts. This indicates that, on average, the extent to which women felt their physical activity knowledge affects the way they feel about themselves was not associated with overall activity across participants. It also indicates that daily fluctuations in the extent to which women felt their physical activity knowledge affects the way they feel about themselves was not associated with daily activity counts. The model fit was also significantly worse with the addition of knowledge self-worth item 1, χ^2 (3) = -17.21, $p < 0.001$, when compared with the final preliminary model (Table 11). The fixed effect of mean knowledge self-worth from item 2 was marginally significant; therefore, item 2 was tested in the model without item 1 (Table 12). In this model, the fixed effect of mean knowledge self-worth from item 2 was marginally significant, β = 0.18, $t(55.76) = 1.67$, $p = 0.10$. When compared with the final preliminary model (Step

Table 10

EMA Survey Inter-Item Correlations

		Self-Efficacy	General Self-Worth	Knowledge Self-Worth Item 1	Knowledge Self-Worth Item 2	Emotional Self-Worth Item 1	Emotional Self-Worth Item 2	Social Self-Worth Item 1	Social Self-Worth Item 2	Body Attractiveness	Physical Condition	Natural Log Daily Activity Counts
Self-Efficacy	Pearson r	1.00	.134**	.068**	.384**	.409**	.184**	-.034*	.125**	.169**	.253**	.315**
	p -value		0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
	N	3566	3553	3548	3548	3343	3538	3531	3531	3531	3519	3566
General Self-Worth	Pearson r	.134**	1.00	-.082**	.149**	0.01	.129**	.182**	.275**	.720**	.574**	.093**
	p -value	0.00		0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00
	N	3553	3555	3541	3540	3338	3531	3524	3523	3523	3511	3555
Knowledge Self-Worth 1	Pearson r	.068**	-.082**	1.00	.295**	.137**	.141**	-.336**	-.087**	0.00	.096**	.037*
	p -value	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.03
	N	3548	3541	3550	3538	3334	3528	3521	3520	3520	3508	3550
Knowledge Self-Worth 2	Pearson r	.384**	.149**	.295**	1.00	.406**	.431**	-.036*	.203**	.247**	.301**	.313**
	p -value	0.00	0.00	0.00		0.00	0.00	0.03	0.00	0.00	0.00	0.00
	N	3548	3540	3538	3550	3334	3530	3524	3522	3524	3511	3550
Emotional Self-Worth 1	Pearson r	.409**	0.01	.137**	.406**	1.00	.379**	-0.01	.124**	.044*	.076**	.186**
	p -value	0.00	0.44	0.00	0.00		0.00	0.75	0.00	0.01	0.00	0.00
	N	3343	3338	3334	3334	3347	3327	3320	3319	3320	3310	3347
Emotional Self-Worth 2	Pearson r	.184**	.129**	.141**	.431**	.379**	1.00	-.061**	.146**	.219**	.162**	.190**
	p -value	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	N	3538	3531	3528	3530	3327	3540	3518	3517	3517	3505	3540
Social Self-Worth 1	Pearson r	-.034*	.182**	-.336**	-.036*	-0.01	-.061**	1.00	.464**	.150**	0.00	-0.03
	p -value	0.04	0.00	0.00	0.03	0.75	0.00		0.00	0.00	0.79	0.07
	N	3531	3524	3521	3524	3320	3518	3533	3515	3515	3504	3533
Social Self-Worth 2	Pearson r	.125**	.275**	-.087**	.203**	.124**	.146**	.464**	1.00	.236**	.070**	.098**
	p -value	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
	N	3531	3523	3520	3522	3319	3517	3515	3533	3517	3506	3533
Body Attractiveness	Pearson r	.169**	.720**	0.00	.247**	.044*	.219**	.150**	.236**	1.00	.608**	.178**
	p -value	0.00	0.00	0.87	0.00	0.01	0.00	0.00	0.00		0.00	0.00
	N	3531	3523	3520	3524	3320	3517	3515	3517	3533	3510	3533
Physical Condition	Pearson r	.253**	.574**	.096**	.301**	.076**	.162**	0.00	.070**	.608**	1.00	.244**
	p -value	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00		0.00
	N	3519	3511	3508	3511	3310	3505	3504	3506	3510	3521	3521
Natural Log Daily Activity Counts	Pearson r	.315**	.093**	.037*	.313**	.186**	.190**	-0.03	.098**	.178**	.244**	1.00
	p -value	0.00	0.00	0.03	0.00	0.00	0.00	0.07	0.00	0.00	0.00	
	N	3566	3555	3550	3550	3347	3540	3533	3533	3533	3521	3573

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table 11

Preliminary Mixed Models Associated with Daily Activity Counts

Predictor Variable	UMM			UGM: Linear Time Fixed			Step 3: Linear Time Random			Step 6: Centered Self-Efficacy Random		
Fixed Effects	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*
Within Person												
Intercept	11.16 (0.04)	281.68	<0.001	11.19 (0.04)	278.49	<0.001	11.19 (0.05)	231.14	<0.001	10.83 (0.13)	87.23	<0.001
Time				-0.001 (0.00)	-5.12	<0.001	-0.001 (0.00)	-1.93	0.06	-0.001 (0.00)	-1.86	0.07
Self-Efficacy Centered										0.001 (0.00)	5.43	<0.001
Between Person												
Mean Self-Efficacy										0.006 (0.002)	3.06	0.003
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.045 (0.001)	41.92	<0.001	0.045 (0.001)	41.91	<0.001	0.040 (0.001)	41.5	<0.001	0.037 (0.001)	41.13	<0.001
Intercept	0.092	5.34	<0.001	0.092 (0.02)	5.34	<0.001	0.135 (0.03)	5.29	<0.001	0.116 (0.02)	5.23	<0.001
Time							0.00 (0.00)	4.34	<0.001	0.00 (0.00)	4.36	<0.001
Self-Efficacy Centered										0.00 (0.00)	3.11	0.002
Model Fit												
-2 Log Likelihood	-620.63			-631.04			-933.70			-1089.61		
BIC	-604.27			-614.68			-909.15			-1056.90		
Pseudo-R^2 Within				0.01			0.119			0.031		
Pseudo-R^2 Between				-0.01			-0.461			0.010		

6), however, the model fit did not significantly improve, χ^2 (1) = 0.11, p = 0.74. No fixed or random effects were observed for daily fluctuations in knowledge self-worth from item 2 (Table 12). These data indicated that daily fluctuations in knowledge self-worth form item 2 were not associated with daily activity counts, nor were there any individual differences in these associations.

Emotional self-worth. No significant fixed effects of mean emotional self-worth from item 1 were observed, indicating that average levels in how important women thought it was to be physically active were not associated with overall activity across participants. However, the fixed effect of daily fluctuations in emotional self-worth item from item 1 was significant, β = 0.045, t(3279.87) = 5.30, p < 0.001, indicating that daily fluctuations in how important women thought it was to take time to be active were associated with daily activity levels. Despite these results, the model fit significantly worsened with the addition of daily fluctuations in emotional self-worth from item 1, χ^2 (1) = -57.39, p < 0.001. The random effects model indicated that the predictive influence of daily fluctuations in emotional self-worth from item 1 significantly differed across women, β = 0.014, Z = 2.91, p = 0.004. Because item 1 contributed only small effects and did not contribute to the model fit, it was removed from the model and item 2 was tested independently. The final emotional self-worth model is presented in Table 13.

Neither the fixed effects of mean emotional self-worth from item 2 nor daily fluctuations in emotional self-worth from item 2 were significant predictors of activity counts. This indicates that, on average, the way women felt about being a better mother,

Table 12

Associations between Knowledge Self-Worth and Daily Activity Counts

Predictor Variable	Step 7: Mean Knowledge Self-Worth 2 Fixed			Step 8: Centered Knowledge Self-Worth 2 Fixed			Step 8: Centered Knowledge Self-Worth 2 Fixed		
Fixed Effects	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*
Within Person									
Intercept	10.45 (0.26)	40.98	<0.001	10.45 (0.26)	40.82	<0.001	10.45 (0.26)	40.81	<0.001
Time	-0.001 (0.00)	-1.86	0.07	-0.001 (0.00)	-1.82	0.08	-0.001 (0.00)	-1.83	0.07
Self-Efficacy Centered	0.001 (0.00)	5.43	<0.001	0.001 (0.00)	5.29	<0.001	0.001 (0.00)	5.31	<0.001
Knowledge SW2 Centered				0.009 (0.009)	1.00	0.32	0.009 (0.01)	0.82	0.37
Between Person									
Mean Self-efficacy	0.003 (0.002)	1.56	0.12	0.003 (0.002)	1.56	0.12	0.003 (0.002)	1.56	0.12
Mean Knowledge SW2	0.177 (0.11)	1.67	0.10	0.177 (0.11)	1.66	0.10	0.177 (0.11)	1.66	0.10
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.037 (0.001)	41.12	<0.001	0.037 (0.001)	41.01	<0.001	0.037 (0.001)	40.66	<0.001
Intercept	0.112 (0.02)	5.18	<0.001	0.113 (0.02)	5.18	<0.001	0.113 (0.02)	5.18	<0.001
Time	0.00 (0.00)	4.35	<0.001	0.00 (0.00)	4.35	<0.001	0.00 (0.00)	4.36	<0.001
Self-Efficacy Centered	0.00 (0.00)	3.11	0.002	0.00 (0.00)	3.12	0.002	0.00 (0.00)	3.11	0.002
Knowledge SW2 Centered							0.00 (0.001)	0.32	0.75
Model Fit									
-2 Log Likelihood	-1089.72			-1073.04			-1073.15		
BIC	-1057.01			-1040.35			-1032.29		
Pseudo-R^2 Within	0.000			0.000			0.001		
Pseudo-R^2 Between	0.031			-0.008			0.000		

wife, friend, and daughter by taking time to take care of themselves was not associated with overall activity across participants. This also indicates that daily fluctuations in responses to items 2 were not associated with daily activity. The random effect of daily fluctuations in emotional self-worth from item 2 was significant, indicating differences across women in relationships between daily fluctuations in item 2 and daily activity, β = 0.007, $Z = 2.53$, $p = 0.01$. Additionally, the model fit improved significantly when compared with the preliminary model, $\chi^2 (3) = 8.78$, $p = 0.03$. The final emotional self-worth model is presented in Table 13. This model explained an additional 1.9% of within-persons variance when compared with the final preliminary model in Step 6 (Table 11).

Social self-worth. No significant fixed effects of mean or daily fluctuations in social self-worth were observed for either item 1 or item 2. The random effect of daily fluctuations in social self-worth from item 1 was not significant, while the random effect of daily fluctuations in social self-worth from item 2 was significant, $\beta = 0.003$, $Z = 2.08$, $p = 0.04$. Therefore individual differences were observed across women in the relationship between daily fluctuations in how women felt about taking time away from her family to exercise and their daily activity levels. Despite the latter result, the inclusion of social self-worth in the model did not explain any additional within- or between-persons variance. Additionally, the model fit, as indicated by both the -2LL and BIC and when compared with the final preliminary model in Step 6, worsened with the inclusion

of the fixed and random effects of social self-worth, χ^2 (6) = -15.78, p = 0.01 (no table included).

Table 13

Associations between Emotional Self-Worth and Daily Activity Counts

Predictor Variable	Step 9: Emotional Self-Worth 2 Centered Random		
Fixed Effects	β (SE)	t	p
Within Person			
Intercept	10.46 (0.35)	30.32	<0.001
Time	-0.001 (0.00)	-1.89	0.07
Self-Efficacy Centered	0.001 (0.00)	5.34	<0.001
Emotional SW2 Centered	0.003 (0.02)	0.19	0.85
Between Person			
Mean Self-efficacy	0.005 (0.002)	2.69	0.009
Mean Emotional SW2	0.12 (0.11)	1.12	0.27
Random Effects	*var* (SE)	Z	p
Residual	0.037 (0.001)	40.68	<0.001
Intercept	0.116 (0.02)	5.18	<0.001
Time	0.00 (0.00)	4.39	<0.001
Self-Efficacy Centered	0.00 (0.00)	3.18	0.002
Emotional SW2 Centered	0.007 (0.003)	2.53	0.01
Model Fit			
-2 Log Likelihood	-1098.39		
BIC	-1057.54		
Pseudo-R^2 Within	0.019		
Pseudo-R^2 Between	-0.016		

Physical self-worth. Due to possible multicollinearity between body attractiveness and physical condition (r = 0.61) (Table 10), mean and centered body attractiveness variables were standardized in order to create orthogonal variables. The

physical self-worth results are presented in Tables 14 (physical condition) and 15 (body attractiveness [residual]). No significant fixed effects of average levels or daily fluctuations in body attractiveness or physical condition were observed.

A significant random effect of daily variations in physical condition was observed, $\beta = 0.006$, $Z = 2.19$, $p = 0.03$, indicating there were individual differences in the relationship between daily fluctuations in women's perceived physical condition and their daily activity counts. This effect became marginally significant, $\beta = 0.005$, $Z = 1.71$, $p = 0.09$, when the random effect of daily fluctuations in body attractiveness (residual) was added to the model. The model fit worsened with the addition of body attractiveness and physical condition to the fixed and random effects models. Additionally, body attractiveness and physical condition explained no additional variance in daily activity counts (Tables 14 and 15).

General self-worth. The general self-worth model is presented in Table 16. The fixed effect of mean general self-worth was not significant; however, significant fixed, $\beta = 0.048$, $t(3494.44) = 5.65$, $p < 0.001$, and random, $\beta = 0.005$, $Z = 2.40$, $p = 0.09$ effects of daily fluctuations in general self-worth were observed. These results indicate that, while average level general self-worth did not significantly predict activity, daily fluctuations in self-worth predicted daily activity counts and this relationship varied across participants. Daily fluctuations in general self-worth explained an additional 2.6% within-persons variance in daily activity counts, but explained 1.8% less between-persons variance. The model fit significantly improved with the addition of daily fluctuations in

Table 14

Associations between Physical Condition and Daily Activity Counts

Predictor Variable	Step 7: Mean Physical Condition Fixed			Step 8: Centered Physical Condition Fixed			Step 9: Centered Physical Condition Random		
Fixed Effects	β (SE)	*t*	*p*	β (SE)	*t*	*p*	β (SE)	*t*	*p*
Within Person									
Intercept	10.68 (0.18)	60.51	<0.001	10.67 (0.18)	60.48	<0.001	10.67 (0.18)	60.40	<0.001
Time	-0.001 (0.00)	-1.87	0.07	-0.001 (0.00)	-1.72	0.09	-0.001 (0.00)	-1.64	0.11
Self-Efficacy Centered	0.001 (0.00)	5.43	<0.001	0.001 (0.00)	5.53	<0.001	0.001 (0.00)	5.45	<0.001
Physical Condition Centered				0.012 (0.01)	1.06	0.29	0.01 (0.02)	0.60	0.56
Between Person									
Mean Self-efficacy	0.005 (0.002)	2.33	0.02	0.005 (0.002)	2.33	0.020	0.005 (0.002)	2.34	0.020
Mean Physical Condition	0.087 (0.07)	1.19	0.24	0.088 (0.07)	1.21	0.23	0.086 (0.07)	1.18	0.24
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.037 (0.001)	41.13	<0.001	0.037 (0.001)	40.84	<0.001	0.037 (0.001)	40.57	<0.001
Intercept	0.115 (0.02)	5.18	<0.001	0.115 (0.02)	5.19	<0.001	0.115 (0.02)	5.18	<0.001
Time	0.00 (0.00)	4.36	<0.001	0.00 (0.00)	4.35	<0.001	0.00 (0.00)	4.36	<0.001
Self-Efficacy Centered	0.00 (0.00)	3.11	0.002	0.00 (0.00)	3.00	0.003	0.00 (0.00)	3.01	0.003
Physical Condition Centered							0.006 (0.00)	2.19	0.03
Model Fit									
-2 Log Likelihood	-1087.64			-1050.93			-1067.08		
BIC	-1054.93			-1018.27			-1026.26		
Pseudo-R^2 Within	0.00			-0.004			0.014		
Pseudo-R^2 Between	0.007			0.000			-0.003		

Table 15

Associations between Body Attractiveness and Daily Activity Counts

Predictor Variable	Step 10: Mean Body Attractiveness (Residual) Fixed			Step 11: Centered Body Attractiveness (Residual) Fixed			Step 12: Centered Body Attractiveness (Residual) Random		
Fixed Effects	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*
Within Person									
Intercept	10.59 (0.28)	37.26	<0.001	10.59 (0.28)	37.25	<0.001	10.59 (0.28)	37.27	<0.001
Time	-0.001 (0.00)	-1.64	0.11	-0.001 (0.00)	-1.60	0.12	-0.001 (0.00)	-1.61	0.11
Self-Efficacy Centered	0.001 (0.00)	5.44	<0.001	0.001 (0.00)	5.42	<0.001	0.001 (0.00)	5.40	<0.001
Body Attractiveness Centered				-0.03 (0.02)	-1.69	0.09	-0.03 (0.02)	-1.64	0.11
Physical Condition Centered	0.01 (0.02)	0.59	0.56	0.035 (0.02)	1.60	0.11	0.036 (0.02)	1.64	0.11
Between Person									
Mean Self-efficacy	0.005 (0.002)	2.33	0.02	0.005 (0.002)	2.34	0.02	0.005 (0.002)	2.33	0.020
Mean Body Attractiveness	-0.061 (0.16)	-0.38	0.71	-0.061 (0.16)	-0.38	0.70	-0.061 (0.16)	-0.38	0.70
Mean Physical Condition	0.121 (0.12)	1.04	0.30	0.121 (0.12)	1.04	0.30	0.121 (0.12)	1.04	0.30
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.037 (0.001)	40.57	<0.001	0.037 (0.001)	40.50	<0.001	0.037 (0.001)	40.41	<0.001
Intercept	0.117 (0.02)	5.14	<0.001	0.117 (0.02)	5.14	<0.001	0.117 (0.02)	5.14	<0.001
Time	0.00 (0.00)	4.37	<0.001	0.00 (0.00)	4.37	<0.001	0.00 (0.00)	4.36	<0.001
Self-Efficacy Centered	0.00 (0.00)	3.01	0.002	0.00 (0.00)	3.00	0.003	0.00 (0.00)	3.01	0.003
Body Attractiveness Centered							0.001 (0.001)	0.57	0.57
Physical Condition Centered	0.006 (0.003)	2.19	0.03	0.006 (0.003)	2.18	0.03	0.005 (0.003)	1.71	0.09
Model Fit									
-2 Log Likelihood	-1065.37			-1053.89			-1054.28		
BIC	-1024.55			-1013.09			-1055.31		
Pseudo-R^2 Within	0.00			-0.001			0.001		
Pseudo-R^2 Between	-0.016			0.00			0.001		

general self-worth in both the fixed effects model, χ^2 (2) = 12.58, p = 0.002, and random effects model, χ^2 (1) = 22.66, $p < 0.001$.

Final model. Based on the above results, final models examining the effects of emotional self-worth item 2, independent of self-efficacy and general self-worth, were tested. The effects of self-efficacy and general self-worth remained significant with the addition of emotional self-worth item 2 in the model. Similar to the emotional self-worth model (Table 13), neither the fixed effect of average levels of emotional self-worth from item 2 nor the daily fluctuations in emotional self-worth from item 2 were significantly associated with daily activity counts. However, the random effect of daily fluctuations in emotional self-worth from item 2 was significant, β = 0.006, Z = 2.34, p = 0.02, independent of self-efficacy and general self-worth. Despite these results, the model fit did not improved as assessed by changes in the -2LL, χ^2 (3) = 4.57, p = 0.21, or the BIC when compared with the final general self-worth model.

The final model, including time, self-efficacy, general self-worth, and emotional self-worth item 2, is presented in Table 17. This model explained an additional 23.7% of within persons variance, but explained 34.3% less between persons variance in daily activity (mainly due to the random effects of time). Time (pseudo-R^2 = 0.126) and self-efficacy (pseudo-R^2 = 0.065) were the strongest predictors of within persons variance in daily activity, followed by general self-worth (pseudo-R^2 = 0.031) and emotional self-worth item 2 (pseudo-R^2 = 0.016). Self-efficacy was the strongest predictor of between persons variance in daily activity (pseudo-R^2 = 0.148). Time, general self-worth, and

emotional self-worth item 2 did not explain any between persons variance in daily activity.

Table 16

Associations between General Self-Worth and Daily Activity Counts

Predictor Variable	Step 7: Mean General Self-Worth Fixed			Step 8: Centered General Self-Worth Fixed			Step 9: Centered General Self-Worth Random		
Fixed Effects	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*	*β* (SE)	*t*	*p*
Within Person									
Intercept	10.78 (0.20)	55.49	<0.001	10.77 (0.20)	53.78	<0.001	10.77 (0.20)	53.51	<0.001
Time	-0.001 (0.00)	-1.86	0.07	-0.001 (0.00)	-1.55	0.13	-0.001 (0.00)	-1.58	0.12
Self-Efficacy Centered	0.001 (0.00)	5.43	<0.001	0.001 (0.00)	5.12	<0.001	0.001 (0.00)	5.38	<0.001
General SW Centered				0.048 (0.008)	5.65	<0.001	0.048 (0.01)	3.47	0.001
Between Person									
Mean Self-efficacy	0.005 (0.002)	2.91	0.005	0.005 (0.002)	2.93	0.005	0.005 (0.002)	2.92	0.005
Mean General SW	0.018 (0.06)	0.28	0.78	0.02 (0.07)	0.32	0.75	0.018 (0.07)	0.28	0.78
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.037 (0.001)	41.13	<0.001	0.037 (0.001)	41.04	<0.001	0.036 (0.001)	40.73	<0.001
Intercept	0.111 (0.021)	5.32	<0.001	0.118 (0.02)	5.19	<0.001	0.120 (0.02)	5.19	<0.001
Time	0.00 (0.00)	4.39	<0.001	0.00 (0.00)	4.43	<0.001	0.00 (0.00)	4.47	<0.001
Self-Efficacy Centered	0.00 (0.00)	3.1	0.002	0.00 (0.00)	3.06	0.002	0.00 (0.00)	2.96	0.003
General SW Centered							0.005 (0.002)	2.40	0.02
Model Fit									
-2 Log Likelihood	-1086.05			-1102.19			-1124.85		
BIC	-1053.34			-1069.50			-1083.98		
Pseudo-R^2 Within	0.00			0.009			0.017		
Pseudo-R^2 Between	-0.017			-0.007			-0.011		

Table 17

Final Mixed Models Associated with Daily Activity Counts

Predictor Variable	Step 10: Table 16 + Mean Emotional Self-Worth 2 Fixed			Step 11: Centered Emotional Self-Worth Fixed			Step 13: Centered Emotional Self-Worth Random		
Fixed Effects	β (SE)	*t*	*p*	β (SE)	*t*	*p*	β (SE)	*t*	*p*
Within Person									
Intercept	10.44 (0.37)	28.39	<0.001	10.44 (0.37)	28.48	<0.001	10.44 (0.37)	28.30	<0.001
Time	-0.001 (0.00)	-1.57	0.12	-0.001 (0.00)	-1.59	0.12	-0.001 (0.00)	-1.63	0.11
Self-Efficacy Centered	0.001 (0.00)	5.38	<0.001	0.001 (0.00)	5.47	<0.001	0.001 (0.00)	5.32	<0.001
General SW Centered	0.048 (0.01)	3.47	0.001	0.047 (0.014)	3.35	0.002	0.044 (0.01)	3.21	0.003
ESW2 Centered							0.004 (0.02)	0.24	0.81
Between Person									
Mean Self-efficacy	0.005	2.60	0.01	0.005 (0.002)	2.30	0.01	0.005 (0.002)	2.62	0.010
Mean General SW	0.009 (0.07)	0.14	0.89	0.008 (0.07)	0.13	0.90	0.009 (0.07)	0.14	0.89
Mean ESW2	0.119 (0.11)	1.09	0.28	0.117 (0.11)	1.07	0.29	0.116 (0.11)	1.05	0.30
Random Effects	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*	*var* (SE)	*Z*	*p*
Residual	0.036 (0.001)	40.73	<0.001	0.036 (0.001)	40.59	<0.001	0.036 (0.001)	40.32	<0.001
Intercept	0.119 (0.02)	5.14	<0.001	0.118 (0.02)	5.14	<0.001	0.120 (0.02)	5.14	<0.001
Time	0.00 (0.00)	4.47	<0.001	0.00 (0.00)	4.46	<0.001	0.00 (0.00)	4.5	<0.001
Self-Efficacy Centered	0.00 (0.00)	2.96	0.003	0.00 (0.00)	2.92	0.002	0.00 (0.00)	3.03	0.002
General SW Centered	0.005 (0.002)	2.40	0.02	0.005 (0.002)	2.41	0.02	0.005 (0.002)	2.33	0.02
ESW2 Centered							0.006 (0.003)	2.34	0.02
Model Fit									
-2 Log Likelihood	-1123.45			-1111.81			-1129.42		
BIC	-1082.58			-1070.98			-1080.42		
Pseudo-R^2 Within	0.00			0.001			0.015		
Pseudo-R^2 Between	0.022			0.005			-0.013		

Chapter 5

DISCUSSION

The purpose of this study was to explore (a) the feasibility of an EMA protocol, administered via text messaging and mobile Internet-based surveys, in middle-aged women (Aim 1), (b) temporal relationships between self-worth and physical activity participation in middle-aged women (Aim 2), and (c) associations between non-physical self-worth domains and physical activity participation in middle-aged women (Aim 3). Major findings of this study suggest that an EMA protocol employing text messaging, mobile Internet, and participants' personal mobile phones is feasible for collecting momentary data on middle-aged women's psychosocial and behavioral states. Findings related to Aims 2 and 3 suggest that self-worth may not predict regular activity in middle-aged women. However, daily fluctuations in general self-worth and, to a lesser extent, emotional self-worth may be associated with daily fluctuations in women's physical activity. There may also be individual differences in these relationships across women. Despite this evidence, self-efficacy appears to remain a stronger predictor of both regular physical activity and daily fluctuations in physical activity when compared with self-worth.

Aim 1: Feasibility

The findings related to Aim 1 indicate that the methodology designed for this study was feasible and may be applied to future studies within and outside of physical activity research. Smyth and Heron (2014) have stressed the importance of participant compliance in order to validly answer research questions. As such, they recommend

researchers employ passive data collection techniques in addition to momentary self-report, balance the frequency and duration of assessments, adequately train participants, utilize user-friendly hardware and software, and provide cues to remind participants to complete assessments. When designing this study, all of these measures were considered and contributed to the successful completion of Aim 1.

Participant compliance with objective physical activity monitoring. Wear time among women in both phases was very high, higher than rates reported in other EMA studies (Dunton et al., 2012) and studies in middle-aged women (Gabriel, McClain, High, Schmid, Whitfield, & Ainsworth, 2012). Women wore the accelerometer for almost sixteen hours per day and had valid data on approximately 25 of 28 days. High wear time may have been due to (a) the use of a wrist-worn accelerometer (as opposed to a waist-worn monitor) (Huberty, Ehlers, Kurka, Ainsworth, & Buman, in review), and (b) passive techniques of physical activity data collection (Smyth & Heron, 2014).

Wrist-worn accelerometer. The GENEActiv was chosen because of its placement on the wrist, in addition to its moderate cost and ability to continuously measure movement for 30 days at a relatively fast sampling rate (20Hz) (Matthews, Hagströmer, Pober, & Bowles, 2012). Results from Huberty et al. (in review) indicated that middle-aged women prefer to wear activity monitors on their wrist compared with their hip, where monitors are traditionally positioned (Troiano et al., 2008). However, women in Huberty et al. (in review) also reported preferring their upper arm to their wrist. Our data support this previous research, as only approximately half of the survey respondents liked the placement of the GENEActiv on the wrist. As such, researchers may consider newer

innovations in physical activity measurement. The new wave of consumer devices (e.g., Jawbone UP band, Fitbit) may provide promising alternatives to activity monitors traditionally used in research settings because devices are less conspicuous than research-grade monitors. Many of these monitors are small, wrist-worn, and more attractive than the GENEActiv; provide wireless, real-time access to participant data; and are currently undergoing validity testing in laboratory and free-living environments.

Adoption of these commercial monitors may have important implications in EMA research. First, it may provide the opportunity to mitigate data lost due to device malfunction and non-wear. For example, the GENEActiv does not allow real-time monitoring of activity states and we were not able to identify device malfunction or non-wear time as they occurred during the study. As a result, a total of 449 observations (8.5% of eligible observations) were lost due to device malfunction, resulting in complete loss of data in four participants. Real-time monitoring may also help researchers remedy consistent non-wear among less compliant participants or to enroll new participants to maintain target sample sizes without substantially extending study timelines. Second, the use of activity monitors that offer real-time, remote access to participant data may provide opportunities to design ecological momentary interventions (EMIs) using a combination of momentary data on psychological states and objectively measured physical activity. This combined approach permits researchers to individually tailor the content and timing of interventions delivered in real time. Pew Internet and American Life data indicate that cell phone and smartphone owners (70% and 86%, respectively) are already using their phones to access “just in time” information within the course of

their own lives (Rainie & Fox, 2012). Combined EMA-EMI represents a new area gaining a lot of attention in health behavior research and warranting further study (Heron & Smyth, 2010; Smyth & Heron, 2014).

Passive technique of data collection. Despite moderate to high levels of dissatisfaction with the GENEActiv, women may have worn the device as instructed because of other efforts taken to reduce participant burden. As a passive method of data collection, the GENEActiv did not require a large amount of effort from the participant. For example, participants were not required to recharge, download, or replace the monitor in the middle of the assessment period. This is important, as battery and memory limitations represent a significant challenge in objective physical activity monitoring in studies with intensive longitudinal designs. Many research-grade accelerometers are limited to a battery and memory capacity of 7-10 days, depending upon the sampling rate (Matthews et al., 2012). A strength of this study is its reliance upon an accelerometer that did not add participant burden in the forms of monitor maintenance or additional contact with research personnel.

Although concerted efforts were made to limit participant burden, women reported that logging their wake and bed times via the GENEActiv's "button" and on the paper-based log was inconvenient. This may have contributed to mixed responses related to the ease of use of the GENEActiv (Table 9). This is a relatively new research challenge, as 24-hour objective monitoring has only recently gained attention in behavioral research (Buman et al., 2013; Huberty et al., in review; Matthews et al, 2012). To reduce this burden, future iterations of this study may test alternate methods of

recording, such as (a) including a wake and bed time item on the morning and evening surveys or (b) scheduling an extra prompt with a link specifically designated for the report of wake and bed times.

Limitations and Future Research. The GENEActiv has only recently emerged in the physical activity literature, with most studies still validating its use in different contexts and populations (Esliger et al., 2011; Welch et al., 2013; Zhang, Rowlands, Murray, & Hurst, 2012). While data from this study indicate its practicability, more research testing its validity in free-living environments is warranted. Women's activity levels as estimated by the GENEActiv were quite sobering. Although participants self-reported 230 minutes of moderate-to-vigorous physical activity at baseline, the accelerometer captured only 5.59 minutes per day. Women achieved at least 30 minutes of physical activity on only 7.71% of days, but at baseline 63.8% self-reported at least 150 minutes of moderate-to-vigorous physical activity during the week prior to their participation in the study. There is empirical evidence that correlations between objectively measured physical activity and subjective ratings of physical activity are not strong, especially among females (Kanning et al., 2013). Although more research testing the GENEActiv in free-living environments is needed, the disparity in self-reported v. objectively measured physical activity is disconcerting. These results are similar to NHANES data in which accelerometry estimates indicated that only approximately 6% of women achieve physical activity guidelines compared with 50% from self-reported surveillance data (Troiano et al., 2008).

The use of a wrist-worn accelerometer in this study may have limited our ability to capture some of the activities women reported on the PW-MAQ (e.g., gardening, cycling, strength training). Further efforts to more accurately estimate and characterize women's activity levels (Matthews et al., 2012; Troiano, McClain, Brychta, & Chen, 2014) are needed. Despite the above limitation, a strength of this study includes the collection of momentary, self-reported data on women's current activity, in addition to accelerometer-derived estimates of activity. Examination of women's responses to the current activity item (Figure 5, Table 2) in conjunction with concurrently measured objective physical activity estimates may provide important contextual information related to women's activity levels. Such information may provide further information on associations between psychological and activity states and may aid in the development of new strategies for improving women's physical activity.

Participant compliance with mobile survey completion. Despite loss of data from the accelerometer, the overall percentage of observations that were valid was quite high, higher than rates observed in other studies utilizing more sophisticated/expensive designs (Dunton et al., 2012). Dunton and colleagues (2012) observed a valid observation rate of approximately 61% over the course of a 4-day study, while 67.5% of observations in this study were valid. High accelerometer wear time and moderate to low device malfunction, in addition to survey completion rates, contributed to the large number of valid observations. Survey completion rates may have been high because of the balanced frequency and duration of assessments, baseline training of participants, utilization of

participants' personal cell phones and user-friendly data collection software, and use of prompts to remind participants to complete surveys.

Frequency and duration of assessments. Survey completion across 28 days was high (80.8%) and is similar to compliance in other EMA studies utilizing cell phones for data collection (Dunton et al., 2012; Courvoisier, Eid, & Lischetzke, 2012). For example, Dunton and colleagues (2012) reported 82% compliance across 32 assessments prompted on a study issued cell phone over 4 days. Our study was much longer and included over twice as many prompts. Further, completion rates in our study excluded responses not meeting eligibility criteria, in addition to missing responses. Only 25 percent of women who responded to the usability survey thought the 28-day assessment period was too long. Several repeated observations are needed to conduct adequately powered studies examining dynamic correlates of physical activity (Shiffman et al., 2008). Limiting the number of prompts to 3 times per day and tailoring the prompting scheme to each woman's schedule may have contributed to the high response rate despite the study length. While this is promising for future EMA research, the frequency and duration of assessment should ultimately be determined by the research questions and the nature of the psychological and behavioral states of interest (Kanning et al., 2013; Shiffman et al., 2008).

Training of participants. Participants were taught how to complete the survey during a one-on-one intake appointment with research personnel (Smyth & Heron, 2014). A sample prompt was sent to participants during the appointment to ensure they could receive text messages from a short code SMS service and to provide them with an

opportunity to preview the survey. Women were instructed to take the survey to become familiar with the interface and the content of the eleven items, and to practice responding in relation to how they feel *right now*. Experts in EMA research have stressed the importance of training participants to optimize the number of non-missing observations and the validity of response (Armey, Crowther, & Miller, 2011; Smyth & Heron, 2014).

User-friendly hardware and software. The high response rate may also be partially explained by the usability of the mobile survey. Only minimal amounts of training were required because other measures to optimize the usability of the survey were taken when designing the protocol (Heron & Smyth, 2010). The delivery protocol was developed using previous research in mobile applications and physical activity in middle-aged women (Ehlers & Huberty, 2013), in consultation with an expert in Information Systems, and using Information Systems technology acceptance theory (i.e., Unified Theory of Acceptance and Use of Technology [UTAUT]) (Venkatesh et al., 2003). ISS research in technology acceptance has provided evidence that usability features related to ease of use are particularly important for women and aging individuals when considering whether or not to adopt (i.e., use) a system (Venkatesh et al., 2003). In a study by Ehlers and Huberty (2013), factors related to effort expectancy (i.e., perceived ease of use) were more often cited as important to middle-aged women when using a physical activity mobile application as compared to factors related to performance expectancy (i.e., perceived usefulness). Findings of the current study support this previous research, as over 90 percent of participants thought the survey was easy to complete, easy to read, and did not take too long to complete, while only 62 percent were

motivated by the prospect of receiving informational feedback at the end of the study. Most women also reported that the survey items were clear and understandable and that the effort required was acceptable. Strategies to maximize ease of use in this study included: utilization of a user-friendly mobile interface, inclusion of only one item per screen, use of women's personal cell phones, and limiting the length of time required to complete the survey. Usability results are promising, as this study utilized commercially available software and sampled women 84 times over the course of 28 days. Improvements in mobile Internet technologies and employment of Information Systems theory-based principles of technology acceptance may improve the availability and feasibility of intensive longitudinal studies, especially among researchers with limited resources.

In addition to the usability of the survey, the use of women's personal cell phones may have contributed to the high response rate observed in this study. Rates were higher than other studies that issued devices to participants. For example, LePage and Crowther (2010) provided participants personal data assistants (PDAs), and completion rates averaged 75% for signal-contingent and 46% for event-contingent (i.e., after bouts of physical activity) assessments. Today 81% of cell phones owners send or receive text messages and 58% of American adults own smartphones (Pew Internet & American Life, 2014). The inclusion criteria related to smartphone ownership and willingness to accept text message costs excluded very few women (n=8) from the study. This is not only important from a cost perspective, but in relation to the feasibility and validity of EMA as well. First, Information Systems research suggests that utilizing systems with which

participants are already familiar improves the likelihood that users will adopt the system (Venkatesh et al., 2003). Some women reported that they liked completing the surveys on their cell phones because it was convenient (Courvoisier et al., 2012). Moreover, EMA experts have emphasized that designs capitalizing on systems with which participants are already familiar (e.g., personal devices) may yield more valid responses (Walls et al., 2006). The additional burden of learning a new system or remembering to carry a study-issued mobile device may introduce unintended error. Efforts to minimize the amount of training required may, therefore, not only improve the feasibility of EMA designs, but may improve the integrity of the data as well. To date, few studies have used participants' personal cell phones to collect EMA data (Courvoisier et al., 2012; Kuntsche & Labhart, 2013). Our findings support recent data from Kuntsche and Labhart (2013), who demonstrated the feasibility of an Internet-based EMA methodology using participants' personal cell phones. This study also provided evidence that Internet-based methods of data collection can be easily administered on personal cell phones and that the use of personal devices may ultimately improve participant retention and compliance.

Survey prompts. Almost all women agreed the prompts reminded them to take the mobile surveys. Indeed, prompts are a staple of signal-contingent sampling schemes (Shiffman et al., 2008; Smyth & Heron, 2014). The current study included a prompting schedule tailored to women's wake and bed times. Specifically, the morning and evening text message prompts were sent fifteen minutes after women's typical wake time and 90 minutes before women's typical bedtime (respectively). The tailored prompting schedule was novel and may have contributed to the convenience women reported in relation to the

times of day they were prompted. Future studies may consider tailoring the afternoon prompt as well (messages sent to all women at a random time between 2:00 and 3:00pm). Not only was the afternoon reported as the least convenient time of day, but for some women it did not represent the midpoint of the day. For example, one woman awoke at approximately noon and went to bed at approximately 3:00am each day. The afternoon prompt may not have provided an accurate measure of midday variation in any of the measures because of its proximity to the morning prompt.

Despite tailoring the morning prompts to women's typical wake time and women reporting the morning time as convenient, morning had the fewest number of valid observations. This was mostly due to invalid responses (not missing data). Because few morning prompts were missed, women may have reported the morning time as convenient. However, the loss of data due to participation in physical activity prior to the prompt is a problem. Important information regarding relationships between self-worth and physical activity may have been lost due to the loss of 252 invalid morning observations. Tailoring schedules to women's actual wake time (rather than typical wake time) may mitigate some of these missing data. Development of methods to prompt women immediately after waking are needed. However, researchers should take care to anticipate unintended consequences that may result from the adoption of more precise approaches of prompting. Such consequences may include increased missing data due to increased participant burden or reliance upon the participant to initiate interaction with the system to receive the link to the morning survey (Shiffman et al., 2008).

Limitations of the approach. Although inexpensive, the approach was relatively time intensive on the front end and ongoing during the study. The Panels feature in Qualtrics was used to reduce participant burden and made backend data management organized and simple. The Panels feature provided the opportunity to embed data in the surveys. In this study we embedded participant ID, study day, and time of day (e.g., ID 001, Day 25, Time 3) into each survey. Therefore, each time a woman completed a survey, the data output included this information, in addition to her responses to the eleven EMA items, without requiring her to enter it. However, in order to include unique embedded data in each survey, panels had to be created for each data point (N = 84) and separate links had to be created and text messaged to each participant for each observation (i.e., N = 84 text messages created and scheduled per participant). The use of basic text messaging software and an Internet-based survey system contributed to the uniqueness and availability of this EMA approach. Nevertheless, testing of more sophisticated programs that better automate test message scheduling and/or utilize machine learning to progressively embed data, such as observation number, is warranted.

Women were instructed to contact the researcher if they did not receive a text message as expected. Some women were more communicative than others. Therefore, the number of ineligible responses due to researcher error or text message prompting malfunction may be underestimated. The text messaging software provided confirmation that messages were sent successfully, but provided no information relative to whether messages were received or read. This is a limitation in most studies utilizing text messaging to communicate with participants due to carrier and user restrictions. As such

most studies have relied upon participant self-report of text message receipt and reading (Fjeldsoe, Miller, & Marshall, 2010; Fjeldsoe, Phongsavan, Bauman, Goode, Maher, & Eakin, 2014). Objective tracking data may provide important information related to the feasibility of EMA approaches that rely upon text message prompts.

The simple sampling scheme prohibited our ability to automate reminder prompts when participants did not complete surveys. The number of valid observations declined in a linear fashion over the 28-day period (Figure 11), indicating that more efforts to promote survey completion may have been needed. Although many of the invalid observations during the second half of the study period were due to accelerometer device malfunctions, survey responses also declined. Future studies may consider including "booster" communications between researchers and participants to mitigate non-response and/or may consider innovative incentive structures that include greater rewards towards the end of the study period (e.g., survey responses on days 14-28 are worth two submissions in the cash drawing).

Aims 2 and 3: Temporal Relationships between Self-Worth and Physical Activity

The findings related to Aims 2 and 3 indicate that self-worth may not be a strong predictor of regular or daily activity in middle-aged women. Self-efficacy, on the other hand, may be a strong predictor of daily variations in activity in middle-aged women (Dunton et al., 2009), in addition to regular participation in physical activity (Bandura, 2004; Elavsky & McAuley, 2007; McAuley et al., 2005; White et al., 2005). Despite modest effects related to self-worth, further research in this area is warranted, particularly in relation to general and emotional self-worth.

Knowledge self-worth. Results of this study suggest that middle-aged women's knowledge self-worth may not predict regular or daily participation in physical activity. Knowledge, although necessary, is not recognized as a sufficient ingredient in health behavior change, making it a weak predictor of health behaviors (Bauman, Sallis, Dzewaltowski, & Owen, 2002). The influence of knowledge is thought to be most relevant in insufficiently active women desiring to make a behavior change (Silva et al., 2010), as individuals at this stage lack knowledge and need action-oriented information for adopting behaviors (Weinstein, Sandman, & Blalock, 2008). The majority of women in this study perceived themselves as already regularly physically active at baseline, suggesting that most already perceived some level of physical activity knowledge. Testing the influence of knowledge self-worth on physical activity participation in a sample of inactive or insufficiently middle-aged women may be more informative.

The second knowledge self-worth item used in this study addressed women's feelings of happiness when thinking about physical activity/exercise ("RIGHT NOW thinking about exercising/physical activity makes me happy"). Previous research has proposed that happiness may be too global of a construct to be related to physical activity (McAuley, Blissmer, Marquez, Jerome, Kramer, & Katula, 2000b). This suggests that, while physical activity generally varies within individuals, happiness may be a relatively stable construct that does not vary over time. Therefore, Item 2 used in this study may not have been a good indicator of the extent to which knowledge self-worth may vary within and across days.

Finally, the internal consistency of the two items used to assess knowledge self-worth in this study was unacceptable. Therefore, valid conclusions related to the predictive role of knowledge self-worth cannot be made. Although the WPASWI has been tested for reliability and validity (Huberty et al., 2013b), its external validity and validity in EMA studies are unknown. Further testing of and refinements to the WPASWI are needed (Huberty et al., 2013b), particularly in the context of EMA research. Finally, variations in knowledge self-worth within participants were limited (Table 8). Health behavior theories provide evidence that cognitive (i.e., knowledge) orientations to behavior change may be more effective in determining less complex behaviors (e.g., preventive screenings), as they do not consider the emotional component of behavior (Champion & Skinner, 2008). Findings of the current study suggest that, while further testing of the influence of knowledge self-worth on regular physical activity may be warranted, there is little evidence to suggest that knowledge self-worth serves as a meaningful predictor of daily fluctuations in physical activity.

Emotional self-worth. Like knowledge self-worth, emotional self-worth did not predict regular activity or daily variations in activity in middle-aged women. However, small individual differences were observed in the relationship between daily fluctuations in women's responses to Item 2 and their daily physical activity. This suggests that some women were more physically active on days when they felt taking care of themselves would help them be a better wife, mother, or daughter. The small sample size limited our ability to test time invariant predictors, such as age, marital status, and reasons for exercise, that may have contributed to the individual differences observed in the

relationship between daily fluctuations in Item 2 and daily physical activity. For example, was this relationship different for married women when compared with single women? Was this relationship stronger for women more intrinsically motivated for physical activity (Teixeira, Carraça, Markland, Silva, & Ryan, 2012)? Although the model fit did not improve with the addition of emotional self-worth item 2, these preliminary data justify additional research examining potential relationships between emotional self-worth and physical activity in middle-aged women.

No significant results related to Item 1 were observed. Item 1 addressed women's perceived importance of physical activity "today". Although early research indicated that perceived importance of behaviors were related to self-worth (Marsh et al., 1994), more recent data have suggested that changes in ratings related to perceived importance have little impact on changes in self-worth (McAuley et al., 1997). Additionally, women's overall ratings for this item were quite high, suggesting that most women, regardless of their daily physical activity levels, perceived daily physical activity as important. Therefore, emotional self-worth as measured from Item 1 was a non-factor in influencing women's daily physical activity participation.

Social self-worth. No significant effects were observed relative to social self-worth. Rasch analyses in the original validation study indicated that the social self-worth needed some revision (Huberty et al., 2013b). Although original items and revised items were tested in a new sample of women, results of exploratory and confirmatory factor analyses in the cross-validation sample still suggest the scale needs further revision (unpublished data). Therefore, the scale may not have been a valid measure of women's

social self-worth related to physical activity. Despite this, results related to social self-worth were surprising. Item 1 directly addressed social support from family and friends, while Item 2 focused on taking time away from family to exercise. Social support is known as a strong determinant of physical activity in women and support from family and friends may be specifically important to women (Eyler et al., 2002; Huberty et al., 2013b; Vrazel et al., 2008). Despite this, less is known about relationships between social support and self-worth in the context of physical activity (Thoits, 2011). In a recent study by Huberty and colleagues (2013b), women reported valuing social support from family (particularly husbands) and other women participating in the physical activity program; however, women did not relate this support to how they felt about themselves. This suggests that while social support may influence women's physical activity participation and quality of life, it may not impact her feelings of worthiness. More research to understand the social aspect of self-worth in the context of physical activity is needed.

In the same study (Huberty et al., 2013b), women discussed their self-worth in terms of prioritizing themselves and did not express feelings of guilt for taking time for themselves. Results related to social self-worth Item 2 support these findings. Item 2 addressed how taking time away from family to exercise made women feel. Not only were no significant effects observed between Item 2 and physical activity, but women's ratings on Item 2 suggest that they did not feel bad taking time away from their families to be active (Table 8).

Physical self-worth. Physical self-worth is one of the most studied self-worth domains relative to physical activity participation. Despite consistent evidence linking

physical activity with perceived body attractiveness and physical condition, neither were significant predictors of activity in this study. However, correlations between body attractiveness and physical condition and general self-worth were moderate to high (Table 10). Although more research is needed, these data indicate that women's perceptions of body attractiveness in particular may be associated with their overall perceptions of worthiness. Previous research provides evidence that body attractiveness and physical condition predict general self-worth in middle-aged women and that many women refer to their overall self-worth in relation to their body image (Elavsky & McAuley, 2007; Elavsky, 2009; McAuley et al., 2005; Moore et al., 2012). This is problematic, as our findings, in addition to previous research, suggest that physical motives may not be good predictors of women's participation in physical activity (Segar et al., 2006, 2008). Unfortunately, a large body of evidence indicates that women often have physical motives for participating in physical activity, which may be detrimental to their self-worth (Elavsky & McAuley, 2007) and physical activity participation (Segar et al., 2006). Findings in this study support this, as women's activity levels were lower on days of lower general self-worth. More research testing relationships between physical self-worth and general self-worth in the context of this study is warranted. Further, because physical motives may be particularly salient in women, the development of effective physical activity promotion strategies based upon non-physical motives may provide a promising avenue for improving middle-aged women's physical activity levels. Results related to Aim 3 provide little empirical evidence that the non-physical self-worth domains represent effective constructs to inform such strategies. However, further

research to better understand the roles of knowledge, emotional, and social self-worth are needed.

General self-worth. Interestingly, while general self-worth was not predictive of overall activity, daily fluctuations were predictive of daily activity. Theoretical suppositions of self-concept posit that self-worth at the global level is a relatively stable construct (Marsh & Shavelson, 1985; Shavelson et al., 1976). However, recent findings from a study in college students by Maher and colleagues (2013) provided evidence that global self-esteem may have a substantial amount of within-person variability across days (ICC = 0.47). Data from the current study generally support theoretical assumptions, but also suggest there may be some important within-person variation in general self-worth that impacts daily physical activity. Crocker and Knight (2005) have argued that self-worth may demonstrate state-like qualities in response to good or bad events. Momentary increases or decreases in self-esteem around trait levels as a result of daily events can in turn have motivational and behavioral consequences. Additional research examining contextual factors, such as current activity and sleep quality, may help uncover more information about the mechanisms causing daily fluctuations in self-worth and its impact on behavior (Schwerdtfeger & Scheel, 2012).

Understanding women's values and attitudes related to their self-worth and physical activity may also lead to a better understanding of the dynamic relationship between them. Crocker and Knight (2005) have proposed that daily fluctuations in individuals' self-esteem may be contingent upon their success in a valued domain (e.g., sports, academics). This is similar to introjected regulation, a self-deterministic construct

that denotes the use of self-imposed contingencies (e.g., self-worth, guilt, self-approval) to regulate behavior (Teixeira et al., 2012). For example, Crocker and Knight (2005) found that college students who placed high value on academic achievement reported decreased self-esteem on the days they received rejection letters from graduate schools. Therefore, understanding the value women attach to physical activity in relation to their self-worth, may be important. Although self-worth is generally viewed as a positive correlate of physical activity participation, in the view of Crocker & Knight (2005), interventionists utilizing self-worth as a motivational strategy for physical activity may need to be careful that participants do not adopt introjected regulations for physical activity as a result. Evidence not only indicates that introjected regulation is negatively associated with physical activity participation in women (Teixeira et al., 2012), but that it can also negatively impact physical and psychological health (Crocker & Knight, 2005). Our data, in addition to findings from Crocker & Knight (2005) related to academics, provide justification for further examination of the relationship between daily fluctuations in general self-worth and daily physical activity. Such research may be used to inform momentary self-worth intervention strategies and to ensure that daily self-worth promotion does not undermine women's self-worth in the face of physical activity failures or barriers.

Relationships observed between daily fluctuations in general self-worth and daily activity may also be explained by the self-worth item chosen for this study. General self-worth was operationalized as women's momentary satisfaction with themselves (Table 2). Areas of a woman's life other than physical activity, such as her family or career, may

have contributed to the relationships observed. For example, on days when a woman reported decreased satisfaction with herself, she may have been less satisfied due to perceptions of herself relative to other competing domains (e.g., job or family responsibilities) and may have prioritized these aspects of her life over physical activity. Developing strategies to help women prioritize physical activity amidst "high risk" psychological states or "failures" in other valued domains are warranted.

In a sample of college students, Maher and colleagues (2013) observed direct effects of daily fluctuations in global self-esteem on daily satisfaction with life. In a sample of older adults (*M* age = 66.71 ± 5.35 years), McAuley and colleagues (2000b) found that physical activity frequency and changes in social interactions improved satisfaction with life over the course of a 6-month intervention and attenuated declines in satisfaction with life over a 6-month follow-up period. Satisfaction with life is thought to be a stable construct, especially as individuals age (Maher et al., 2013). However, results from McAuley and colleagues (2000b) suggest that physical activity frequency may predict subsequent satisfaction with life. Similarly, Huberty and colleagues (2008b) observed increases in general self-worth in middle-aged women over the course of a physical activity intervention. Findings from our study, together with previous research, suggest that physical activity may influence satisfaction with life and/or general self-worth, and these perceptions may, in turn, influence women's daily decisions related to physical activity. Improvements in life satisfaction and/or self-worth as a result of a physical activity intervention may, therefore, help women maintain activity levels after interventions end. Further research testing the bidirectional relationship between general

self-worth and physical activity participation in middle-aged women is warranted. Analyses that examine model changes over the course of behavior change from physical activity adoption to maintenance may be specifically valuable to our understanding of how self-worth and physical activity interact (Wasserkampf et al., 2014). For example, improvements in self-worth as a result of physical activity adoption may be needed before self-worth can influence continued participation in physical activity (Huberty et al., 2008a).

Self-efficacy. Findings related to self-efficacy are similar to previous findings indicating self-efficacy is an important determinant of regular physical activity among middle-aged women (White et al., 2005). However, this study also suggests that fluctuations in self-efficacy may partially influence middle-aged women's activity at the daily level. These results are similar to those reported by Dunton and colleagues (2009) in a small sample of middle-aged to older adults. Specifically, self-efficacy independently predicted moderate-to-vigorous physical activity between daily prompts. More research is needed to better understand the underlying mechanisms driving daily fluctuations in middle-aged women's self-efficacy. Research to identify which types of self-efficacy vary in middle-aged women (physical v. barriers self-efficacy) may be valuable. Understanding why women report lower levels of self-efficacy on some days and higher levels on other days can help clinicians develop momentary strategies to build women's self-efficacy for physical activity at the daily or within-day level (Dunton et al., 2009). For example, self-efficacy is often operationalized as confidence in one's ability to complete a task *despite barriers*. Future studies may consider assessing women's barriers

to physical activity on a daily basis to identify momentary strategies to help women anticipate barriers and increase their daily self-efficacy for overcoming barriers.

Further research examining relationships between self-worth and self-efficacy may also help uncover important information related to daily fluctuations in self-efficacy. Moderate correlations were observed between self-efficacy and some of the self-worth variables (i.e., knowledge self-worth item 2, emotional self-worth item 1, physical condition). A large body of previous research has provided evidence in support of associations between self-efficacy and self-worth subdomains in adults (McAuley et al., 2000a, 2005), including middle-aged women (Elavsky, 2009; Elavsky & McAuley, 2007). Therefore, additional exploration of the influence of daily fluctuations in self-worth on daily fluctuations in self-efficacy, and vice versa,

Physical activity. More research is needed to examine differences between actual physical activity and perceived physical activity in relation to self-worth. Previous research has linked self-reported physical activity or physical activity frequency to self-worth in women (Elavsky, 2009; Elavsky & McAuley, 2007; McAuley et al., 1997, 2000a, 2005; Moore et al., 2012). The current study represents one of the few to have examined relationships in the context of objectively measured activity (Opdenacker et al., 2009). Women self-reported 230 minutes of moderate to vigorous physical activity at baseline, but the accelerometer estimated only 5.59 minutes per day. Previous research has provided evidence that women's subjective ratings of physical activity participation often are not correlated with objectively measured estimates (Kanning et al., 2013). Therefore, a woman's evaluation of her self-worth may be more related to her perceived

physical activity than her actual physical activity participation. Understanding how perceived versus actual behaviors interact with women's psychological/emotional states and traits may be important.

Implications for Future Research

The findings of this research provide several important areas of future research related to EMA (Aim 1) and relationships between self-worth and physical activity (Aims 2 and 3). This is the first study to employ the EMA approach described here. Therefore, replication of the approach in future studies and additional populations is needed to provide more information about its feasibility. Subsequent iterations of the protocol may consider testing electronic methods of daily wake and bed time reporting, as recommended by the participants in this study. Additionally, examination of women's self-reported activity states, in addition to currently measured objective activity states, may better characterize middle-aged women's physical activity states and provide a profile of within- and across-day fluctuations in activity.

In relation to Aims 2 and 3, several areas of future research are warranted, including (a) independent tests of relationships between self-worth domains and daily physical activity in middle-aged women, (b) investigation of acute effects of physical activity on self-worth, (c) exploration of dynamic relationships between self-worth domains and general self-worth, (d) examination of relationships between key predictors and other health behaviors (sleep quality, sedentary behavior), (e) development and pilot testing of a self-efficacy based EMI for middle-aged women, and (f) model evaluation

strategy that more effectively distinguishes between contributions made by fixed and random effects.

The small number of items per self-worth domain (i.e., two) may have contributed to the poor psychometric properties observed across scales, particularly in the non-physical self-worth scales. Two areas of future research are needed in this area. First, modifications to and further testing of the WPASWI are needed to improve the non-physical scales overall (Huberty et al., 2013b). Second, a series of EMA studies focusing on each self-worth domain and general self-worth separately may provide a more informative preliminary assessment of relationships between self-worth and physical activity. Such studies may permit the use of several survey items (e.g., six) targeting one domain to improve the psychometric properties of the scale without increasing participant burden and reducing feasibility. Data from these studies can be used to develop a refined version of the current study that tests only those domains identified as significant in preliminary studies. This series may provide a stronger empirical evaluation of temporal relationships between self-worth and physical activity in middle-aged women.

Findings from this study provided little support of self-worth as a predictor of physical activity in middle-aged women. However, research to further test the predictive role of physical activity on self-worth is justified. Despite a generous amount of evidence supporting the influence of regular physical activity on women's self-worth/self-esteem (Table 1), no research has examined the predictive influence of daily fluctuations in physical activity on daily self-worth. Although such research may not lead to refinements in the self-worth/physical activity conceptual model, it may provide important

information related to acute interactions between physical activity and self-worth (Sonstroem et al., 1994). A substantial amount of variance in activity was within individuals (33 percent), suggesting that interventions designed to improve physical activity and self-worth at the daily level may be beneficial. Information gathered from this future research may be used to design EMIs for middle-aged women.

General self-worth, of the five self-worth variables, was the strongest predictor of daily fluctuations in physical activity in this study. Given moderate to strong correlations between some of the domains and general self-worth (Table 10), in addition to previous evidence related to associations between the domains and general self-worth (Elavsky, 2009, 2010), examination of the contribution of domain-level self-worth to overall and daily fluctuations in general self-worth is warranted. Results from this research may reveal important targets for self-worth promotion and/or may clarify current self-worth models relative to physical activity in women.

Because this study included 24-hour behavioral monitoring, data are available to examine the influence of daily sleep quantity and quality on daily self-worth, self-efficacy, and physical activity. A growing body of literature has begun to focus on relationships between sleep quality and physical activity because of the important health benefits derived from both. Results of these studies indicate that the relationship between sleep and physical activity may be reciprocal and that acute associations may exist (Buman & King, 2010; Chennaoui, Arnal, Sauvet, & Léger, 2014; Dzierzewski et al., 2014). Evidence suggests that regular physical activity is predictive of regular sleep quality (and vice versa), and daily bouts of physical activity are predictive of nightly

sleep quality (and vice versa). For example, Buman and King (2010) recently found that moderate-intensity exercise improved daily fluctuations in sleep quality, particularly sleep onset latency. Despite known relationships between sleep and physical activity and among self-worth, self-efficacy, and physical activity, less is known about how sleep quality influences acute changes in self-worth and self-efficacy (e.g., from previous evening to morning). Findings from this study, in combination with previous research, support exploration of interactions among sleep quality, self-worth, self-efficacy, and daily physical activity participation in middle-aged women. Findings in the current study related to daily fluctuations in self-efficacy suggest research exploring the moderating role of sleep on changes in self-efficacy for physical activity from previous evening to following morning is warranted. Self-efficacy is a consistent predictor of physical activity in middle-aged women, as evidenced by a strong line of previous research (Ayotte, Margrett, & Hicks-Pagtrick, 2010; White et al., 2005), in addition to findings of this study. If poor sleep quality compromises a woman's confidence in her ability to be active, her likelihood of participating in physical activity may also be compromised. Middle-aged and young-old women, due to the onset of menopause and chronic disease, often suffer sleep disturbances that have been shown to negatively affect their physical activity participation, quality of life (a known correlate of self-worth in middle-aged women [Elavsky, 2009; Elavsky & McAuley, 2005, 2007]), and overall physical and psychological health (Lambiase & Thurston, 2013; Lampio, Polo-Kantola, Polo, Kauko, Aittokallio , & Saaresranta, 2014). Results of the current study indicate that self-efficacy may fluctuate on a daily basis and that these fluctuations may be related to daily physical

activity. Understanding the underlying mechanisms driving these fluctuations (e.g., poor sleep) may help researchers better design strategies to help women maintain regular amounts of physical activity and improve sleep quality on a daily basis.

Self-efficacy emerged as an important predictor of daily fluctuations in women's physical activity and may, therefore, present an opportunity for EMI. A recent study by Conroy, Yang, & Maher (2014) found that strategies related to self-efficacy were some of the most commonly included behavior change techniques in the most popular commercially available mobile applications. This suggests that self-efficacy strategies, such as mastery experience and social modeling, may be conducive to the mobile platform and attractive to participants. Future research to develop and pilot test a self-efficacy based EMI administered on women's cell phones may represent a promising approach to improve middle-aged women's daily physical activity in real time.

Additional studies employing a more complex model evaluation are needed. Only the restricted maximum likelihood (REML) estimation was applied in this study. Future exploration of associations between self-worth and physical activity may use the full maximum likelihood (FML) estimation in addition to REML. FML and REML are comparable when models differ in the fixed effects; however, REML is required when models differ in their random effects only. Additionally, this study reported pseudo-R^2 estimates, which may not have been an ideal indicator of effect size due the fact that large, but negative between-persons variance was observed despite the addition of predictors. This is a known challenge in research utilizing multilevel models where an overwhelming amount of variance in the dependent variable is either within- or between-

persons. Pseudo-R^2 was used because, due to the natural log transformation of daily activity counts, the beta coefficients did not provide an interpretable metric of effect. Creating standardized coefficients for the predictor variables may provide one alternative to reliance upon pseudo-R^2 values. Further research using more complex modeling is warranted.

Strengths and Limitations

This study has many strengths and adds to what we know about utilizing an inexpensive and innovative EMA methodology to examine associations between middle-aged women's self-worth states and physical activity participation. The results of this study indicate that this approach is feasible and thus may be replicated in the future within and outside of physical activity research. First, the use of EMA and multilevel modeling provided the opportunity to examine within person changes in self-worth and physical activity. Although data indicate that the majority of variation in physical activity was between participants, a significant amount (40 percent) was within participants. Had we utilized standard ordinary least squares regression analyses to examine the data important information regarding women's physical activity behaviors may have been overlooked. Second, this study used an objective measure of physical activity to accompany EMA-based data collection. The objective monitor provided a more accurate estimate of women's activity when compared with self-report due to recall bias associated with self-report. Additionally, few self-worth studies have examined relationships in the context of objectively measured physical activity behavior (Opdenacker et al., 2009). Compliance with the daily surveys and the accelerometer was

also very high, suggesting that this approach may be applied in a variety of settings and populations. The high level of compliance may also contribute to the validity of our results.

Despite these strengths, there are some notable limitations. First, the internal consistency estimates for the knowledge, emotional, and social self-worth domains were quite low. Therefore, caution should be taken when interpreting the findings. Research to improve the WPASWI and focus on each self-worth domain separately may be particularly useful in ameliorating this limitation (see (a) in Implications for Future Research). Although the EMA design was innovative, another limitation of this study included the simplicity of the data collection methods. This prohibited the ability to send participants reminder prompts. Internet-based text messaging options (i.e., email to SMS) may provide a better opportunity to automate text message prompts and include automated reminders while preserving the low cost of the design. Including reminders may decrease the number of missing and invalid responses. Although national recruitment was a strength of this study, the majority of participants were affluent, married, educated, and Caucasian. The homogeneity of the sample limits the generalizability of the results to other populations. Additional research with a more diverse sample of women is needed. Finally, as this was an exploratory study, no data were available to accurately power the study. The small sample size prohibited our ability to examine cross-level interactions between daily self-worth and time-invariant predictors, such as demographics and baseline data. Because individual differences in relationships between self-worth (emotional and general) and physical activity were

observed, examination of cross-level interactions is needed to identify why these differences may exist.

Conclusions

Overall, the results related to Aim 1 indicate that EMA approaches to studying behaviors and behavioral correlates can be feasible, even amidst limited resources. Advances in mobile technologies, in addition to burgeoning rates of adoption among middle-aged adults, have made EMA more available in research settings. A major strength of this study was the use of specific, evidence-based strategies for improving the usability of the approach for both the user and the researcher. Strategies included: (a) consulting with an expert in technology acceptance, (b) incorporating tenets of technology acceptance theory and recent evidence in mobile applications and middle-aged women, (c) adopting best practices in EMA research, and (d) pilot-testing the approach and modifying procedures based upon results of the pilot test. These strategies, in conjunction with advancements in mobile technologies, may explain the success of this study's EMA approach.

Findings related to Aims 2 and 3 suggest that, overall, self-worth may not be a strong predictor of regular or daily physical activity in middle-aged women. However, additional research is warranted to better understand the roles of emotional and general self-worth in predicting women's daily activity. Findings related to self-efficacy are consistent with a large body of previous research providing unequivocal evidence that self-efficacy is a strong determinant of regular physical activity in middle-aged women. Results of this study add evidence that self-efficacy may predict middle-aged women's

physical activity participation on a daily level as well. Further research to better understand the mechanisms behind daily fluctuations in women's daily self-efficacy is warranted in order to design momentary strategies to help women stay active on a daily basis.

REFERENCES

Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett Jr., D.R., Tudor-Locke, C., … & Leon, A.S. (2011). 2011 Compendium of Physical Activities: A second update of codes and MET values. *Medicine and Science in Sports and Exercise 43*(8), 1575-1581.

Armey, M. F., Crowther, J. H., & Miller, I. W. (2011). Changes in ecological momentary assessment reported affect associated with episodes of nonsuicidal self-injury. *Behavior Therapy*, *42*(4), 579-588.

Atienza, A.A., Oliveira, B., Fogg, B.J., & King, A.C. (2006). Using electronic diaries to examine physical activity and other health behaviors in adults age 50+. *Journal of Aging and Physical Activity, 14*, 192-202.

Ayotte, B. J., Margrett, J. A., & Hicks-Patrick, J. (2010). Physical activity in middle-aged and young-old adults: The roles of self-efficacy, barriers, outcome expectancies, self-regulatory behaviors and social support. *Journal of Health Psychology*, *15*(2), 173-185.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education and Behavior*, *31*, 143-164.

Bauman, A.E., Sallis, J.F., Dzewaltowski, D.A., & Owen, N. (2002). Toward a better understanding of the influences on physical activity: The role of determinants, correlates, causal variables, mediators, moderators, and confounders. *American Journal of Preventive Medicine, 23*(2S), 5-14.

Buman, M. P., & King, A. C. (2010). Exercise as a treatment to enhance sleep. *American Journal of Lifestyle Medicine*, *4*(6), 500-514.

Buman, M. P., Winkler, E. A., Kurka, J. M., Hekler, E. B., Baldwin, C. M., Owen, N., ... & Gardiner, P. A. (2013). Reallocating time to sleep, sedentary behaviors, or active behaviors: Associations with cardiovascular disease risk biomarkers, NHANES 2005–2006. *American Journal of Epidemiology*. doi: 10.1093/aje/kwt292

Carels, R.A., Coit, C., Young, K.M., Berger, B. (2007). Exercise makes you feel good, but does feeling good make you exercise? An examination of obese dieters. *Journal of Sport and Exercise Psychology*, *29*, 706-722.

Caspersen, C.J., Powell, K.E., & Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126-131.

Centers for Disease Control & Prevention (CDC). (2011a, February 16). Physical activity and health: The benefits of physical activity. Retrieved October 25, 2014 from http://www.cdc.gov/physicalactivity/everyone/health/index.html#ControlWeight.

Centers for Disease Control & Prevention (CDC). (2011b, December 1). How much physical activity do adults need? Retrieved October 25, 2014 from http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html.

Centers for Disease Control & Prevention (CDC). (2009). Behavioral Risk Factor Surveillance System: Prevalence and trends data. Retrieved October 25, 2014 from http://apps.nccd.cdc.gov/brfss/list.asp?cat=PA&yr=2009&qkey=4418&state=US.

Centers for Disease Control & Prevention (CDC). (2014, April 15). Surveillance systems. Retrieved October 25, 2014 from http://www.cdc.gov/physicalactivity/data/surveillance.html.

Champion, V.L., & Skinner, C.S. (2008). The Health Belief Model. In K. Glanz, B.K. Rimer, K. Viswanath (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (4th ed.) (pp. 123-147). San Francisco: Jossey-Bass.

Chennaoui, M., Arnal, P. J., Sauvet, F., & Léger, D. (2014). Sleep and exercise: A reciprocal issue? *Sleep Medicine Reviews*. doi: 10.1016/j.smrv.2014.06.008

Conroy, D.E., Yang, C.H., & Maher, J.P. (2014). Behavior change techniques in top-ranked mobile apps for physical activity. *American Journal of Preventive Medicine, 46*(6), 649-652.

Cocker, J., & Knight, K.M. (2005). Contingencies of self-worth. *Current Directions in Psychological Science, 14*(4), 200-203.

Courvoisier, D. S., Eid, M., & Lischetzke, T. (2012). Compliance to a cell phone-based ecological momentary assessment study: The effect of time and personality characteristics. *Psychological Assessment*, *24*(3), 713-720.

Deci, E.L., Ryan, R.M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268.

Dunn, A. L., Andersen, R. E., & Jakicic, J. M. (1998). Lifestyle physical activity interventions: History, short-and long-term effects, and recommendations. *American Journal of Preventive Medicine, 15*(4), 398-412.

Dunton, G. F., Atienza, A. A., Castro, C. M., & King, A. C. (2009). Using ecological momentary assessment to examine antecedents and correlates of physical activity bouts

in adults age 50+ years: a pilot study. *Annals of Behavioral Medicine, 38*(3), 249-255.doi: 10.1007/s12160-009-9141-4

Dunton, G. F., Liao, Y., Intille, S., Wolch, J., & Pentz, M. A. (2011). Physical and social contextual influences on children's leisure-time physical activity: An ecological momentary assessment study. *Journal of Physical Activity and Health*, *8*(1), S103.

Dunton, G. F., Liao, Y., Kawabata, K., & Intille, S. (2012). Momentary assessment of adults' physical activity and sedentary behavior: Feasibility and validity. *Frontiers in psychology, 3*. doi: 10.3389/fpsyg.2012.00260

Dzierzewski, J. M., Buman, M. P., Giacobbi, P. R., Roberts, B. L., Aiken-Morgan, A. T., Marsiske, M., & McCrae, C. S. (2014). Exercise and sleep in community-dwelling older adults: Evidence for a reciprocal relationship. *Journal of Sleep Research*, *23*(1), 61-68.

Ehlers, D. K., & Huberty, J. (2013). Middle-Aged Women's Preferred Theory-Based Features in Mobile Physical Activity Applications. *Journal of Physical Activity and Health*.

Elavsky, S. (2009). Physical activity, menopause, and quality of life: The role of affect and self-worth across time. *Menopause, 16*(2), 265-271.

Elavsky, S. (2010). Longitudinal examination of the exercise and self-esteem model in middle-aged women. *Journal of Sport and Exercise Psychology, 32*(6), 862-880.

Elavsky, S., & McAuley, E. (2005). Physical activity, symptoms, esteem, and life satisfaction during menopause. *Maturitas*, *52*(3), 374-385.

Elavsky, S., & McAuley, E. (2007). Exercise and self-esteem in menopausal women: A randomized controlled trial involving walking and yoga. *American Journal of Health Promotion*, *22*(2), 83-92.

Elavsky, S., McAuley, E., Motl, R. W., Konopack, J. F., Marquez, D. X., Hu, L., ... & Diener, E. (2005). Physical activity enhances long-term quality of life in older adults: Efficacy, esteem, and affective influences. *Annals of Behavioral Medicine*, *30*(2), 138-145.

Esliger, D. W., Rowlands, A. V., Hurst, T. L., Catt, M., Murray, P., & Eston, R. G. (2011). Validation of the GENEA Accelerometer. *Medicine and Science in Sports and Exercise*, *43*(6), 1085-1093.

Eyler, A. A., Vest, J. R., Sanderson, B., Wilbur, J., Matson-Koffman, D., Evenson, K. R., ... & Young, D. R. (2002). Environmental, policy, and cultural factors related to physical

activity in a diverse sample of women: The Women's Cardiovascular Health Network Project–introduction and methodology. *Women & Health*, *36*(2), 1-15.

Fjeldsoe, B. S., Miller, Y. D., & Marshall, A. L. (2010). MobileMums: A randomized controlled trial of an SMS-based physical activity intervention. *Annals of Behavioral Medicine*, *39*(2), 101-111.

Fjeldsoe, B., Phongsavan, P., Bauman, A., Goode, A., Maher, G., & Eakin, E. (2014). 'Get Healthy, Stay Healthy': Protocol for evaluation of a lifestyle intervention delivered by text-message following the Get Healthy Information and Coaching Service®. *BMC Public Health*, *14*(1), 112. doi:10.1186/1471-2458-14-112

Fox, K. R. (1997). *The physical self: From motivation to well-being*. Champaign, IL: Human Kinetics.

Fox, K. R. (2000). The effects of exercise on self-perceptions and self-esteem. In S.J.H. Biddle, K.R. Fox, & S.H. Boutcher (Eds.), *Physical activity and psychological well-being*, (pp. 88-117). London: Routledge.

Fox, K.R., Boutcher, S.H., Faulkner, G.E., & Biddle, S.J.H. (2000). The case for exercise in the promotion of mental health and psychological well-being. In S.J.H. Biddle, K.R. Fox, & S.H. Boutcher (Eds.), *Physical activity and psychological well-being*, (p. 1-9). London: Routledge.

Fox, K. R., & Corbin, C. B. (1989). The physical self-perception profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*, 408-430.

Gabriel K.K.P., McClain, J.J., High, R.R., Schmid, K.K., Whitfield, G.P., & Ainsworth, B.E. (2012). Patterns of accelerometer-derived estimates of physical inactivity in middle-aged women. *Medicine and Science in Sports and Exercise, 44*(1): 104-110.

Gabriel, K. P., McClain, J. J., Schmid, K. K., Storti, K. L., & Ainsworth, B. E. (2011). Reliability and convergent validity of the past-week Modifiable Activity Questionnaire. *Public Health Nutrition*, *14*(3), 435-442.

Gothe, N. P., Mullen, S. P., Wójcicki, T. R., Mailey, E. L., White, S. M., Olson, E. A., ... & McAuley, E. (2011). Trajectories of change in self-esteem in older adults: Exercise intervention effects. *Journal of Behavioral Medicine*, *34*(4), 298-306.

Hayes, S. D., Crocker, P. R., & Kowalski, K. C. (1999). Gender differences in physical self-perceptions, global self-esteem and physical activity: Evaluation of the physical self-perception profile model. *Journal of Sport Behavior, 22*(1), 1-14.

Heron, K. E., & Smyth, J. M. (2010). Ecological momentary interventions: Incorporating mobile technology into psychosocial and health behaviour treatments. *British Journal of Health Psychology*, *15*(1), 1-39.

Huberty, J. L., Ehlers, D., Coleman, J., Gao, Y., & Elavsky, S. (2013a). Women Bound to Be Active: Differences in long-term physical activity between completers and noncompleters of a book club intervention. *Journal of Physical Activity and Health, 10*(3), 368-378.

Huberty, J., Ehlers, D.K., Kurka, J., Ainsworth, B., & Buman, M.P. (In Review). Feasibility of three wearable sensors for 24 hour monitoring in middle-aged women. *BMC Women's Health*.

Huberty, J. L., Ransdell, L. B., Sidman, C., Flohr, J. A., Shultz, B., Grosshans, O., & Durrant, L. (2008a). Explaining long-term exercise adherence in women who complete a structured exercise program. *Research Quarterly for Exercise and Sport*, *79*(3), 374-384.

Huberty, J.L., Vener, J., Gao, Y., Matthews, J., Ransdell, L., & Elavsky, S. (2013b). Developing an instrument to measure physical activity related self-worth in women: Rasch analysis of the Women's Physical Activity Self-Worth Inventory (WPASWI). *Psychology of Sport and Exercise, 14*(1), 111-121.

Huberty, J. L., Vener, J., Ransdell, L., Schulte, L., Budd, M. A., & Gao, Y. (2010). Women Bound to Be Active (years 3 and 4): can a book club help women overcome barriers to physical activity and improve self-worth? *Women & Health*, *50*(1), 88-106.

Huberty, J. L., Vener, J., Schulte, L., Roberts, S. M., Stevens, B., & Ransdell, L. (2009). Women Bound to Be Active: one year follow-up to an innovative pilot intervention to increase physical activity and self-worth in women. *Women and Health*, *49*(6-7), 522-539.

Huberty, J. L., Vener, J., Sidman, C., Meendering, J., Blissmer, B., Schulte, L, … & Ransdell, L. B. (2008b). Women Bound to Be Active: A pilot study to explore the feasibility of an intervention to increase physical activity and self-worth in women. *Women and Health*, *48*(1), 83-101.

Hurd, A.R., & Anderson. D.M. *The Park and Recreation Professional's Handbook*. Champaign, IL: Human Kinetics.

Kanning, M.K., Ebner-Priemer, U.W., & Schlicht, W.M. (2013). How to investigate within-subject associations between physical activity and momentary affective states in everyday life: A position statement based on a literature overview. *Frontiers in Psychology, 4*, 1-16. doi: 10.3389/fpsyg.2013.00187

Kanning, M., & Schlicht, W. (2010). Be active and become happy: An ecological momentary assessment of physical activity and mood. *Journal of Sport and Exercise Psychology, 32*, 253-261.

King, A. C., Oka, R. K., & Young, D. R. (1994). Ambulatory blood pressure and heart rate responses to the stress of work and caregiving in older women. *Journal of Gerontology*, *49*(6), M239-M245.

Kuntsche, E., & Labhart, F. (2013). ICAT: Development of an Internet-based data collection method for ecological momentary assessment using personal cell phones. *European Journal of Psychological Assessment*, *29*(2), 140-148.

Lambiase, M. J., & Thurston, R. C. (2013). Physical activity and sleep among midlife women with vasomotor symptoms. *Menopause*, *20*(9), 946-952.

Lampio, L., Polo-Kantola, P., Polo, O., Kauko, T., Aittokallio, J., & Saaresranta, T. (2014). Sleep in midlife women: Effects of menopause, vasomotor symptoms, and depressive symptoms. *Menopause*, *21*(11), 1.

LePage, M.L., & Crowther, J.H. (2010). The effects of exercise on body satisfaction and affect. *Body Image, 7*, 124-130. doi:10.1016/j.bodyim.2009.12.002

Levy, S. S., & Ebbeck, V. (2005). The exercise and self-esteem model in adult women: The inclusion of physical acceptance. *Psychology of Sport and Exercise*,*6*(5), 571-584.

Levy, C. E., Buman, M. P., Chow, J. W., Tillman, M. D., Fournier, K. A., & Giacobbi Jr, P. (2010). Use of power assist wheels results in increased distance traveled compared with conventional manual wheeling. *American Journal of Physical Medicine & Rehabilitation*, *89*(8), 625-634.

Maher, J.P., Doerksen, S.E., Elavsky, S., Hyde, A.L., Pincus, A.L., Ram, N., & Conroy, D.E. (2013). A daily analysis of physical activity and satisfaction with life in emerging adults. *Health Psychology, 32*(6), 647-656.

Marsh, H. W. (1986). Global self-esteem: Its relation to specific facets of self-concept and their importance. *Journal of Personality and Social Psychology*,*51*(6), 1224-1236.

Marsh, H. W. (1990). A multidimensional, hierarchical model of self-concept: Theoretical and empirical justification. *Educational Psychology Review*, *2*(2), 77-172.

Marsh, H. W. (1992). Content specificity of relations between academic achievement and academic self-concept. *Journal of Educational Psychology*,*84*(1), 35-42.

Marsh, H. W., & O'Neill, R. (1984). Self Description Questionnaire III: The construct validity of multidimensional self-concept ratings by late adolescents. *Journal of Educational Measurement*, *21*(2), 153-174.

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist*, *20*(3), 107-123.

Marsh, H. W. (1988). Causal effects of academic self-concept on academic achievement: A reanalysis of Newman (1984). *The Journal of Experimental Education*, *56*(2), 100-103.

Marsh, H. W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. *Journal of Educational Psychology*, *81*(3), 417.

Marsh, H.W., Richards, G.E., Johnson, S., Roche, L., & Tremayne, P. (1994). Physical Self-Description Questionnaire: Psychometric properties and a multitrait-multi-method analysis of relations to existing instruments. *Journal of Sport and Exercise Psychology, 16*, 270-305.

Matthews, C. E., Hagströmer, M., Pober, D. M., & Bowles, H. R. (2012). Best practices for using physical activity monitors in population-based research. *Medicine and Science in Sports and Exercise*, *44*(1 Suppl 1), S68-S76.

McAlister, A.L., Perry, C.L., & Parcel, G.S. (2008). How individuals, environments, and health behaviors interact: Social Cognitive Theory. In K. Glanz, B.K. Rimer, K. Viswanath (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (4th ed.) (pp. 169-188). San Francisco: Jossey-Bass.

McAuley, E. (1993). Self-efficacy and the maintenance of exercise participation in older adults. *Journal of Behavioral Medicine*, *16*(1), 103-113.

McAuley, E., & Blissmer, B. (2000). Self-efficacy determinants and consequences of physical activity. *Exercise and Sport Sciences Reviews*, *28*(2), 85-88.

McAuley, E., Blissmer, B., Katula, J., Duncan, T. E., & Mihalko, S. L. (2000a). Physical activity, self-esteem, and self-efficacy relationships in older adults: A randomized controlled trial. *Annals of Behavioral Medicine*, *22*(2), 131-139.

McAuley, E., Blissmer, B., Marquez, D. X., Jerome, G. J., Kramer, A. F., & Katula, J. (2000b). Social relations, physical activity, and well-being in older adults. *Preventive Medicine*, *31*(5), 608-617.

McAuley, E., Doerksen, S. E., Morris, K. S., Motl, R. W., Hu, L., Wójcicki, T. R., ... & Rosengren, K. R. (2008). Pathways from physical activity to quality of life in older women. *Annals of Behavioral Medicine*, *36*(1), 13-20.

McAuley, E., Elavsky, S., Motl, R. W., Konopack, J. F., Hu, L., & Marquez, D. X. (2005). Physical activity, self-efficacy, and self-esteem: Longitudinal relationships in older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *60*(5), P268-P275.

McAuley, E., Jerome, G. J., Marquez, D. X., Elavsky, S., & Blissmer, B. (2003). Exercise self-efficacy in older adults: Social, affective, and behavioral influences. *Annals of Behavioral Medicine*, *25*(1), 1-7.

McAuley, E., Mihalko, S. L., & Bane, S. M. (1997). Exercise and self-esteem in middle-aged adults: Multidimensional relationships and physical fitness and self-efficacy influences. *Journal of Behavioral Medicine*, *20*(1), 67-83.

Messer, B. J., & Harter, S. (1986). *Manual for the adult self-perception profile*. University of Denver.

Moore, J. B., Mitchell, N. G., Beets, M. W., & Bartholomew, J. B. (2012). Physical self-esteem in older adults: A test of the indirect effect of physical activity. *Sport, Exercise, and Performance Psychology*, *1*(4), 231-241.

Opdenacker, J., Delecluse, C., & Boen, F. (2009). The longitudinal effects of a lifestyle physical activity intervention and a structured exercise intervention on physical self-perceptions and self-esteem in older adults. *Journal of sport & exercise psychology*, *31*(6), 743-760.

Pew Research Internet Project (2014). Mobile technology fact sheet. *Pew Internet and American Life*. Accessed October 25, 2014 at http://www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/.

Rainie, L., & Fox, S. (2012, May 7). Just-in-time information through mobile connections. Retrieved October 29, 2014 from http://www.pewinternet.org/2012/05/07/just-in-time-information-through-mobile-connections/.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Schwerdtfeger, A. R., & Scheel, S. M. (2012). Self-esteem fluctuations and cardiac vagal control in everyday life. *International Journal of Psychophysiology*, *83*(3), 328-335.

Sebire, S. J., Standage, M., & Vansteenkiste, M. (2009). Examining intrinsic versus extrinsic exercise goals: Cognitive, affective, and behavioral outcomes. *Journal of Sport and Exercise Psychology*, *31*(2), 189-210.

Segar, M. L., Eccles, J. S., Peck, S. C., & Richardson, C. R. (2007). Midlife women's physical activity goals: Sociocultural influences and effects on behavioral regulation. *Sex Roles*, *57*(11-12), 837-849.

Segar, M. L., Eccles, J. S., & Richardson, C. R. (2008). Type of physical activity goal influences participation in healthy midlife women. *Women's Health Issues*,*18*(4), 281-291.

Segar, M. L., Eccles, J. S., & Richardson, C. R. (2011). Rebranding exercise: Closing the gap between values and behavior. *International Journal of Behavioral Nutrition & Physical Activity*, *8*, 94. doi:10.1186/1479-5868-8-94

Segar, M., Spruijt-Metz, D., & Nolen-Hoeksema, S. (2006). Go figure? Body-shape motives are associated with decreased physical activity participation among midlife women. *Sex Roles*, *54*(3-4), 175-187.

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407-441.

Shavelson, R. J., & Marsh, H. W. (1986). On the structure of self-concept. In R. Schwarzer (Ed.), *Anxiety and Cognitions* (pp.305-330). Hillsdale, NJ: Lawrence Erlbaum.

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1-32.

Shiyko, M. P., Lanza, S. T., Tan, X., Li, R., & Shiffman, S. (2012). Using the time-varying effect model (TVEM) to examine dynamic associations between negative affect and self confidence on smoking urges: Differences between successful quitters and relapsers. *Prevention Science*, *13*(3), 288-299.

Silberstein, L. R., Striegel-Moore, R. H., Timko, C., & Rodin, J. (1988). Behavioral and psychological implications of body dissatisfaction: Do men and women differ? *Sex roles*, *19*(3-4), 219-232.

Silva, M. N., Vieira, P. N., Coutinho, S. R., Minderico, C. S., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2010). Using self-determination theory to promote physical activity and weight control: a randomized controlled trial in women. *Journal of Behavioral Medicine*, *33*(2), 110-122.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York: Oxford University Press.

Smyth, J. M., & Heron, K. E. (2014). Ecological Momentary Assessment (EMA) in Family Research. In S. McHale, P. Amato, & A. Booth (Eds.), *Emerging Methods in Family Research* (pp. 145-161). New York: Springer International Publishing.

Sonstroem, R. J. (1984). Exercise and self-esteem. *Exercise and Sport Sciences Reviews*, *12*(1), 123-156.

Sonstroem, R. J., Harlow, L. L., & Josephs, L. (1994). Exercise and self-esteem: Validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology, 16*, 29-42.

Sonstroem, R. J., & Morgan, W. P. (1989). Exercise and self-esteem: Rationale and model. *Medicine & Science in Sports & Exercise, 21*(3), 329-337.

Spencer, E. A., Appleby, P. N., Davey, G. K., & Key, T. J. (2002). Validity of self-reported height and weight in 4808 EPIC–Oxford participants. *Public Health Nutrition*, *5*(04), 561-565.

Stone, A. A., & Shiffman, S. (2002). Capturing momentary, self-report data: A proposal for reporting guidelines. *Annals of Behavioral Medicine*, *24*(3), 236-243.

Strelan, P., Mehaffey, S. J., & Tiggemann, M. (2003). Brief report: Self-objectification and esteem in young women: The mediating role of reasons for exercise. *Sex Roles*, *48*(1-2), 89-95.

Tan, X., Shiyko, M. P., Li, R., Li, Y., & Dierker, L. (2012). A time-varying effect model for intensive longitudinal data. *Psychological methods*, *17*(1), 61-77.

Texeira, P.J., Carraça, E.V., Markland, D., Sliva, M.N., & Ryan, R.M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition & Physical Activity, 9*(78). doi: 10.1186/1479-5868-9-78

Thoits, P. A. (2011). Mechanisms linking social ties and support to physical and mental health. *Journal of Health and Social Behavior*, *52*(2), 145-161.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise*, *40*(1), 181-188.

Troiano, R. P., McClain, J. J., Brychta, R. J., & Chen, K. Y. (2014). Evolution of accelerometer methods for physical activity research. *British Journal of Sports Medicine*. doi:10.1136/bjsports-2014-093546

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478.

Vrazel, J. E., Saunders, R. P., & Wilcox, S. (2008). An overview and proposed framework of social-environmental influences on the physical-activity behavior of women. *American Journal of Health Promotion*, *23*(1), 2-12.

Walls, T. A., & Schafer, J. L. (Eds.). (2006). *Models for intensive longitudinal data* (pp. xi-xxii). New York: Oxford University Press.

Walls, T.A., Jung,H., & Schwartz, J.E. (2006). In T.A. Walls & J.L. Schafer (Eds.), *Models for intensive longitudinal data* (pp. 3-37). New York: Oxford University Press.

Wasserkampf, A., Silva, M. N., Santos, I. C., Carraça, E. V., Meis, J. J. M., Kremers, S. P. J., & Teixeira, P. J. (2014). Short-and long-term theory-based predictors of physical activity in women who participated in a weight-management program. *Health Education Research*. doi:10.1093/her/cyu060

Weinstein, N.D., Sandman, P.M., & Blalock, S.J. (2008). The Precaution Adoption Process Model. In K. Glanz, B.K. Rimer, K. Viswanath (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (4th ed.) (pp. 123-147). San Francisco: Jossey-Bass.

Welch, W. A., Bassett, D. R., Thompson, D. L., Freedson, P. S., Staudenmayer, J. W., John, D., ... & Fitzhugh, E. C. (2013). Classification accuracy of the wrist-worn gravity estimator of normal everyday activity accelerometer. *Medicine and science in sports and exercise*, *45*(10), 2012-2019.

White, J. L., Randsdell, L. B., Vener, J., & Flohr, J. A. (2005). Factors related to physical activity adherence in women: review and suggestions for future research. *Women & Health*, *41*(4), 123-148.

White, S. M., Wójcicki, T. R., & McAuley, E. (2012). Social cognitive influences on physical activity behavior in middle-aged and older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 67*(1), 18-26. doi: 10.1093/geronb/gbr064

Wilson, P. M., & Rodgers, W. M. (2002). The relationship between exercise motives and physical self-esteem in female exercise participants: An application of Self-Determination Theory. *Journal of Applied Biobehavioral Research*, *7*(1), 30-43.

Zhang, S., Rowlands, A. V., Murray, P., & Hurst, T. L. (2012). Physical activity classification using the GENEA wrist-worn accelerometer. *Medicine and Science in Sports and Exercise*, *44*(4), 742-748.

APPENDIX A

HUMAN SUBJECTS APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jennifer Huberty
From:	Carol Johnston, Chair Biosci IRB
Date:	09/05/2013
Committee Action:	**Expedited Approval**
Approval Date:	09/05/2013
Review Type:	Expedited F4 F7
IRB Protocol #:	1308009564
Study Title:	Exploring temporal relationships between self-worth and physical activity in middle-aged women
Expiration Date:	09/04/2014

The above-referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Biosci IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Biosci IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

TABLES

Table 1

Review of Literature Examining Relationships between Self-Worth and Physical Activity in Women

Author, Year	Study Design Participants	Methods Description	Outcomes	Assessment Points	Major Results
Duncan et al., 1993	Prospective design Participants were previously sedentary males (*n*=41) and females (*n*=44) (*M* age=53.98)	Participants currently enrolled in 10th week of 5-month exercise program	Domain-specific social support, exercise adherence	Baseline (10th week), adherence measured daily for 10 weeks	When controlling for outside social support, no social provisions predicted adherence in males. Guidance from leaders and the group and reassurance of worth (i.e., self-esteem) predicted adherence in females after controlling for outside social support.
Elavsky & McAuley, 2005	Cross-sectional design Participants (n=133) were menopausal women (*M* age=51.12)	Women contacted to complete questionnaires by mail	Menopausal status, menopausal symptoms, self-reported physical activity, BMI, global self-esteem[d], physical self-esteem[d], quality of life	One time point	Physical activity was associated with higher global and physical self-esteem independent of menopausal status. Physical activity was also associated with less frequent/severe menopausal symptoms. Physical activity and symptoms were indirectly associated with quality of life through physical self-esteem.
Elavsky & McAuley, 2007	3-arm (walking, yoga, control) randomized controlled trial Participants (n=164) were inactive middle-aged women (*M* age=49.9) experiencing	4-month supervised walking or yoga program that included efficacy building activities	Self-reported physical activity, BMI, fitness level, body composition, global self-esteem,[a] physical self-worth,[c] exercise self-efficacy	Baseline, 4 months	Walking: greater increases in physical condition and strength esteem. Walking and yoga: greater increases in body attractiveness esteem. Self-efficacy increases and body fat decreases related to increases in physical condition. Body fat decreases related to body attractiveness. Mediation analyses supported EXSEM.

	menopausal symptoms				
Elavsky, 2009, 2010	Follow-up to Elavsky & McAuley (2007) Sample size not reported	Women contacted to complete questionnaires by mail	Menopausal symptoms, self-reported physical activity, BMI, affect, physical self-worth,[c] menopause specific quality of life (QOL), self-efficacy	2 year follow-up	Post-intervention: Direct effects of physical activity on physical self-worth, symptoms, positive affect. Direct effects of physical self-worth and positive affect on QOL. Direct effects of self-efficacy on physical condition. Direct negative effects of BMI on condition and body attractiveness. Direct effects of condition, attractiveness and strength perceptions on physical self-worth. Direct effect of physical self-worth on global self-esteem. Follow-up: Increases in covariates led to same results as concurrent post-intervention tests, except: changes in physical activity led to increased condition, and changes in strength perceptions were not associated with increases in physical self-worth.
Hayes et al., 1999	Cross-sectional design Participants were 94 female (M age=19.46) and 89 male (M age=20.03) university students	N/A	Physical self-worth and physical subdomains[c], global self-esteem[b], leisure-time physical activity	One time point	Women score lower on all PSPP scales, despite having physical activity levels similar to men. Contribution of body attractiveness to physical self-worth was large in both genders, but greater among women. Physical condition was only subdomain associated with physical activity levels in women. Association between physical condition and physical activity was larger for moderate physical activity as compared to vigorous physical activity.

Huberty et al., 2008a	Participants (n=19) were women (*M* age=46) who previously participated in a physical activity program	Women were contacted to complete questionnaires and participate in a focus group	Past-year physical activity; insights related to physical activity adherence	1-3 year follow-up	12 of 19 women were classified as non-adherers to physical activity. Self-worth contributed to physical activity adherence. Non-adherers: lower self-worth, less likely to make themselves and physical activity a priority, lacked motivation for physical activity, poor body image, competing commitments with physical activity, lacked access to support. Adherers: higher self-worth influenced motivation for physical activity, valued impact of physical activity on quality of life, feared lack of physical activity's impact of quality of life, more likely to enjoy physical activity, positive attitudes towards physical activity, better physical activity planning, better physical acceptance
Huberty et al., 2008b	Pre-experimental design Participants (n=45) were women (*M* age=48.1) in the contemplation stage of change	8-month theory-based, book club intervention. Sessions designed to promote lifestyle physical activity, and improve physical activity knowledge, awareness, confidence, and self-worth	BMI, steps, self-reported physical activity, general self-worth	Baseline, 8 months	Significant decrease in BMI and increases in steps, self-reported physical activity, and general self-worth.
Huberty et al., 2009	Follow-up to Huberty et al. (2008b) Participants (n=32) were women (*M*	Women were contacted to complete questionnaires by mail and participate in a phone interview	BMI, self-reported physical activity, general self-worth. Interviews	1 year follow-up	BMI and physical activity did not change from baseline or post to follow-up. General self-worth increased from baseline and post to follow-up. Qualitative results:

	age=50.6 years) who previously participated in a physical activity book club		assessed experiences with physical activity after program		women liked social support of program, valued physical and emotional benefits of physical activity, reported time and motivation as biggest physical activity barriers, and used self-monitoring skills to stay active.
Huberty et al., 2010	Quasi-experimental design Participants (n=110) were women (*M* age=52.7 years (intervention), 58.35 (control))	2nd cohort of book club intervention in Huberty et al. (2008b) compared with women in existing social support groups	BMI, general self-worth[b], physical activity benefits and barriers, steps, self-reported physical activity	Baseline, 8 months	BMI and self-reported physical activity did not change in either group. Physical activity trended in positive direction for intervention group. Self-worth, ratio of benefits to barriers, steps, and number of women meeting physical activity guidelines increased in intervention group.
Huberty et al., 2013a	Follow-up to Huberty et al. (2010) Participants (n=30) were women (*M* age=51.8 years) who completed (n=17) and did not complete (n=13) a physical activity intervention	Women were contacted to complete questionnaires by mail and participate in a phone interview	BMI, self-reported, physical activity, benefits and barriers, general self-worth[b]. Interviews assessed experiences with physical activity after program		BMI decreased among completers and increased among non-completers from baseline to follow-up. No changes in physical activity were observed from baseline to follow-up, but completers had greater physical activity levels at follow-up. Benefits relative to barriers increased among completers and decreased among non-completers. Both groups reported increases in self-worth from baseline to follow-up. Qualitative results: Time was biggest physical activity barriers for both groups, but completers report more strategies for overcoming barriers. Both groups reported increased understanding of self-worth, but completers more

					often reported prioritizing and feeling good about themselves. Both groups reported valuing the support from the women in the program.
Huberty et al., 2013b	Cross-sectional design Participants (n=335) women ages 20-80 years (*M* age=36.69)	Development and validation of the Women's Physical Activity Self-Worth Inventory	physical activity self-worth in non-physical domains, general self-worth[b], leisure-time physical activity	One time point; women randomly selected to completed questionnaires again 7 days later (n=70)	Of the 47 items tested, 10 misfits were identified, resulting in a final 37-item questionnaire. Knowledge and emotional self-worth were higher in regularly active women compared to sometimes active women. Knowledge and emotional self-worth were higher in regularly and sometimes active women compared to never active women. Social self-worth was higher in regularly and sometimes active women compared to never active women.
Levy & Ebbeck, 2005	Cross-sectional design Participants (n=122) were insufficiently active women (*M* age=45.9)	N/A	Global self-esteem[b], physical competence[c], physical acceptance, exercise self-efficacy, leisure-time exercise	One time point	Physical acceptance provided most significant contribution to explained variance in global self-esteem. Physical acceptance mediated association between self-efficacy and global self-esteem.
Sontroem et al., 1994	Cross-sectional design Participants (n=216) were female group exercise participants (*M* age=38.4) attending aerobic dance classes	Test the validity of the physical self-worth model as proposed by Fox & Corbin (1989)	Self-esteem[b], physical self-worth[c], self-efficacy, self-reported physical activity	One time point	Structural equations confirmed the physical self-worth model. High perceptions of physical condition and body dissatisfaction predicted exercise participation.

Strelan et al., 2003	Cross-sectional design Participants (n=104) were white women (16-25 years) attending a fitness center	N/A	Self-objectification, reasons (motivation) for exercise, body satisfaction, body esteem self-esteem[a]	One time point	Most common reasons for exercise: appearance, health/fitness; least common reasons: enjoyment, mood. Self-objectification and appearance motivations negatively correlated with body satisfaction, body esteem, self-esteem. Health/fitness and enjoyment/mood positively correlated with body satisfaction, body esteem, self-esteem. Health/fitness and enjoyment/mood negatively correlated with self-objectification. Reasons for exercise mediated association between self-objectification and body satisfaction, body esteem, and self-esteem
Wilson & Rogers, 2002	Pre-experimental design Participants (n=114) were women (*M* age=25.98) enrolled in a campus recreation exercise class	15-week exercise class focusing primarily on cardiovascular fitness exercises. Analyses based upon Self-Determination Theory.	Behavioral regulation, physical self-esteem,[d]	Week 2 of class, Week 12	Controlled behavioral regulations were negatively correlated with physical self-esteem, autonomous regulations were positively correlated.

[a]Rosenberg Self-esteem Scale (Rosenberg, 1965); [b]General Self-worth Subscale of the Adult Self-Perception Profile (Messer & Harter, 1986); [c]Physical Self-Perception Profile (PSPP) (Fox & Corbin, 1989); [d]Physical Self-Description Questionnaire (Marsh et al., 1994)

Table 8

Descriptive Statistics of Responses to EMA Survey (N=59)

	M	± SD	ICC
General Self-Worth			
Some adults are dissatisfied with themselves but other adults are satisfied with themselves.	2.81	± 0.82	0.75
AM	2.79	± 0.81	
Mid	2.84	± 0.81	
PM	2.79	± 0.83	
Knowledge Self-Worth			
My knowledge about physical activity affects the way I feel about myself.	2.72	± 0.63	0.66
AM	2.71	± 0.63	
Mid	2.73	± 0.63	
PM	2.73	± 0.64	
Thinking about exercise/physical activity makes me happy.	2.90	± 0.63	0.64
AM	2.88	± 0.63	
Mid	2.91	± 0.64	
PM	2.91	± 0.63	
Emotional Self-Worth			
I feel it is important to me to take time to be physically active today/tomorrow.	3.21	± 0.58	0.40
AM	3.22	± 0.57	
Mid	3.18	± 0.59	
PM	3.24	± 0.58	
I feel I will be a better mother, wife, friend, and daughter if I take time to take care of myself.	3.31	± 0.54	0.64
AM	3.31	± 0.53	
Mid	3.30	± 0.55	
PM	3.31	± 0.56	
Social Self-Worth			
I need to know I have friends or family to support my commitment to exercise in order to feel good about myself.	2.79	± 0.76	0.78
AM	2.77	± 0.76	
Mid	2.80	± 0.75	
PM	2.80	± 0.75	
Thinking about taking time away from my family to exercise makes me feel bad about myself.	3.11	± 0.68	0.72
AM	3.12	± 0.67	
Mid	3.09	± 0.69	

PM	3.13	± 0.66	
Physical Self-Worth[a]			
Body Attractiveness			
I feel confident about the appearance of my body.	2.55	± 0.72	0.78
AM	2.55	± 0.71	
Mid	2.58	± 0.73	
PM	2.54	± 0.73	
Physical Condition			
I am confident in my level of physical conditioning and fitness.	2.43	± 0.75	0.80
AM	2.43	± 0.75	
Mid	2.46	± 0.76	
PM	2.42	± 0.75	
Lifestyle Self-Efficacy	66.35	± 36.47	0.46
AM	64.96	± 35.21	
Mid	66.63	± 39.63	
PM	67.37	± 34.38	
Physical Activity[b]			
Daily Activity Counts (Sum)	77215.92	± 38090.68	0.67
MVPA (min per day)	5.59	± 15.10	-
% of Days with ≥30 min MVPA	7.71	± 17.21	-

[a]Modified scaling used for EMA Survey. Global questionnaire summary measure is a sum, while EMA summary measure is an average

[b]Physical activity was defined as ≥4.0 METs as defined by published cutpoints for the GENEActiv accelerometer (Welch et al., 2010)

APPENDIX C

EMA SURVEY

EMA Test Phase Survey

Q1 What were you DOING right before you received the text message? (Choose your main activity)

- ❍ Reading/Computer (1)
- ❍ Watching TV/Movies (2)
- ❍ Eating/Drinking (3)
- ❍ Sleeping/Napping (4)
- ❍ Bathing/Hair/Makeup (7)
- ❍ Physical Activity/Exercising (5)
- ❍ Other (6)

Answer If What were you DOING right before you received the text me... Physical Activity/Exercising Is Selected

Q2 What type of PHYSICAL ACTIVITY/EXERCISE?

- ❍ Walking (e.g., outside, treadmill, track) (1)
- ❍ Running/Jogging (e.g., outside, treadmill, track) (2)
- ❍ Weightlifting/Strength Training (e.g., machines, free weights, body weight) (3)
- ❍ Using Cardiovascular Equipment (e.g., elliptical, StairMaster) (4)
- ❍ Group Fitness Class (e.g., step aerobics, Zumba, kickboxing) (5)
- ❍ Mind/Body (e.g., yoga, Pilates) (6)
- ❍ Other (7)

Answer If What were you DOING right before you received the text me... Other Is Selected

Q3 What was this OTHER activity?

- ❍ Talking/On the phone (1)
- ❍ Cooking/Chores (2)
- ❍ Riding in a car (3)
- ❍ Childcare/Helping children (4)
- ❍ Something else (5)

Answer If What was this OTHER activity? Something else Is Selected

Q4 Were you?

- ❍ Sitting (1)
- ❍ Standing (2)
- ❍ Walking (3)
- ❍ Jogging/Running (4)

Answer If TimeofDay Is Less Than 3

Q5 Using the scale listed below please indicate how confident you are RIGHT NOW that you will be able to be physically active TODAY. If you have complete confidence, choose 100%. If you have no confidence at all, choose 0%. If you have already been active today, choose "I was already active today." I will participate in physical activity at a moderate intensity for 30+ minutes today without quitting.

- ❍ 0% (1)
- ❍ 10% (2)
- ❍ 20% (3)
- ❍ 30% (4)
- ❍ 40% (5)
- ❍ 50% (6)
- ❍ 60% (7)
- ❍ 70% (8)
- ❍ 80% (9)
- ❍ 90% (10)
- ❍ 100% (11)
- ❍ I was already active today (12)

Answer If TimeofDay Is Equal to 3

Q6 Using the scale listed below please indicate how confident you are RIGHT NOW that you will be able to be physically active TOMORROW. If you have complete confidence, choose 100%. If you have no confidence at all, choose 0%. I will participate in physical activity at a moderate intensity for 30+ minutes TOMORROW without quitting.

- ❍ 0% (1)
- ❍ 10% (2)
- ❍ 20% (3)
- ❍ 30% (4)
- ❍ 40% (5)
- ❍ 50% (6)
- ❍ 60% (7)
- ❍ 70% (8)
- ❍ 80% (9)
- ❍ 90% (10)
- ❍ 100% (11)

Q7 The following is a statement which allows people to describe themselves. Please choice the item that best describes you. Which of the following statements is most true of how you feel RIGHT NOW?

- ❍ It is REALLY TRUE that I am dissatisfied with myself (1)
- ❍ It is SORT OF TRUE that I am dissatisfied with myself (5)
- ❍ It is SORT OF TRUE that I am satisfied with myself (2)
- ❍ It is REALLY TRUE that I am satisfied with myself (3)

Q8 Read the following statements carefully and decide if you strongly disagree (1), disagree (2), agree (3), strongly agree (4). RIGHT NOW. . .My knowledge about physical activity affects the way I feel about myself.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q9 RIGHT NOW. . . Thinking about exercising/physical activity makes me happy.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Answer If TimeofDay Is Less Than 3

Q10 RIGHT NOW. . . I feel it is important for me to take time to be physically active today.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Answer If TimeofDay Is Equal to 3

Q16 RIGHT NOW. . . I feel it is important for me to take time to be physically active tomorrow.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q11 RIGHT NOW. . . I feel I will be a better mother, wife, friend, and daughter if I take time to take care of myself.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q12 RIGHT NOW. . .I need to know I have friends or family to support my commitment to exercise in order to feel good about myself.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q13 RIGHT NOW. . . Thinking about taking time away from my family to exercise makes me feel bad about myself.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q14 RIGHT NOW. . .I feel confident about the appearance of my body.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

Q15 RIGHT NOW. . .I am confident in my level of physical conditioning and fitness.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Agree (3)
- ❍ Strongly Agree (4)

APPENDIX D

USABILITY SURVEYS

PILOT PHASE USABILITY SURVEY

Q1 Completing the Survey: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, I found the survey easy to complete. (1)	❍	❍	❍	❍	❍
Morning was a convenient time to complete the survey. (2)	❍	❍	❍	❍	❍
Afternoon (2-3pm) was a convenient time to complete the survey. (3)	❍	❍	❍	❍	❍
Evening was a convenient time to complete the survey. (4)	❍	❍	❍	❍	❍
Completing the survey 3 times per day was too much. (5)	❍	❍	❍	❍	❍
Completing the survey 2 times per day was too much. (6)	❍	❍	❍	❍	❍
The survey contained too many questions. (7)	❍	❍	❍	❍	❍
Each survey took too long to complete. (8)	❍	❍	❍	❍	❍
I did not mind completing the surveys for two	❍	❍	❍	❍	❍

consecutive weeks. (9)					
The survey was easy to read on my smartphone. (10)	❍	❍	❍	❍	❍
The survey questions were clear and understandable. (11)	❍	❍	❍	❍	❍
The text message prompts helped me to remember to take the survey. (12)	❍	❍	❍	❍	❍

Q2 Wearing the Activity Monitor: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, I found the activity monitor easy to wear. (1)	❍	❍	❍	❍	❍
I liked the placement of the activity monitor on my wrist. (2)	❍	❍	❍	❍	❍
Wearing the activity monitor during sleep was comfortable. (3)	❍	❍	❍	❍	❍
Wearing the activity monitor for 24 hours each day was too long. (4)	❍	❍	❍	❍	❍
It was easy to remember to press the event marker at bedtime and wake time. (5)	❍	❍	❍	❍	❍
I liked that I did not have to remove the activity monitor during water-based activities and bathing. (6)	❍	❍	❍	❍	❍
Responding to prompts AND wearing the activity monitor was inconvenient. (7)	❍	❍	❍	❍	❍

Q3 Completing the Log: Please rate your agreement with the following statement on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree". Overall completing the log was convenient.

- ❍ 1 (Completely Agree) (1)
- ❍ 2 (Somewhat Disagree) (2)
- ❍ 3 (Neither Agree nor Disagree) (3)
- ❍ 4 (Somewhat Agree) (4)
- ❍ 5 (Completely Agree) (5)

Q4 Completing the Log: Were any of the following were inconvenient? (mark all that apply)

- ☐ Recording bedtime (1)
- ☐ Recording wake time (2)
- ☐ Recording the times I did not wear the device (3)

Q5 Completing the Log: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree". Responding to prompts AND completing the log was inconvenient.

- ❍ 1 (Completely Disagree) (1)
- ❍ 2 (Somewhat Disagree) (2)
- ❍ 3 (Neither Agree nor Disagree) (3)
- ❍ 4 (Somewhat Agree) (4)
- ❍ 5 (Completely Agree) (5)

Q6 Other: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, responding to prompts, wearing the activity monitor, and completing the log was inconvenient. (1)	❍	❍	❍	❍	❍
I thought the compensation for this study was fair. (2)	❍	❍	❍	❍	❍
The incentive motivated me to respond to prompts. (3)	❍	❍	❍	❍	❍

Q7 Please provide us with any other comments you have to help us improve the prompts, the survey, and the procedures overall.

TEST PHASE USABILITY SURVEY

Q1 Completing the Survey: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, I found the mobile survey easy to complete. (1)	❍	❍	❍	❍	❍
The time I received the prompt in the morning was a convenient time to complete the survey. (13)	❍	❍	❍	❍	❍
The time I received the prompt in the afternoon (2-3pm) was a convenient time to complete the survey. (3)	❍	❍	❍	❍	❍
The time I received the prompt in the evening was a convenient time to complete the survey. (4)	❍	❍	❍	❍	❍
Completing the survey 3 times per day was too much. (5)	❍	❍	❍	❍	❍
The survey contained too many questions. (7)	❍	❍	❍	❍	❍
Each survey took too long to complete. (8)	❍	❍	❍	❍	❍
The effort required for completing the	❍	❍	❍	❍	❍

surveys was acceptable. (6)					
Completing the survey for 28 consecutive days was too much. (9)	❍	❍	❍	❍	❍
The survey was easy to read on my smartphone. (10)	❍	❍	❍	❍	❍
The survey questions were clear and understandable. (11)	❍	❍	❍	❍	❍
The text message prompts helped me to remember to take the survey. (12)	❍	❍	❍	❍	❍

Q2 Wearing the Activity Monitor: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, I found the activity monitor easy to wear. (1)	❍	❍	❍	❍	❍
I liked the placement of the activity monitor on my wrist. (2)	❍	❍	❍	❍	❍
Wearing the activity monitor during sleep was comfortable. (3)	❍	❍	❍	❍	❍
Wearing the activity monitor for 24 hours each day was too long. (4)	❍	❍	❍	❍	❍
The effort required for starting to use the activity monitor was acceptable. (8)	❍	❍	❍	❍	❍
Overall, the benefits of wearing the activity monitor outweighed my efforts to learn how to use it. (9)	❍	❍	❍	❍	❍
It was easy to remember to press the event marker at bedtime and wake time. (5)	❍	❍	❍	❍	❍

Responding to prompts AND wearing the activity monitor was inconvenient. (7)	❍	❍	❍	❍	❍
Given my experience wearing activity monitors, I feel certain about the answers I gave above. (6)	❍	❍	❍	❍	❍
Based on my exposure to wearable activity monitors, I am confident about my above assessments. (10)	❍	❍	❍	❍	❍
On the whole, wearing the activity monitor was valuable to me. (11)	❍	❍	❍	❍	❍

Q3 Completing the Log: Please rate your agreement with the following statement on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree". Overall completing the log was convenient.

- ❍ 1 (Completely Disagree) (1)
- ❍ 2 (Somewhat Disagree) (2)
- ❍ 3 (Neither Agree nor Disagree) (3)
- ❍ 4 (Somewhat Agree) (4)
- ❍ 5 (Completely Agree) (5)

Q4 Completing the Log: Were any of the following were inconvenient? (mark all that apply)

- ❑ Recording bedtime (1)
- ❑ Recording wake time (2)
- ❑ Recording the times I did not wear the device (3)

Q5 Completing the Log: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree". Responding to prompts AND completing the log was inconvenient.

- ❍ 1 (Completely Disagree) (1)
- ❍ 2 (Somewhat Disagree) (2)
- ❍ 3 (Neither Agree nor Disagree) (3)
- ❍ 4 (Somewhat Agree) (4)
- ❍ 5 (Completely Agree) (5)

Q6 Other: Please rate your agreement with the following statements on a scale of 1 to 5, with 1 meaning that you "Completely disagree" and 5 meaning that you "Completely agree".

	1 (Completely Disagree) (1)	2 (Somewhat Disagree) (2)	3 (Neither Agree nor Disagree) (3)	4 (Somewhat Agree) (4)	5 (Completely Agree) (5)
Overall, responding to prompts, wearing the activity monitor, and completing the log was inconvenient. (1)	❍	❍	❍	❍	❍
Knowing that I would receive feedback on my activity motivated me to respond to the prompts. (2)	❍	❍	❍	❍	❍
The incentive (chance to receive a $100 cash award) motivated me to respond to the prompts. (3)	❍	❍	❍	❍	❍

Q7 Please provide us with any other comments you have about completing the daily surveys and/or wearing the activity monitor.

APPENDIX E

PARTICIPANT WEAR LOG

GENEActiv Accelerometer

The GENEActiv is a monitor worn on your wrist to record your physical activity and sleep patterns. This handout provides some general information about how it works and how it should be used.



- **How to position the GENEActiv**
  The monitor should be worn like a watch on your **non-dominant** wrist.

- **How to wear the GENEActiv**
  The wristband should be snug enough to hold the monitor in place. Position the wristband so that the monitor faces upward (like a watch face). Do not position the monitor on the inside of your wrist.

- **When to wear the GENEActiv**
  The monitor should be worn throughout the entire 24-hour period, including the time you are sleeping, for the 7 consecutive days that you are assigned. This monitor **is waterproof,** so it can be worn when showering, bathing, or participating in any water activities.

- **Using the event marker to record bed and wake times**
  When getting into bed each night for the purpose of going to sleep, please press the face of the monitor firmly (directly over the printed numbers). If you read, watch television, etc. in bed before going to sleep, please wait **until you are ready to go to sleep** to press the monitor face. When getting up each morning for the purpose of being awake for the day, please press the face of the monitor firmly again. Similarly, when you wake up in the morning, please wait **until you are ready to get up for the day** to press the monitor face.

- **Cleaning the GENEActiv**
  You will probably not need to clean the monitor. However, if it gets dirty or becomes uncomfortable, it can be taken off briefly and be wiped off with a damp cloth.
- **Using the GENEActiv Log** (see other side):
  Please use the **GENEActiv Log** to record:
  - Any times you take off the monitor for more than 20 minutes. Please record the exact time of day, how long you did not wear the monitor, and the reason for not wearing the monitor.
  - The time you went to bed each evening and the time you woke up each morning. **(Also, please remember to press the monitor face at bedtime and waketime!)**
  - **Please bring your completed log with you to your next appointment.**

GENEActiv LOG

PLEASE RECORD ANY TIMES DURING WHICH YOU WERE NOT WEARING YOUR GENEActiv FOR AT LEAST 20 MINUTES. PLEASE ENTER THE **EXACT** TIME AND ONE OF THE FOLLOWING CODES:

1 - BATHING/SHOWERING 2 – SWIMMING/WATER ACTIVITIES 3 – FORGOT 4 – OTHER

Date **Time**	**Week 1** **Day you receive monitor** Bedtime: _____	Waketime _____ Bedtime: _____	Waketime _____ Bedtime: _____	Waketime _____ Bedtime: _____	Waketime _____ Bedtime: _____	Waketime: _____ Bedtime: _____	Waketime _____ Bedtime: _____	Waketime _____ Bedtime: _____	Waketime _____ Bedtime: _____
12:00 am									
01:00 am									
02:00 am									
03:00 am									
04:00 am									
05:00 am									
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APPENDIX F

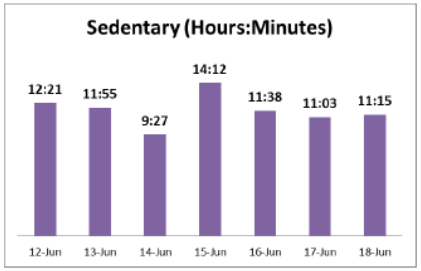
EXAMPLE PARTICIPANT HANDOUT

Physical Activity Summary for Participant: Sample

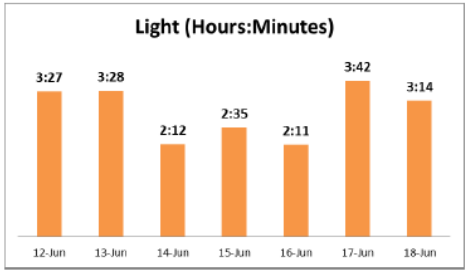
GENEActiv

Monitoring Your Health Behaviors: Tracking your Physical Activity

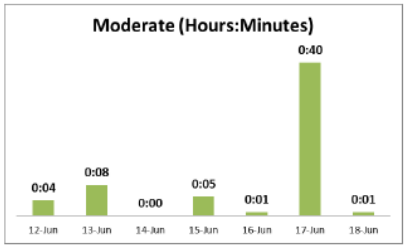
The Centers for Disease Control and Prevention (CDC) recommend that adults limit their sedentary activity and get at least **150 minutes of moderate-intensity activity** OR **75 minutes of vigorous-intensity activity every week** to reduce the risk of chronic diseases (heart disease, cancer, and diabetes). The following provides a breakdown of the activity you completed each day last week:



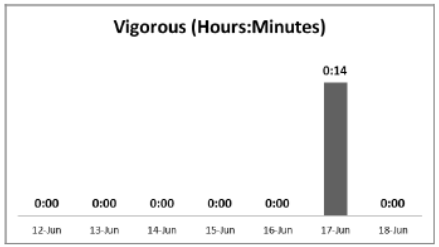
What are sedentary activities? Sedentary activities are those that cause no change in your resting heart rate. Most sedentary activities involve being seated for a long period of time. Examples include: watching a movie on the couch, eating dinner, sitting on the light rail, or sitting at a desk browsing the web.



What are light activities? Light activities are those that are difficult enough to get your heart rate up, but not quite difficult enough to break a sweat. These activities are similar to everyday activities and may include: walking around the house or work, leisure walks around the neighborhood, making dinner, or getting the kids ready for school.



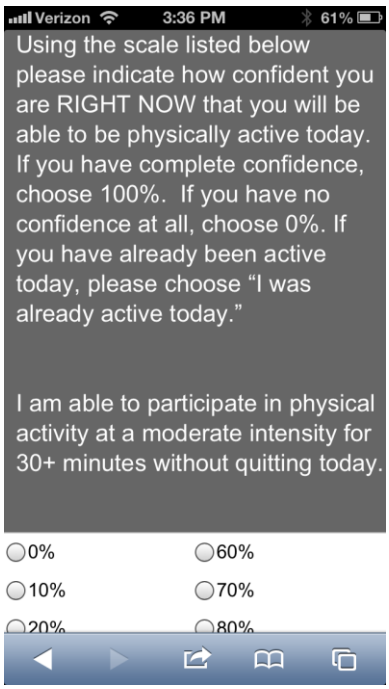
What are moderate-intensity activities? Moderate-intensity activities are those that are difficult enough to increase your heart rate and break a sweat. Moderate activities may include going for a brisk walk, doing water aerobics, riding a bike with a few hills, or even mowing the lawn.

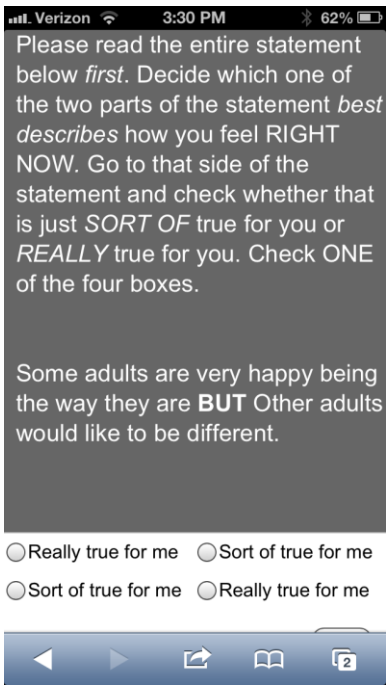


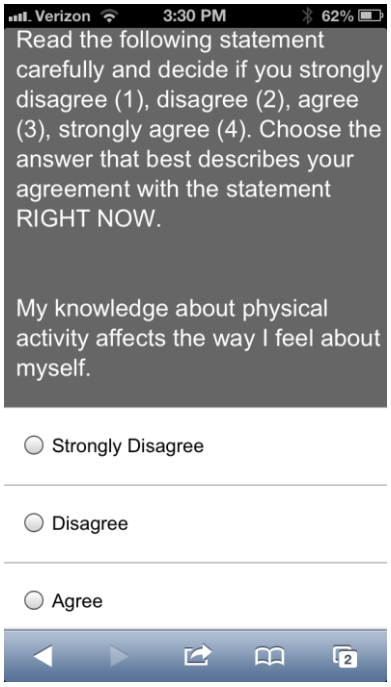
What are vigorous-intensity activities? Vigorous-intensity activities are those that make you breathe more heavily and raise your heart rate substantially. Vigorous activities may include jogging, running, swimming laps, playing basketball, or riding a bike fast or on hills.

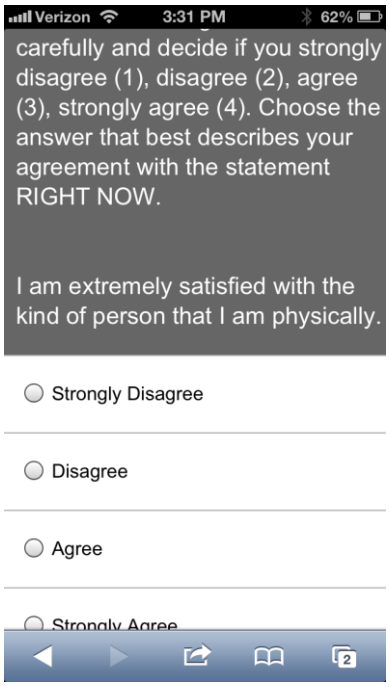
APPENDIX G

QUALTRICS INTERFACE EXAMPLES


Verizon 3:36 PM 61%
Using the scale listed below please indicate how confident you are RIGHT NOW that you will be able to be physically active today. If you have complete confidence, choose 100%. If you have no confidence at all, choose 0%. If you have already been active today, please choose "I was already active today."
I am able to participate in physical activity at a moderate intensity for 30+ minutes without quitting today.
0%
10%
20%
60%
70%
80%


Verizon 3:30 PM 62%
Please read the entire statement below *first*. Decide which one of the two parts of the statement *best describes* how you feel RIGHT NOW. Go to that side of the statement and check whether that is just *SORT OF* true for you or *REALLY* true for you. Check ONE of the four boxes.
Some adults are very happy being the way they are **BUT** Other adults would like to be different.
Really true for me
Sort of true for me
Sort of true for me
Really true for me


Verizon 3:30 PM 62%
Read the following statement carefully and decide if you strongly disagree (1), disagree (2), agree (3), strongly agree (4). Choose the answer that best describes your agreement with the statement RIGHT NOW.
My knowledge about physical activity affects the way I feel about myself.
Strongly Disagree
Disagree
Agree


Verizon 3:31 PM 62%
carefully and decide if you strongly disagree (1), disagree (2), agree (3), strongly agree (4). Choose the answer that best describes your agreement with the statement RIGHT NOW.
I am extremely satisfied with the kind of person that I am physically.
Strongly Disagree
Disagree
Agree